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# Effects of Transcranial Galvanic Stimulation on Post Stroke Depression

## ABSTRACT

**Introduction:** Transcranial galvanic stimulation (TGS), a non-invasive method in modulation of cortical excitability, shows potentially positive effects on post stroke depression (PSD).

**Aim of the Study:** The aim of this study was to estimate the effects of transcranial galvanic stimulation on post-stroke depression in patients after acute stroke.

**Patients and Methods:** The study group (N=11) received TGS and conventional physical and occupational therapy. All patients were stimulated with transcranial galvanic stimulation for 20 minutes with 1mA current intensity, once a day for two weeks (five days a week). The Beck Depression Inventory was applied to score the depression levels in patients before and after the intervention.

**Results:** Application of TGS therapy, along with a conventional rehabilitation treatment entailed a statistically significant decrease in the level of depression in our group of patients. There was no statistically significant difference regarding depression in relation to gender, localization and type of stroke.

**Conclusion:** The study has confirmed that the application of transcranial galvanic stimulation during stroke rehabilitation improves the depression symptoms in patients.

**Key words:** Transcranial Galvanic Stimulation, Post Stroke Depression

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## Introduction

Transcranial galvanic stimulation (TGS), a non-invasive method in modulation of cortical excitability, shows potentially positive effects on post stroke depression (PSD). PSD occurs in about 40% of patients with stroke and is associated with cognitive failure, slowing down of recovery of motor and daily activities, prolonged hospitalization period and increased mortality rate. It is defined as a depressive disorder that occurs after acute focal cerebrovascular events and in the presence of clinical signs of apparent stroke. This mental disorder is one of the key factors in the rehabilitation process and the main negative prognostic factor for the quality of life after a stroke.

Typical symptoms are reduced mood, loss of interest and satisfaction, reduced energy, increased fatigue and reduced participation in activities. Pharmacological treatment is often limited by side effects, pharmacological interactions and severe outcome in elderly patients. As an alternative, TGS may be a very useful treatment for such conditions. Although studies show modest significance of those effects, neurorehabilitation leads to reduction of functional disability measured by index of daily life activities.<sup>1</sup>

Neurorehabilitation studies have many limitations such as heterogeneity of impairments and disabilities, poorly defined rehabilitation treatments, lack of randomization process and absence of sensitive monitoring parameters.<sup>2</sup>

Generally speaking, recovery, especially during the first weeks after stroke, is a reflection of changes in neurotransmission that occurs due to the recovery of hemodynamics and metabolic factors in the zone of neurologic lesion. After stroke, hypo-activation in cortical and subcortical area occurs thus correlating with the onset of neuropsychological symptoms such as depression, aphasia and neglect. The possibility that transcranial non-invasive stimulation methods induce selective modulation of neural circles and systems has brought about their use in therapy.

TGS is a non-invasive method used for modulation of cortical excitability by direct application on brain structures.<sup>3</sup> The method is cheap and simple, and unlike epidural stimulation, it is completely non-invasive.<sup>4</sup>

Methods of non-invasive transcranial neuromodulation have a long history, but only in the past decades, there has been some significant progress in terms of technical methodology and understanding of physiological mechanisms. Compared to surgical methods, non-invasiveness is an apparent advantage, and compared to pharmacotherapeutic methods, the advantage is

functional selectivity of stimulation.<sup>5</sup>

The primary result of TGS is that there is a change of potential in brain neurons of corticospinal system so that in the anode stimulation there is an increase of cortical excitability, and in the cathode stimulation, there is a decrease of cortical excitability.<sup>6</sup>

Stimulation lasting more than 5 minutes can induce significant "after" effects that can last for a few hours. The facilitating effects of TGS may be also used to improve the mood in healthy people,<sup>7,8</sup> thus making it possible to treat people who suffered from stroke.

Beck's Depression Inventory (BDI) is one of the most commonly used instruments for testing the intensity of signs of depression in the clinical and general population. BDI was developed in 1974 (Beck et al., 1974), and since then, in an unchanged form, it has showed continuously good psychometric characteristics. It has its applicability and usefulness, not only in research but also in practical - clinical domain.

## Aim of the Study

The aim of this study was to estimate the effects of transcranial galvanic stimulation on post-stroke depression in patients after acute stroke.

## Patients and Methods

The study included eleven patients with post stroke depression. Each patient was previously given a detailed description, and shown the protocol and device. Each of them had to submit the written consent in accordance with the Helsinki Declaration. The study was conducted in Rehabilitation Clinic "Dr Miroslav Zotović" Banja Luka in January and February, 2018.

The stroke diagnosis was confirmed by neuroradiologic diagnostics NMR or CT Scan. All examinees were examined by specialists in neurology who had 10 years of experience in neurological rehabilitation. Inclusion criteria were: depression after stroke which occurred in the past 3 months, capability to understand simple instructions; minimal active mobility. Non-inclusion criteria were: severe sensory deficits; severe accompanying illnesses, presence of metal in endocranium and epilepsy. Besides monitoring parameters, demographic data (gender, age) and information regarding the stroke (localization and type of lesion) were recorded.

The study group was consisted of patients with moderate to severe depression who were measured with Beck's depression level above 20. The TGS protocol was achieved

by the clinical standard device- The Soterix Medical tDCS 1x1 CT system, USA. Respecting the International 10-20 system, the anode was placed on the left dorsolateral prefrontal cortex (DLPFC) while the cathode was positioned on the right supraorbital area.

All patients were stimulated by TGS for 20 minutes with 1mA current intensity, once a day for two weeks (five days a week). They carried out conventional physical and occupational therapy, each in duration of forty-five minutes per day. The monitoring parameters were taken at the beginning and at the end of the treatment. The significance indifference between scores measured before and after treatment was determined with the use of paired t-test. The statistical significance level (p) was set at 0.05.

## Results

The treatment group consisted of 6 men and 5 women, 7 patients had left sided hemiparesis, while 4 patients had right-sided hemiparesis. The cause of stroke was cerebral infarction in 8 patients and cerebral hemorrhage in 3 patients. The average age of the patients was  $59.2 \pm 10.4$  (Table 1).

**Table 1. The general characteristics of the subjects (N=11)**

Gender	Male	6	54.5%
	Female	5	45.5%
Age (years)	$59.2 \pm 10.4$		
Paretic side	Left	7	63.6%
	Right	4	36.4%
Cause of disease	Cerebral infarction	8	72.7%
	Cerebral hemorrhage	3	37.3%

The depression level in patients according to BDI before TGS therapy was  $32.2 \pm 3.6$  (the level of severe depression 30-40) and it significantly decreased to  $21.8 \pm 4.2$  (moderate depression) after TGS treatment intervention (Table 2). There was no statistically significant decrease in depression in relation to gender, localization and type of stroke.

**Table 2. The changes in depression after TGS**

	Before TGS	After TGS
Depression	$32.2 \pm 3.6$	$21.8 \pm 4.2$

\* $p < 0.05$

## Discussion

Our results in a small sample of patients show that the therapeutic intervention of TGS significantly reduces the level of depression in patient with PSD. Previous studies regarding the effectiveness of TGS in clinical rehabilitation practice have pointed to heterogeneity of examined population, small samples of examinees and non-standardized methodology of monitoring.

The results of studies on the TGS use presented in meta-analyses show that generalization on effectiveness cannot be done because the parameters of monitoring are not the same, and the TGS method can be very different depending on duration and place of stimulation.

The sample does not include a large number of patients as these patients are hardly recruited due to a dominant interest in motor deficit while depression symptoms are often neglected. Furthermore, these patients can hardly be included in the treatment because they seem not to be interested.<sup>9</sup>

The biological way of looking at PSD was most prominent in the research of Robinson and his associates (Johns Hopkins University, USA) who first described the significant association of PSD with lesions in the left frontal lobes and left-sided in the basal ganglia.<sup>10</sup>

The results of this study correspond to the study of Valiengo and associates who observed the effects of TGS in forty eight patients with PSD and without antidepressants in therapy. After 6 weeks of TGS administration in the regimen, one procedure per week produced a statistically significant reduction in depression scores in the experimental group. This study has several significant limitations such as a small sample size that does not allow generalization, absence of a control group and existence of uncontrolled external effects on depression in the observed patients.<sup>11</sup>

Due to all these reasons, further studies are needed on a larger number of patients and randomized control groups for the definitive confirmation of the efficacy of TGS in the treatment of depression after stroke. TGS is a promising therapeutic tool in the treatment of stroke due to the ease of application, accessibility and minimal side effects of the method.

## Conclusion

The application of transcranial galvanic stimulation in patients during stroke rehabilitation may decrease the depression symptoms.

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# Efekti transkranijalne galvanske stimulacije na depresiju nastalunakon moždanog udara

## SAŽETAK

**Uvod:** Transkranijalna galvanska stimulacija je neinvazivni metod u modulaciji kortikalne ekscitabilnosti i pokazuje potencijalno pozitivne efekte na depresiju nakon moždanog udara.

**Cilj rada:** Cilj ove studije je procjena efekata dejstava transkranijalne galvanske stimulacije (TGS) na pacijente sa znacima depresije nastale nakon preživljenog akutnog moždanog udara.

**Ispitanici i metode:** Pacijenti u studijskoj grupi (N=11) su sproveli terapiju transkranijalne galvanske stimulacije uz konvencionalnu fizikalnu i radnu terapiju. Svi su stimulisani transkranijalnom galvanskom stimulacijom u trajanju od 20 min, intenzitetom struje od 1mA, jednom dnevno, dvije sedmice, (pet dana sedmično). Bekova skala depresivnosti je primjenjena u određivanju stepena depresivnosti kod pacijenata prije i nakon tretmana.

**Rezultati:** Primjena terapije transkranijalne galvanske stimulacije uz konvencionalni rehabilitacioni tretman je imala za posljedicu statistički značajno umanjenje depresivnosti u našoj grupi pacijenata. Nije bilo statističke značajnosti u padu depresivnosti vezano za pol, lokaciju i tip moždanog udara

**Zaključak:** Studija ukazuje da primjena transkranijalne galvanske stimulacije na pacijente u toku rehabilitacije moždanog udara može umanjiti simptome depresivnosti.

**Ključne riječi:** Transkranijalna galvanska stimulacija, depresija nakon moždanog udara