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Original Article

Effect of transcranial direct current stimulation of stroke patients on depression and quality of life

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Abstract. [Purpose] The aim of this study was to assess the effects of transcranial direct current stimulation (tDCS) on depression and quality of life (QOL) in patients with stroke, by conducting conventional occupational therapy with and without tDCS on 20 patients each. [Subjects and Methods] The experimental group (N=20) received both tDCS and conventional occupational therapy, while the control group (N=20) received false tDCS and conventional occupational therapy. The treatment was conducted 20 times over a four-week period; each session was 30 minutes long. The Beck Depression Inventory (BDI) was administered to score the depression levels in patients before and after the intervention, while the stroke-specific quality of life (SS-QOL) was measured to compare the QOL. [Result] Following the intervention, the patients in the experimental group showed a significant decrease in depression and an increase in the QOL. In contrast, the control group showed no significant changes in depression or QOL. Our findings indicate that tDCS decreased depression while increasing QOL in patients with stroke. [Conclusion] In other words, our study confirmed that the application of tDCS during stroke rehabilitation improves the depression symptoms and QOL in patients.

Key words: Transcranial Direct Current Stimulation (tDCS), Quality of life, Depression

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INTRODUCTION

Stroke patients experience depression and a decrease in the overall quality of life (QOL) due to long-term disability and loss of motor and cognitive functions from brain damage[1)]. The QOL of stroke is a comprehensive index of stroke recovery comprising physical, psychological, emotional, and social aspects of recovery[2)]. Furthermore, it is difficult to recruit patients who are depressed as their willingness to be involved decreases[3)]. Transcranial direct current stimulation (tDCS) is one of the most convenient and safe rehabilitation methods designed for patients with stroke, as it allows changes in brain plasticity through direct stimulation of the brain[4)]. When tDCS is administered in patients with stroke, they show improvements in hand function, sense of balance, lower limb function, kinesthesis, visual perception ability, and activities of daily living (ADL)[5–7)]. However, no previous study has investigated depression, which is an important psychosocial factor that must be addressed during recovery from stroke. Thus, the QOL and depression remain insufficiently studied. Therefore, the present study aims to investigate how tDCS influences the QOL and the overall psychosocial health of stroke survivors.

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Table 1. The general characteristics of the subjects (N=40)

Categories	Items	Experimental group		Control group	
		N	%	N	%
Gender	Male	17	85.0	13	65.0
	Female	3	15.0	7	35.0
Age (years)		51.0 ± 11.7		62.4 ± 12.4	
Paretic side	Left	13	65.0	5	25.0
	Right	7	35.0	15	75.0
Time since stroke (month)		14.6 ± 6.3		14.7 ± 5.9	
Cause of disease	Cerebral infarction	11	55.0	12	60.0
	Cerebral hemorrhage	9	45.0	8	40.0

SUBJECTS AND METHODS

The patients recruited to this study were diagnosed by computed tomography (CT) or magnetic resonance imaging (MRI), and were admitted to the M rehabilitation center in Busan for four weeks between January and March 2016. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Kaya University Institutional Review Board (Kaya IRB-145). The final group of participants consisted of patients who were confirmed to be severely depressed (as evidenced by a score above 16 on the Beck Depression Inventory), understood the purpose of our study, and provided their written consent. The 40 patients selected based on these criteria were divided into two groups (containing 20 patients each): an experimental group that would receive conventional occupational therapy and tDCS, and a control group that would receive conventional occupational therapy and false tDCS. The participants were divided according to their order of admission, such that patients with an odd admission number were assigned to the control group, while patients with an even admission number were assigned to the experimental group. The tDCS protocol involved generating a direct current using FDA-approved batteries (Phoresor® PM 850 (Phoresor® II Auto Model No. PM 850, IOMED, Inc., Salt Lake City, USA)). According to the International 10–20 system, the anode was wrapped in straps and attached to the left dorsolateral prefrontal cortex (DLPFC), while the cathode was attached in the same manner to the right DLPFC[8]. The experimental group received tDCS applied at 2 mA 20 times over the course of four weeks (five times a week), for 30 minutes during each session based on the stability study by Bueno et al.[8]. In the control group, the anode and cathode positions were the same as in the experimental group; however, the stimulation was stopped 30 seconds after the application without letting the participants know until 30 minutes elapsed. The BDI developed by Beck in 1961 was used to investigate depression levels[9]. This study targeted patients with severe depression (BDI scores of 16 and higher). The Stroke-Specific Quality of Life (SS-QOL) developed by Williams et al.[10] was used to investigate QOL[11]. The mean and standard deviation of all scores in the two groups were calculated using descriptive statistics. The difference between scores measured before and after treatment was determined using a paired t-test. The statistical significance level (α) was set at 0.05. All statistical tests were performed using SPSS v22.0.

RESULTS

The experimental group consisted of 17 men and 3 women, while the control group consisted of 13 men and 7 women. The experimental group had 13 patients with left paralysis (and 7 with right paralysis), while control group had 5 patients with left paralysis (and 15 with right paralysis). The mean age (in years) of the patients in the experimental and control groups was 51.0 ± 11.7 and 62.4 ± 12.4, respectively. As for the disease duration, the experimental group consisted of 9 patients who had stroke for 7–12 months, 7 patients who had stroke for 13–24 months, and 4 patients who had stroke for over 24 months; while the control group consisted of 8 patients who had stroke for 7–12 months, 8 patients who had stroke for 13–24 months, and 4 patients who had stroke for over 24 months. Homogeneity tests conducted on the general characteristics of patients from the two groups revealed no significant between-group differences ($p>0.05$) (Table 1). The depression level of patients in the experimental group significantly decreased from 38.8 ± 4.7 (before tDCS) to 16.8 ± 4.6 (after tDCS). The depression level of patients in the control group also decreased from 39.0 ± 4.6 (before false tDCS) to 37.8 ± 6.1 (after false tDCS); however, this difference was not statistically significant. The QOL measured through SS-QOL significantly increased in the experimental group from 152.1 ± 16.9 (before tDCS) to 167.7 ± 25.7 (after tDCS). The QOL also increased in the control group from 154.3 ± 18.3 (before false tDCS) to 162.1 ± 18.7 (after false tDCS); however, this difference was not statistically significant (Table 2).

Table 2. Comparison of the changes in depression and QOL

	Experimental group		Control group	
	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Pre-test (Mean ± SD)	Post-test (Mean ± SD)
Depression	38.8 ± 4.7	16.8 ± 4.6*	39.0 ± 4.6	37.8 ± 6.1
QOL	152.1 ± 16.9	167.6 ± 25.7*	154.3 ± 18.3	162.1 ± 18.7

*p<0.05

DISCUSSION

Our results reveal that tDCS intervention caused a significant decrease in depression levels in the experimental group. The anode stimulation is known to increase the excitability of cerebral cortex and enhance awareness, while the cathode stimulation is known to suppress the excitability of the cerebral cortex and make the subject quieter and passive[12]. Based on these observations, it can be assumed that the decrease in depression levels was caused by the enhancement of awareness resulting from the increase in brain activity in patients with stroke. Our findings are in line with those observed by Valiengo et al.[13], who used 10 applications of tDCS to the DLPFC of 23 stroke survivors with aphasia, and found that their depressive symptoms decreased after four weeks. In addition to the improvement in depression symptoms, our study found a significant increase in the QOL of the experimental group. This result is similar to that of the study by Viana et al.[14], in which an experimental group (n=10) received virtual reality therapy (VRT) as well as tDCS, while the control group (n=10) received VRT and false tDCS. The authors reported significant improvement in the QOL as well as upper limb function in the experimental group. Our study is significant as it confirms that tDCS, a method to increase brain plasticity in patients with decreased QOL, improves depression and QOL in stroke survivors with depression. Moreover, our results indicate that tDCS can be effectively applied in the patients' depression treatment in order to improve their QOL. This study has two limitations: 1) the results are difficult to generalize due to the small sample size, and 2) other factors influencing QOL have not been investigated. Therefore, future studies should investigate a larger number patient in order to allow generalization of the results, and conduct continuous research on depression and improvement in QOL in patients with stroke.

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