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[ORIGINAL ARTICLE]

Immediate Effect of Transcranial Direct Current Stimulation (tDCS) on Balance in Patients with Chronic Stroke.

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ABSTRACT :

Background: It is necessary to explore options for improving Balance, which is a critical component of function, in a short period low-frequency, Transcranial direct current stimulation (tDCS) is a form of neuro-stimulation that uses constant, non-invasive, low-frequency current delivered via electrodes on the scalp. Balance retraining in patients with chronic Stroke is a challenging task due to the adaptation of a particular behavior in these patients.

Methodology: An Experimental study was carried out on 20 patients with chronic Stroke in which tDCS was applied with the patient in sitting, an anode electrode was placed over the ipsilateral hemisphere, and the cathode was placed above the contralateral hemisphere of the Stroke. The stimulation intensity was set to 2 mA for 30 minutes with a current density of 0.07 C/cm2. Pre- and post-static leg standing balance was assessed using Bobo Master in Accuracy and weight bearing on the forefoot and hind foot in the form of a percentage.

Results: There was a significant difference in the pre and post-test values of Accuracy of weight bearing distribution (t=3.211), Affected Forefoot (t= 0.7830), Affected Hindfoot (t= 0.3344) Non-Affected Forefoot (t=1.595) & Non-Affected Hindfoot (t=0.01169) with $p<0.05$.

Conclusion: There is an immediate effect of tDCS on balance parameters in patients with chronic Stroke, which shows that the body can make appropriate changes despite the longer duration of the condition.

Keywords: tDCS, Balance, Bobo master, Stroke.

Introduction

Stroke is the leading cause of disability, which requires rehabilitation. A clot is defined as obstruction or restriction of blood supply to the brain, usually because a blood vessel supplying the brain is burst or blocked by a clot, causing damage to the brain's cells. This, in turn, may result in physical and/or mental disabilities. Balance Stroke causes much impairment, including motor deficits, loss of voluntary movement, and changes in muscle tone, which reduces Balance and alters gait. Even postural symmetry is altered, which alters the center of pressure (C.O.P.). There is more weight bearing on the unaffected side than the affected side, so the individual cannot balance properly [4].

Transcranial direct current stimulation (tDCS) was developed in humans by Priori in 1998 and by Nitsche and Paulus in 2000. The latter authors showed that, when applied over the motor cortex, tDCS modifies cortical excitability depending on the polarity used. When the anode is placed over the motor cortical area to be stimulated and the cathode above the contralateral eye, tDCS (thus termed anodal) increases cortical excitability, both during and following the stimulation, as demonstrated by an increase in the amplitude of the motor-evoked potential (M.E.P.) generated by T.M.S. Conversely, when the cathode is placed over the motor cortical area to be stimulated and the anode is above the contralateral eye, cortical excitability is reduced. Moreover, the effects of tDCS persist after stimulation (named post-effects). The duration of the post-effects depends on the duration and intensity of the stimulation.

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Furthermore, tDCS is safe, easy to use, well tolerated, and has minor side effects such as[1] a sensation of itching under the stimulating electrode,[2] post-stimulation headache, and[3] mild nausea, which is rare. The effects of tDCS are not limited to the motor cortex below the stimulating electrode. During stimulation, anodal tDCS also induces changes in the excitability of spinal neuronal circuits [7].

The primary motor cortex (M1) and the corticospinal tract play a greater role in the control of locomotion in humans. tDCS is a novice approach that can improve lower limb function by modulating cortical neuronal excitability. Transcranial direct current stimulation (tDCS) is a form of neurostimulation that uses constant, low-frequency current delivered via electrodes on the head. It is a contemporary, portable, non-invasive, neuromodulatory technique that delivers a low electric current to the scalp [4].

In the motor domains, stroke patients naturally display pathologically improved neural activity in numerous areas in the lesioned (ipsilateral) and healthy (contralesional) hemispheres. The membrane polarization may cause single-neuron synaptic and network activity variations, which may eventually be revealed in behavioral and cognitive variations [6]. In recent years, tDCS has been used to remedy neuropsychological and neurological impairments [3].

Recovery of standing Balance after Stroke is a key factor in regaining independence in activities of daily living (A.D.L.) and preventing fall events. A meta-analysis of interventions aimed at improving standing balance did not indicate the superiority of a particular training method, suggesting the need for more effective interventions post-stroke. Recently, non-invasive transcranial direct current stimulation (tDCS) has emerged as an innovative and promising approach to stroke rehabilitation. tDCS may prime the brain before or during therapeutic intervention, providing the potential to augment the positive learning effects of task-specific training, the idea being that such combined peripheral and central input enhances synaptic plasticity and skill relearning. Recent literature, however, reports inconsistent findings on improvement in motor performance when measured with clinical scales in patients with chronic task-specific Stroke, suggesting that, if any effect exists at all, tDCS interventions may only induce subtle changes [6]

The application of non-invasive brain stimulation in rehabilitation aims at prolonged effects on the neural network. It is assumed that these techniques modulate synaptic connectivity, similar to long-term potentiation and long-term depression, which are considered relevant mechanisms of plastic reorganization. The amount and duration of induced neurophysiological changes depend on the stimulation intensity and duration. The available data indicates that a direct current of at least 0.6 mA that is applied for at least three minutes modulates cortical excitability beyond the stimulation period. Applying tDCS of 1 mA for five to seven minutes leads to short-term changes in cortical excitability that last 10–15 min after stimulation. For long-term modulation of cortical excitability (1 h or more), a current of 1 mA needs to be applied over at least 11 min. A session of tDCS induces cortical excitability changes that last for at least 30 min after the end of stimulation [1].

Moreover, the effects of tDCS persist after the stimulation (named post effects). The duration of the post effects depends on the duration and intensity of the stimulation. Furthermore, tDCS is safe, easy to use, well tolerated, and has minor side effects such as (1) a sensation of itching under the stimulating electrode, (2) post-stimulation headache, and (3) mild nausea, which is rare.

The effects of tDCS are not limited to the motor cortex below the stimulating electrode. During stimulation, anodal tDCS also induces changes in the excitability of spinal neuronal circuits.

Methodology

The research was an Experimental Study. The population comprises stroke patients in D.V.V.P.F.'s Hospital Department of Neurophysiotherapy (O.P.D.) and Asha Kendra (Rahuri). A total of 50 patients were selected by the purposive sampling method. The study was carried out over six months. The materials required were a Bobo master, transcranial direct current stimulation (tDCS), electrodes, electrode pads, Velcro straps, saline solution, and a stopwatch.

The inclusion criteria were male and female, aged between 31-65yrs with hemiparesis following unilateral hemispheric cerebral lesions of vascular origin, and patients could stand independently.

Patients having pacemaker or metal implants, seizure or drug-resistance epilepsy or those who were using neuroactive or psychoactive drugs, patients with brain tumors, dementia, and cognitive difficulties that could interfere with comprehension of instructions were excluded.

Procedure

The institutional ethical clearance was obtained from the institution of C.O.P.T. A written informed consent form was taken from all the participants in their language.

Then, the static standing Balance of each leg was assessed using Bobo Master Easy Mode.

The patient was instructed to maintain the white circle that represents them within the limits of the green perimeter, as he sees on the Bobo screen.

The test ran for about 20 seconds, and then reports showed Accuracy and the percentage of weight bearing in each quadrant of the foot.

Then, the transcranial direct current stimulation (tDCS) modality was applied. With the patient sitting on a stool and the anode electrode placed over the ipsilateral hemisphere of the Stroke and the cathode above the contralateral hemisphere of the Stroke, tDCS (thus termed anodal) increases cortical excitability, both during and following the stimulation.

Both electrodes were inserted into saline-soaked electrode pads and fixed in position using Velcro straps.

The stimulation intensity was set to 2 mA for 30 min with a current density of 0.07 C/cm2. These stimulation criteria were well below the threshold for tissue damage. The target intensity was reached in 8 seconds; at the end of the 30 min, it was reduced to over 8s.

Then, the static leg standing Balance was immediately assessed using Bobo Master. It generates reports in Accuracy and weight bearing on the forefoot and hindfoot in the form of percentage.

Fig. 1: Patient balancing on Bobo Master

Outcome Measures-

1) Bobo Master:

Purpose: Using the provider-patient platform, providers can create and easily adjust personalized treatment plans, while the motion sensors allow you to measure and analyze outcomes.

Key Descriptions:

-In this study, we are assessing static both legs standing Balance.

Hindfoot- The patient is instructed to stand on the Bobo master platform with left and right legs on the forefoot and hindfoot sensors, respectively, and eyes open.

Representation- The patient is instructed to maintain the white circle, which is his representation, as he can see on the tablet, within the green perimeter.

Seconds- The test runs for 20 seconds, during which the patient is instructed not to take any form of support.

The results are generated in the form of Accuracy in percentage and percentage of weight bearing in each quadrant.

Fig. 2: Bobo Master Platform

2) Transcranial direct current stimulation:

Purpose:

Transcranial direct current stimulation (tDCS) is a form of neuromodulation that uses constant, low direct current delivered via electrodes on the head.

Key Descriptions:

- tDCS consists of 2 electrodes, an anode, and a cathode.
- The electrodes are inserted in saline solution dipped electrode pads and applied with the help of Velcro straps.

- The anode electrode is placed over the ipsilateral hemisphere to the Stroke, and the cathode is placed over the contralateral hemisphere.
- The patient is sitting, and the stimulation intensity will be set to 2 mA for 30 min with the current density of 0,07 C/cm2.

Table No. 1: Gender-wise Distribution of Participants

Gender-wise Distribution	Total number of Patients
Male	26
Female	4

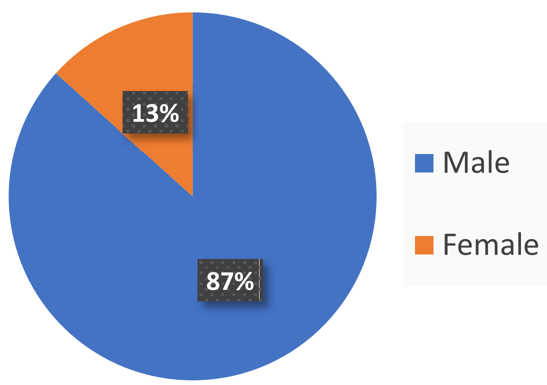

Fig. 1: Gender-wise Distribution of Participants

Table No. 2: Side of Weakness in Chronic Patients

Sides of Weakness	Total number of Patients
Left	10
Right	20

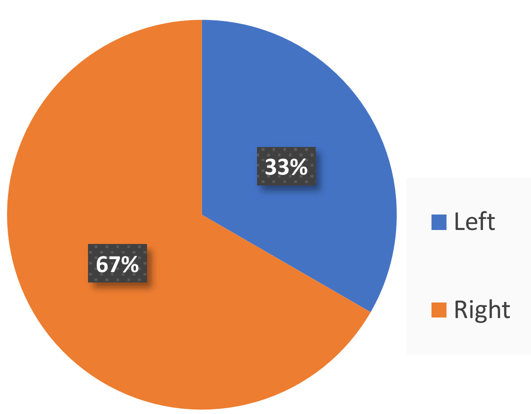

Fig. 2: Side of Weakness in Chronic Patients

Table No. 3: History of Diabetes in Chronic Stroke Patients

Question	Total number of Patients
Yes	3
No	27

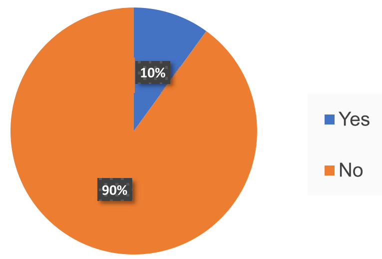

Fig. 3: History of Diabetes in Chronic Stroke Patients

Table No. 4: History of Hypertension in Chronic Stroke Patients

Question	Total No. of Patients
Yes	8
No	22

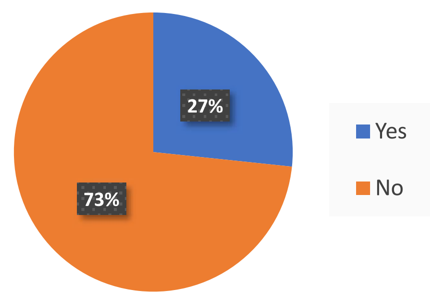

Fig. 4: History of Hypertension in Chronic Stroke Patients

Table No. 5: Treatment Status of Chronic Stroke Patients

Treatment Status of Chronic Stroke Patients	Total number of Patients
New	19
Old	11

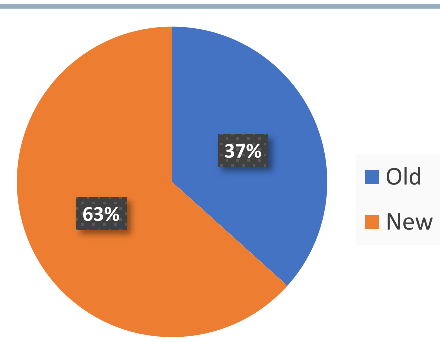

Fig. 5: Treatment Status of Chronic Stroke Patients

Table No. 6: Hand Dominance of Chronic Stroke Patients

Hand Dominance of Chronic Stroke Patients	Total number of Patients
Left	4
Right	26

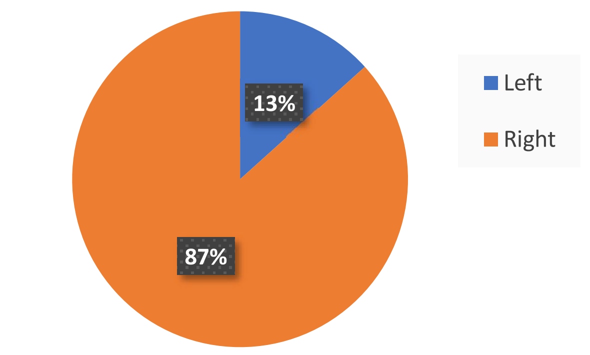

Fig. 6: Hand Dominance of Chronic Stroke Patients

Table No. 7: Occupation wise Distribution of Chronic Stroke Patients

Occupation-wise Distribution of Chronic Stroke Patients	Total number of Patients
Driver	7
Farmer	8
Teacher	2
Worker	2
Student	1
Veterinary Doctor	1
Accountant	1
Shop keeper	2
Housewife	3
Labourer	1
Carpenter	1

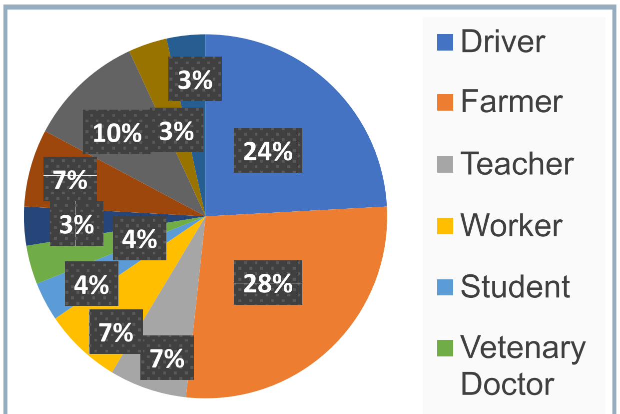

Fig. 7: Occupation-wise Distribution of Chronic Stroke Patients

Table No. 8: B.M.I. wise Distribution of Chronic Stroke Patients

B.M.I. wise Distribution of Chronic Stroke Patients	Total number of Patients
Normal	20
Overweight	9
Obese	1

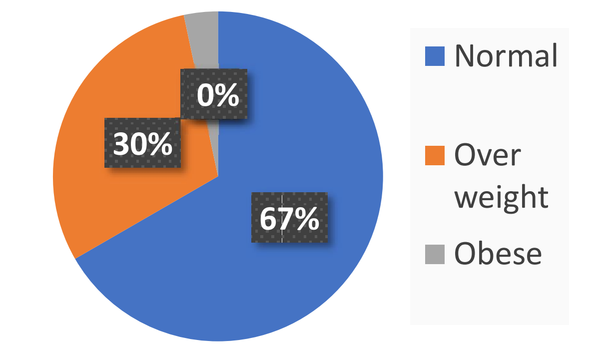

Fig 8: B.M.I. wise Distribution of Chronic Stroke Patients

Discussion:

The study by M. Geiger et al. (2016) compared the effects of anodal and placebo tDCS on the different motor functions & gait and Balance in chronic Stroke, similar to my study of anodal tDCS. The difference between the studies is they also observed effects on gait parameters and functional tests. The mechanism reduces the variability of the C.O.M. during gait, static, and static-dynamic balance tasks. The study also demonstrated that anodal tDCS improves kinematic and kinetic gait parameters and performance on functional tests and reduces the clinical symptoms of Stroke (reduced spasticity and increased strength).

In the study by Víctor Navarro-López et al. (2021), they observed the effect of tDCS combined with Physiotherapy treatment & sessions lasted between 10 and 20 min. And the similarities were the same intensities. The authors suggested that to achieve excitation in the lower limb motor cortex areas, 2 mA intensities are required for at least 10 min, these intensities being higher than those used to stimulate the upper limb motor cortex (1 mA). No significant differences were observed between groups in the studies that worked with intensities lower than 2 mA. It seems that currents of 2 mA should be used to achieve significant improvements in applications aimed at improving parameters related to the lower limb, such as gait, Balance, risk of falls, or functionality and strength of the lower limbs.

Conclusion:

There is an immediate effect of tDCS on balance parameters in patients with chronic Stroke, which shows that the body can make appropriate changes despite the longer duration of the condition.

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