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Direct Transcutaneous Electroneurostimulation of Median Nerve Leads to an Improvement of Bioelectrical Activity of the Brain in Patients with Insomnia

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Research Note

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Abstract

Objective: To study the dynamics of bioelectric activity of the brain in patients with Insomnia after treatment by direct transcutaneous electroneurostimulation (TENS) of the right median nerve. Materials and methods: 19 patients with insomnia accompanied by increased slow EEG activity were studied. All patients showed signs of an increased theta activity index in the posterior and parietal regions. The theta activity index exceeded 25% and averaged 38%. All patients underwent direct transcutaneous electroneurostimulation of the right median nerve (TENS). 10 patients were managed by Low-frequency High-amplitude TENS (1 Hz, 200 mcs, 15 mA). 9 patients underwent a course of high-frequency low-amplitude TENS (100 Hz, 100 mcs, 5 mA). Results: Theta activity index decreased in patients who underwent a course of low-frequency high-amplitude TENS by an average of 39%. In patients after high-frequency low-amplitude TENS, indicators of slow activity did not significantly change. A decrease in the severity of paroxysms of slow activity was also noted against the background of low-frequency and high-amplitude TENS. Conclusion: The low-frequency high-amplitude TENS, in contrast to the high-frequency low-amplitude TENS, can improve the EEG indices in patients with insomnia. This improvement is manifested by a significant decrease in the index of theta activity in the posterior and parietal regions and a decrease in the severity of paroxysmal activity of the theta rhythm. Keywords: EEG, TENS, Insomnia, high frequency low amplitude, Low frequency high amplitude, theta rhythm.

Keywords: Neuroexpeditor; Cubital Fossa

Abbreviations: TENS: Transcutaneous Electroneurostimulation.

Introduction

Primary insomnia is sleeplessness or the perception of poor quality sleep that is not caused by medical or psychiatric diseases, conditions, genetics, or illnesses; or environmental causes, such as drug abuse, medication, shift-work [1]. In some works, results are indicated on the effective use of EEG for the study of insomnia [2-5]. By EEG was found that even during the deepest stage of sleep, sensory and sensorimotor areas in insomnia subjects may still be relatively active compared to control subjects and to the rest of the sleeping brain [6]. Increase in the EEG rhythm is a marker of high brain activity that leads to high degrees of consciousness, while slow waves are suggestive of less brain activity. The pattern of EEG rhythm can be an indicator of some mental disorders [3]. Eelectrosleep or treatment of insomnia by microcurrent electrotherapy is known as a new alternative method for insomnia treatment from the 1970s [7]. Recently another methods and modification of electrotherapy are used like transcutaneous electroneurostimulation (TENS) [6,8-11].

Objective

To study the dynamics of bioelectric activity of the brain in patients with Insomnia after treatment by direct transcutaneous electroneurostimulation (TENS) of the right median nerve.

Materials and Methods

19 patients with insomnia accompanied by increased slow EEG activity were studied. Patients were between 20 and 40 years old. All patients showed signs of an increased theta activity index in the posterior and parietal regions. Registration was carried out using ipsilateral ear referential montage. The theta activity index exceeded 25% and averaged 38%. All patients underwent direct transcutaneous electroneurostimulation of the right median nerve (TENS). 10 patients were managed by Low-frequency High-amplitude TENS (1 Hz, 200 mcs, 15 mA). 9 patients underwent a course of high-frequency low-amplitude TENS (100 Hz, 100 mcs, 5 mA) [2-5].

Methods of Treatment

TENS combined with pharmacotherapy. Median nerve was stimulated by monophasic and square form of electrical impulses. Characteristics of TENS are shown in Table 1.

	Frequency	Duration	Amplitude
high-frequency low amplitude TENS	100Hz	100 μ s	15mA
low-frequency high amplitude TENS	1Hz	200 μ s	5mA

Table 1: Characteristics of TENS.

Stimulation Technique

Low-frequency high-amplitude TENS was used by 2 methods (Figure 1). In the first method, the cathode was fixed over the right median nerve at the level of the cubital fossa, and the anode was not fixed and moved along the nerve from the proximal direction to the distal one every 10 cm. Stimulation at each point was carried out for 20 seconds. The pause between each point and the next was 5 seconds. Nerve stimulation according to this technique was repeated 3 times. In the second method, the cathode was fixed over the right median nerve in the projection of the carpal canal, and the anode was moved from the 1st toe to the 2nd and to the 3rd. In this case, the stimulation of each finger was 20 seconds. The pause between stimulation points is 5 seconds. Number of repetitions 3.

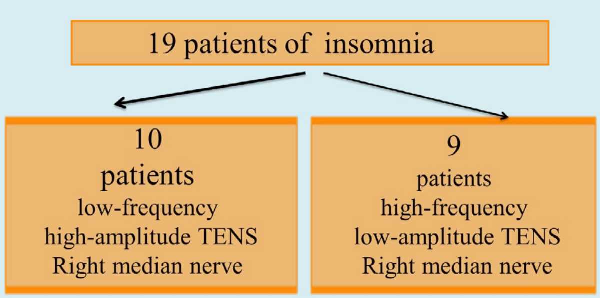

Figure 1: Distribution of Patients into Groups.

In High-frequency low-amplitude TENS, stimulation of the right median nerve was used 2 methods and they carried out, as well as in using of low-frequency high-amplitude TENS. The difference between low-frequency high amplitude TENS and high-frequency low-amplitude TENS techniques is the fixation of electrodes. Anode was fixed at the level of the cubital fossa in the first method and in the projection of the carpal canal in the second methods, and the cathode, not the anode, was moved along the nerve [6,8-11] (Figure 2).

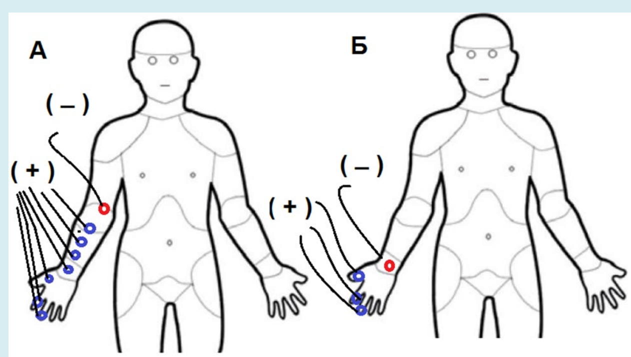

Figure 2: Technique of direct stimulation of the right median nerve. This figure shows 2 stimulation methods. In the first method (A), the cathode (red circle) is fixed at the level of the cubital fossa, and the anode (blue circles) is moved along the nerve. In the second method (B), the cathode (red circle) is fixed above the carpal canal, and the anode (blue circles) is moved from the 1st to the 2nd and to the 3rd fingers (explanation in the text).

The questionnaire of subjective assessment of sleep disorders was used to assess the severity of insomnia disorders, indicated in Table 2. The number of points in all patients was below 18 points and averaged 15 ± 3.9 points, which indicates a subjectively poor quality of sleep.

Subjective assessment of sleep quality	From 1 to 5 points
Duration of falling asleep	
Sleep duration	
Number of awakenings	
Sleep quality	
Number of dreams	
Quality of morning awakening	
Total points	

Table 2: Subjective assessment of sleep quality.

The assessment was carried out on a 5-point rating scale, where the minimum values corresponded to rough manifestations. At the bottom of the table, the total number of points is calculated. The total score values <18 indicate subjectively poor sleep quality,> 22 - about good sleep quality, within 18-22 points - about borderline sleep quality. Electroencephalogrphy was performed before and after treatment on a multifunctional computerized device "Neuroexpeditor" according to TU 9441-023-42882497-2009 with registration number FSR 2010/07889 dated 19.12.2017. Also, in several patients, TENS was performed under EEG control.

Results

Theta activity index decreased in patients who underwent a course of low-frequency high-amplitude TENS by an average of 39%. In patients after high-frequency low-amplitude TENS, indicators of slow activity did not significantly change. A decrease in the severity of paroxysms of slow activity was also noted against the background of low-frequency and high-amplitude TENS with the absence of such dynamics after the application of high-frequency low-amplitude TENS.

EEG monitoring during electrical stimulation has shown a decrease in theta rhythm index and an increase in the alpha rhythm representation a few minutes after low-frequency high-amplitude TENS (Figure 3).

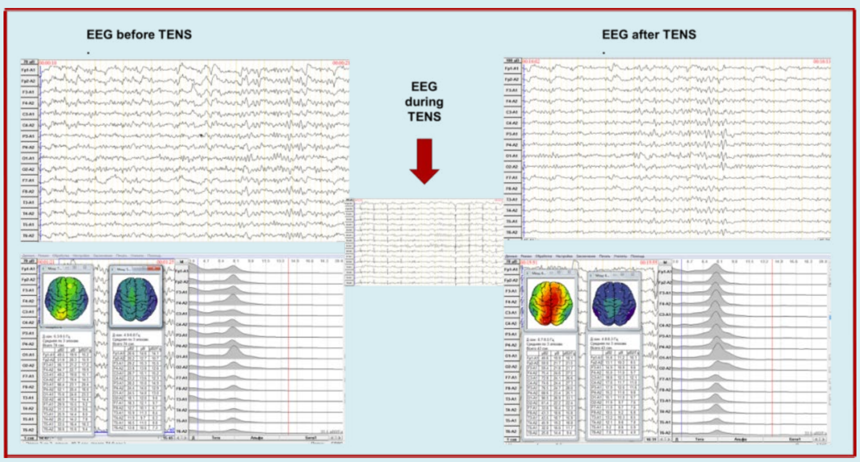

Figure 3: low-frequency high-amplitude TENS controlled by EEG. Left: EEG before TENS. Right: EEG after TENS. In the middle EEG during TENS.

The subjective assessment of sleep quality improved on average by 45% in 6 patients who underwent a course of low-frequency and high-amplitude TENS and in 2 patients after using high-frequency low-amplitude TENS. An improvement in the quality of sleep by 20% was observed in 2 patients after the application of low-frequency high-amplitude TENS and in 3 patients after high-frequency-low-amplitude TENS. Sleep quality was found to be without significant dynamics in 2 patients after low-frequency high-amplitude TENS and in 4 patients after high-frequency low-amplitude TENS.

Conclusion

The low-frequency high-amplitude TENS, in contrast to the high-frequency low-amplitude TENS, can improve the EEG indices in patients with insomnia. This improvement is manifested by a significant decrease in the index of theta activity in the posterior and parietal regions and a decrease in the severity of paroxysmal activity of the theta rhythm. Direct stimulation of the right median nerve with low-frequency high-amplitude TENS contributed to a significant improvement in sleep quality in 60% of patients by 45%

and in 20% by 20%. At the same time, high-frequency low-amplitude TENS improved the quality of sleep in 20% of patients by 45% and in 30% of patients by 20%.

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