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Case Report

Impact of Transcranial Direct Current Stimulation on Patients With Parkinson's disease: A Report of 2 Cases

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Abstract

Introduction: The motor function is associated with the activity of both the motor and prefrontal cortices. The efficacy of transcranial direct current stimulation (tDCS) over specific brain cortices has been examined in many psychiatric and neurologic disorders. This study aims to report the tDCS effects on two females of advanced age with idiopathic Parkinson's disease (PD).

Case Presentation: We considered 50-minute sessions of bilateral primary motor cortices and left dorsolateral prefrontal cortex (DLPFC) anodal stimulation using tDCS with passive stretching exercises simultaneously for a total of 20 sessions in 7 weeks. Clinical signs and electroencephalography (EEG) waveform were assessed at distinct times. Both of the two patients showed improved motor function for a short time. EEG changes to some extent concerned clinical states.

Conclusion: It seems that tDCS can be an auxiliary treatment for motor dysfunction in PD; however, further studies must be carried out to prove the claim.

Keywords: Parkinson Disease, Transcranial Direct Current Stimulation, Electroencephalography

1. Introduction

Numerous studies indicate that transcranial direct current stimulation (tDCS) induces inhibitory or excitability changes in the human motor cortex which can be more significant than the effects induced by transcranial magnetic stimulation.[1] Imaging literature confirms the existence of prefrontal-premotor connectivity. It has been suggested that the rostral sector of the dorsal premotor cortex (pre-PMd) possesses some cognitive and pre-movement processes, and its caudal sector (PMd proper) essentially deals with real movement.[2] The efficacy of anodal tDCS over both the motor and dorsolateral prefrontal cortex (DLPFC) has been observed in Parkinson's disease (PD).[3,4]

It seems that the motor dysfunction in PD is due to the degeneration of dopaminergic neurons.[4,5] Meanwhile, visual hallucination is one of the most prevalent ones, which may be due to dopamine deficiency of the visual system. This problem has mainly been reported concerning the patients treated with L-dopa and dopamine agonists.[6] Surveys in brain imaging in PD patients with visual hallucination have significantly indicated the *frontotemporoparietal* atrophy compared with the PD controls.[7]

In a clinical study, it has been shown that tDCS might be a useful alternative for the treatment of motor performance PD patients.[8]

Studies claim that tDCS may facilitate dopaminergic transmission.[9,10] Moreover, the improvement of learning disability in healthy subjects and motor recovery in old stroke by the tDCS approach has motivated its application.[4] However, due to inadequate evidence, although it bears many benefits, employing this approach regarding rehabilitation is controversial.[11]

A survey assessed the short-term effects of anodal tDCS over the premotor and primary motor cortices on gait. Longer-lasting changes in neural excitability and performance using multisession tDCS designs in Parkinsonism may be probable.[12]

A meta-analytic study on 18 qualified studies found that tDCS protocols may present immediate positive effects on functional locomotion in persons with PD.[13] Researchers insist that the prevalence of electroencephalography (EEG) abnormalities in PD is higher than in normal elderly individuals.

2. Case Presentation

Two right-handed older women (72 and 83 years old, respectively) with idiopathic Parkinsonism not responding to medication introduced by a neurologist for the application of tDCS to attenuate. Motor dysfunction was targeted in our survey. Diagnosis indicated the UK PD

Brain Bank criteria in a Hoehn and Yahr stage of 1-3while 'off' medication. The Parkinson's Disease Questionnaire (PDQ-39) scores for the mobility dimension were 30-37(in percentage). The subjects developed no major psychiatric disorder. The younger woman whose head computed tomography (CT) scanning confirmed apparent atrophy at the right *perisylvian* area complained about visual hallucination (Figure 1).

Their consent was obtained after being informed about the experiment.

Fifty-minute sessions of bilateral primary motor and left dorsolateral prefrontal cortices anodal stimulation with the intensity of 1 mA on both left and right primary motor cortices (20 minutes for each of them) and left DLPFC (10 minutes) were accomplished, respectively. The tDCS was delivered by a battery-driven stimulator with two rubber electrodes placed in 5 cm × 7 cm saline-soaked sponges.

The reference electrode was located at the right base of the neck. The electrical stimulation started in the left motor area, and then the right one (location of reference electrode has been changed to the left side this time) and finished with left DLPFC. All the sessions are accompanied by fifteen minutes, passive stretching exercises. Several successive 20 daily sessions were performed per patient on schedule. To avoid the carry-over effect 24 hours were allocated. The patient's medication was limited to 300 mg L-dopa per day.

Daily mobility and activities of the patients were assessed by applying the PDQ-39 questionnaire every two sessions focusing on the mobility domain. Our motive to apply the questioner has been contingence between the total PDQ-39 score and the mobility domain.[14] The validity of this questionnaire has been approved concerning Iranians while its items have been ranked zero to four from the best to the worst.[15] As similar research indicates,[4,16] we assessed the gait by considering time for 10 m walk both for the on and the of states. So, the patients were asked to walk as fast as they could not fall using secondary devices. In addition, we measured the sequential hand and arm movement time to assess bradykinesia, including hand closing and opening (squeezing a ball); elbow flexion, hand closing, and opening; and elbow extension. These assessments were carried out prior to the intervention, during the sessions, and at intervals of 15 days next to the last session.

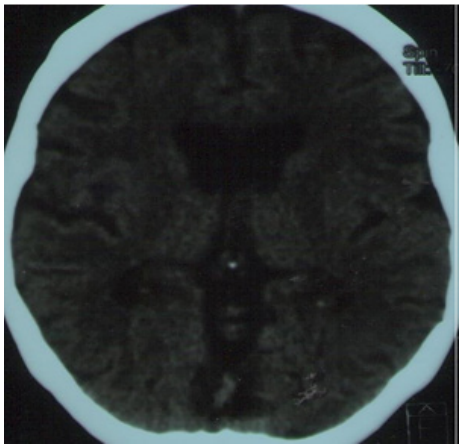

Figure 1. Head (CT) Scanning: An Apparent Atrophy at the Right Perisylvian Area in Younger Women With Visual Hallucination

EEG was performed while resting and awakens in a comfortable, quiet, air-conditioned room for 10 minutes using the Mitsar system at a sampling rate of 256 Hz from 19 scalp sites before the first intervention and two weeks after the last one.

The EEG records were conducted at the exact time every day. The artifact-free periods of one minute eye closed EEG data were analyzed for quantitative EEG (QEEG) measures of background rhythm in the absolute power of delta (1-3.5 Hz), theta (4-7.5 Hz), and alpha (8-12 Hz) bands at diffused electrode sites. Alpha peak frequency was considered, too. The removal of the artifacts and spectral analysis of EEG data were performed using NeuroGuide software. The edited segments were also provided for the same bands' low-resolution electromagnetic tomography (LORETA) analysis. Merging QEEG and the LORETA methods may meliorate the neuroanatomical resolution of the EEG data analysis.

3. Discussion

The study showed that tDCS with passive stretching exercises was an effective intervention for PD's motor and electrophysiological symptoms. Furthermore, no other adverse effects occurred except for a partial visual hallucination enhancement in the involved patient who was presumably due to an interaction between L-dopa and tDCS.

Improvement of the motor function began after the 4th and the seventh sessions considering the patient's age (72 and 83 years old, respectively). We witnessed a mild decrease in their walking time both in off and on states. Meanwhile, bradykinesia improved, particularly in the ON state. The average depletion of the PDQ-39 mobility scores was 15-20 percent which appeared more prominently after the sessions. The fluency and the tone of speech bore promotion for the two treated participants. None of the mentioned outcomes lasted more than 45 days.

The NeuroGuide and LORETA software performed absolute differences for individual statistics and descriptive analysis. As illustrated in Figure 2, delta waves decreased across the anterior regions. Meanwhile, a delta increase was observed in the left frontotemporal areas of the patient with visual hallucination. Despite changes in QEEG, we observed an increase in the EEG source localization of alpha waves (exceptionally high alpha) in the temporoparietal areas (Brodmann areas of 38, 40) for the younger one (Figure 3). The rest of the bands were intact. Surprisingly, unlike the younger patient, both the alpha source localization and global alpha peak frequency alleviated in the older one.

Even though there are no relations between the demographic characteristics and the clinical features in PD's literature,[1] it is assumed that age and disease duration

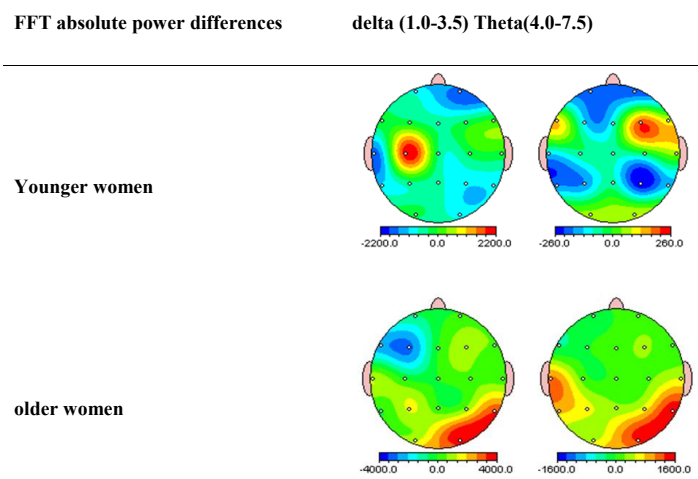

Figure 2. FFT Absolute Power Differences 2 Weeks After the last Session of Intervention: Partial Depletion of the Slow Waves in Modulated Areas and Increasing in the Other Areas.

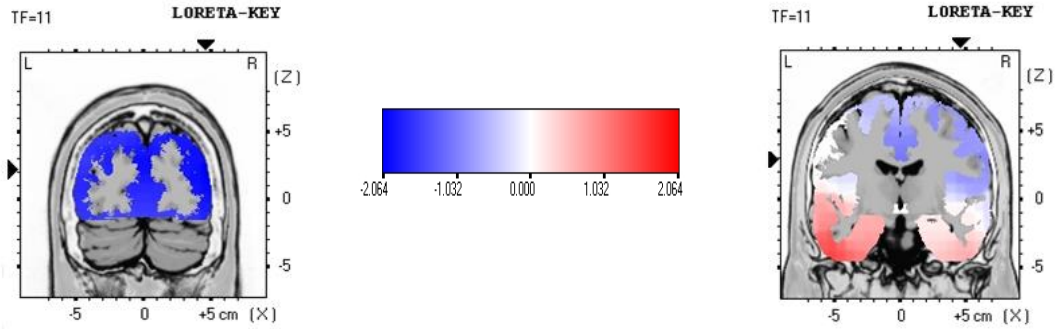

Figure 3. LORETA Statistics: Depletion of the Alpha Waves in PD (left) and Promoting the Same Waves After the Intervention (Right) in Younger Patients.

play a vital role in the rate of improvement. Therefore, age effects, disease duration, stage, or a combination on the rate of recovery seem obscure. We observed that the anodal tDCS stimulation of the mentioned areas improved the motor dysfunction process. In an EEG survey on PD, they found out that the most significant aspect of the findings was enhancing the delta waves. Besides, the patient without dementia enjoyed an increase in the activity of the theta. Patients with PD and dementia are of slower EEGs than those without dementia. These abnormalities are observed in PD's frontal and frontal-pole areas with executive dysfunction (ExD). They are also present in all locations in patients with dementia.[17,18] Resting alpha frequency diminishes in dementia,[19] and current density in delta and alpha bands reflect the pathological changes in the left temporal lobe and the brain deficiency.[20,21] It has been shown that alpha brain waves activity relates to cognitive performance.[22] We observed a global enhancement of alpha peak frequency and EEG source localization in the same waves in temporoparietal regions of the younger patient. At this moment, we conclude that tDCS may affect cognitive function according to age.

As illustrated in Table 1 after the tDCS, EEG power spectra (1-7 Hz) in most modulated areas are fairly suppressed while augmented in the other areas. These changes in the EEG signals of the two patients may indicate the improvement of the motor features.

Even though we did not go through the other deficits of Parkinson's disease, access of the patients to this know-how seems promising.

4. Conclusion

Generally speaking, we suggest the tDCS as an auxiliary and non-invasive method for the temporary diminution of motor dysfunction in PD. However, going through more surveys considering the age, disease duration, and stage of this disorder seems inevitable.

Authors' Contributions

HM: did study, concept, acquisition, analysis, or interpretation of data, designed it and wrote primary draft; NZ wrote primary draft; RB revised and submitted it.

Conflict of Interest Disclosures

The authors have no conflict of interest to disclose.

Ethical Approval

The study was approved by the ethics committee of the Yazd University of Medical Sciences (Ethics ID: IR.SSU.REC.1400.153) and followed ethical considerations of the declaration of Helsinki.

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