fortune Journals

ARCHIVES OF CLINICAL AND BIOMEDICAL RESEARCH

ISSN: 2572-5017

Research Article

Application Value of Transcranial Direct Current Stimulation in Stroke Patients

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Abstract

Objectives: The main objective of the study is to analyze the application value of transcranial direct current Stimulation (TDCS) in stroke patients.

Material and Methods: This pilot study was conducted in Rawal Institute of Health Sciences during June 2019 to June 2020. The components required for TDCS include a Constant Current Stimulator and surface electrodes soaked in normal saline. A Constant Current Stimulator provides a steady flow of direct current (e.g., 0–4mA) while constantly monitoring the resistance in the system.

Results: The study was completed by 136 patients. Their mean age was 53.2 ± 8.4 years (range: 36–61 years). There were more males than females (60% vs. 40%). Their demographic and clinical characteristics are summarized in table 1.

Conclusion: It is concluded that TDCS combined with VR can reduce motor impairment, improve function, increase ADL in the affected upper limb in patients with subacute or chronic ischemic stroke than VR alone.

Introduction

Poststroke consequences including sensorimotor and cognitive impairments impose a stressful situation and a great burden to the victims, their families, and the society. Indeed, stroke is one of the leading causes of adult disability in the western world [1]. Among extensive efforts devoted to the search for more effective rehabilitation therapies of stroke, the idea of using electricity can be traced back almost a century ago [2]. After diminished interest due to mixed results, recent studies with promising results regained the interest in the application of mild electrical currents to the brain as a potential therapy for neurological disorders [3]. Research by Priori and Nitsche and colleagues led to the development of a technique consisting of the application of weak electrical currents through the scalp, which is now called transcranial direct current stimulation (tDCS). Recent findings suggest that tDCS may be beneficial in a wide range of disorders such as epilepsy, Parkinson's disease, chronic pain, depression, drug cravings, pain conditions such as fibromyalgia, and traumatic spinal cord injuries [4]. Over the past few years, the potential therapeutic benefit of tDCS for improvement of cerebral function after stroke has also been reported. Nevertheless, more evidence is needed in order to consider tDCS as a standard therapeutic technique to help patients with stroke and other brain disorders [5]. Stroke is a severe central nervous system disease caused by cerebral ischemia or hemorrhage. Stroke often causes multiple health problems, such as decreased muscle strength, impaired proprioceptive capabilities, and impaired cognitive function [6]. These sensorimotor deficits

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Citation: Usman Haq, Alishba Aftab, Mohammad Hamza Bin Abdul Malik, Ali Haq, Muhammad Awais Bin Abdul Malik, Amna Rashid. Application Value of Transcranial Direct Current Stimulation in Stroke Patients. Archives of Clinical and Biomedical Research 6 (2022): 813-816.

Received: September 20, 2022
Accepted: September 28, 2022
Published: October 05, 2022

will further affect the balance and postural control of stroke patients, which is the key to keeping the body upright and stable in different environments and conditions [7]. Nearly 80% of stroke patients cannot successfully maintain balance and execute postural control. Another study has shown that 38% of stroke patients are still nonambulatory at 6 months after onset. These patients show weight-bearing asymmetry toward the nonparetic leg, increased postural swing, abnormal joint movement, and cannot adjust their posture [8]. Besides, chronic stage stroke can also limit walking ability recovery and increase the risk of falling. Therefore, the recovery of balance and postural control is essential for patients to improve their activities of daily living, quality of life and prevent fall events after stroke. Novel therapies that aim to prevent infarct growth (IG) until successful recanalization occurs, so-called penumbra freezing, hold potential as adjunct to thrombolysis and thrombectomy in acute stroke [9]. Major contributors to IG include waves of peri-infarct depolarizations and cortical spreading depression. Cathodal transcranial direct current stimulation (C-tDCS) is a noninvasive neurostimulation method where application of a weak electrical current to the scalp modulates excitability of underlying cortical neurons [10]. Changes in cortical neurons firing rate under polarizing currents are well established, and inhibitory effects of C-tDCS on motor cortex are documented in rodents and humans [11].

Objectives

The main objective of the study is to analyze the aapplication value of transcranial direct current Stimulation (TDCS) in stroke patients.

Material and Methods

This pilot study was conducted in Rawal Institute of Health Sciences during June 2019 to June 2020.

Inclusion Criteria

Inclusion criteria were adult (>18 years of age) patients with nonlacunar acute ischemic stroke in the MCA territory documented by magnetic resonance imaging (MRI), with National Institutes of Health Stroke Scale (NIHSS) score between 4 and 25, and eligible for intravenous thrombolysis (IVT).

Exclusion Criteria

Contraindications to MRI, presence of forehead skin damage, history of intracranial surgery, impaired consciousness, and known pregnancy. To adjust to changes in practice, 2 amendments were subsequently adopted to include all patients with MCA territory stroke eligible for a revascularization procedure, without limitations regarding admission NIHSS score.

Components for TDCS

The components required for TDCS include a Constant Current Stimulator and surface electrodes soaked in normal saline. A Constant Current Stimulator provides a steady flow of direct current (e.g., 0 – 4mA) while constantly monitoring the resistance in the system. Saline soaked electrodes applied and secured onto the scalp over desired areas such as the left or right precentral gyrus region (corresponding to C3 or C4 of the International 10–20 EEG system) form terminals relaying currents across the scalp and through the underlying brain tissue. The direction of the current flow determines the effects on the underlying tissue [12]. With an active electrode over C3 or C4, a reference electrode over a control region (e.g., supraorbital region) and current flowing from the active to the reference electrode, the excitability of the brain tissue under the anodal electrode is increased and when the current flow is reversed, the excitability of the brain tissue under this electrode is decreased [13-14].

Advantages of TDCS

The advantages of TDCS over other non-invasive brain stimulation methods include its ease of use, its large electrode size allowing influence over a larger neural network, a sham mode allowing controlled experiments and randomized controlled clinical trials, and its portability making it possible to apply stimulation while the patient receives occupational/physical therapy. Nevertheless, TDCS is limited by its poor temporal resolution and anatomical localization. Furthermore, inter-individual variation in conductivity due to differences in hair, scalp, and bone composition can interfere with the current that is carried to the brain. Last but not least, although single sessions and multi-day sessions have been done and found to be safe, the safety of prolonged periods of stimulation requires further studies [15-17].

Results

The study was completed by 136 patients. Their mean age was 53.2 ± 8.4 years (range: 36-61 years). There were more males than females (60% vs. 40%). Their demographic and clinical characteristics are summarized in table 1.

Results of the experimental group and the control group that were recorded before and after treatment. There was no significant difference in FM-UE, ARAT, and BI at baseline between the 2 groups.

Our study is consistent with a prior study led by Lee and Chun who also investigated the effect of c-tDCS combined with VR on upper limb motor function in patients with subacute stroke [18]. The improvement of Manual Function Test (c-tDCS+VR group VS VR group, $p<0.01$) and FM-UE scores(c-tDCS+VR group VS VR group, $p<0.01$) in the combined treatment group was significantly higher than that in the VR group, but there was no significant difference in the Korean-Modified Barthel Index scores [19-20].

Patient characteristics	Frequency n (%)
Age in years	
Mean SD	53.2 ± 8.4
Less than 40	42 (30.9%)
40 or more	94 (69.1%)
Gender	
Male	81 (59.6%)
Female	55 (40.4%)
Risk factors	
Hypertension	81 (59.6%)
Smoking	57 (49.3%)
Obesity	54 (39.7%)
Hba1c	
Less than 10%	54 (39.7%)
10% or more	82 (60.3%)

Patient characteristics	Functional outcome		P value
	Poor (n=94)	Good (n=42)	
Age in years			
Less than 40	14 (14.9%)	28 (66.7%)	0
40 or more	81 (86.2%)	13 (30.9%)	
Gender			
Male	53 (56.4%)	28 (66.7%)	0.12
Female	42 (44.7%)	13 (30.9%)	
Risk factors			
Hypertension	68 (72.3%)	13 (30.9%)	0
Smoking	54 (57.4%)	14 (33.3%)	0.01
Obesity	40 (42.5%)	14 (33.3%)	0.24
Hba1c			
Less than 10%	26 (27.6%)	28 (66.7%)	0
10% or more	69 (73.4%)	13 (30.9%)	

Conclusion

It is concluded that TDCS combined with VR can reduce motor impairment, improve function, and increase ADL in the affected upper limb in patients with subacute or chronic ischemic stroke than VR alone.

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