



tDCS in the Modulation of Central Post-Stroke Pain and Depression : A Randomized Controlled Study

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Introduction

Pain can be caused by various factors, and continuous pain can negatively affect a patient's quality of life. Neuropathic pain caused by stroke, spinal cord injury, or multiple sclerosis is difficult to be cured with painkillers. Central post-stroke pain (CPSP) is a type of neuropathic pain caused by a lesion or dysfunction of the central nervous system, and it is difficult to identify the mechanism that causes it. Non-invasive brain stimulation techniques, such as transcranial direct current stimulation (tDCS), have been studied as treatments for CPSP. The tDCS could potentially stimulate the relevant areas of the brain associated with pain mechanisms. The objective of this study is to investigate whether tDCS has a significant effect on pain reduction in CPSP patients compared to a sham group, and to analyze the potential impact of lesion location on tDCS effectiveness in CPSP patients.

Method

In this study, we used the DC-STIMULATOR PLUS [NeuroConn GmbH (Germany)] for tDCS intervention, which is based on the 10-20 system targeting the primary motor cortex (M1; C3, C4- Anode, over the contralateral supraorbital region-cathode). The intervention lasted for 20 minutes with 2mA, 5 times a week for 2 weeks. The sham device was the same as the tDCS group's device, but the electrical stimulus was blocked. The control group received a post-evaluation two weeks after the baseline, and the follow-up evaluation was conducted one week after the intervention was completed. The study assessed the changes in pain, depression, and quality of life scores using the Brief Pain Inventory (BPI), the Beck Depression Inventory (BDI), and the Euro Quality of Life-5 Dimensions (EQ-5D) respectively.

Result

The study involved 22 participants with CPSP, all of whom completed the intervention, and no one dropped out. The participants were divided into two groups: tDCS (11 participants) and sham (11 participants). There was no significant difference in age or onset period between the two groups. The most common damaged lesion in CPSP patients was basal ganglia, followed by cerebral artery and then thalamus (Table 1). The tDCS group showed a significant change in BPI, BDI, and EQ-5D, while the sham group did not. But there was no significant difference in BPI, BDI and EQ-5D change between the tDCS group and the sham group (Fig. 1).

Table 1. General and medical characteristic of the subjects

Characteristics	tDCS (n=11)	Sham-tDCS (n=11)
Sex [n (%)]		
Male (n=8)	6 (54.5)	2 (18.2)
Female (n=14)	5 (45.5)	9 (81.8)
Age (year) [median (IQR)]	55.00 (48.00-62.00)	60.00 (55.00-61.00)
Since onset (month) [median (IQR)]	30.00 (24.00-32.00)	32.00 (19.00-39.00)
Affected side [n (%)]		
Right	5 (45.5)	6 (54.5)
Left	6 (54.5)	4 (36.4)
Multifocal	0 (0)	1 (9.1)
Pathological sites [n (%)]		
Basal ganglia (n=11, 50.0%)	5 (45.5)	6 (54.5)
Thalamus (n=5, 22.7%)	3 (27.3)	2 (18.2)
CA (MCA or MCA+ACA or MCA+PCA) (n=6, 27.3%)	3 (27.3)	3 (27.3)
Pain symptoms [n (%)]		
Aching (n=8, 15.7%)	3 (11.1)	5 (20.8)
Electrical (n=6, 11.8%)	3 (11.1)	3 (12.5)
Tingling (n=6, 11.8%)	3 (11.1)	3 (12.5)
Numbness (n=5, 9.8%)	3 (11.1)	2 (8.3)
Heavy (n=5, 9.8%)	4 (14.8)	1 (4.2)
Squeezing (n=5, 9.8%)	4 (14.8)	1 (4.2)
Freezing (n=5, 9.8%)	3 (11.1)	2 (8.3)
Burning (n=3, 5.9%)	1 (3.7)	2 (8.3)
Sharp (n=3, 5.9%)	1 (3.7)	2 (8.3)
Stabbing (n=2, 3.9%)	1 (3.7)	1 (4.2)
Pins and needles (n=1, 2.0%)	1 (3.7)	0 (0)
Pressing (n=1, 2.0%)	0 (0)	1 (4.2)
Itchy (n=1, 2.0%)	0 (0)	1 (4.2)
Pain site [n (%)]		
Lower extremity (n=11, 28.9%)	6 (28.6)	5 (29.4)
Upper extremity (n=9, 23.7%)	5 (23.8)	4 (23.5)
Shoulder (n=9, 23.7%)	5 (23.8)	4 (23.5)
Whole body (n=3, 7.9%)	1 (4.8)	2 (11.8)
Headache (n=3, 7.9%)	2 (9.5)	1 (5.9)
Neck (n=2, 5.3%)	1 (4.8)	1 (5.9)
Face (n=1, 2.6%)	1 (4.8)	0 (0)

IQR; Inter Quartile Range; CA; Cerebral Artery; MCA; Middle Cerebral Artery; ACA; Anterior Cerebral Artery; PCA; Posterior Cerebral Artery, Pain symptoms and sites were allowed duplicate responses.

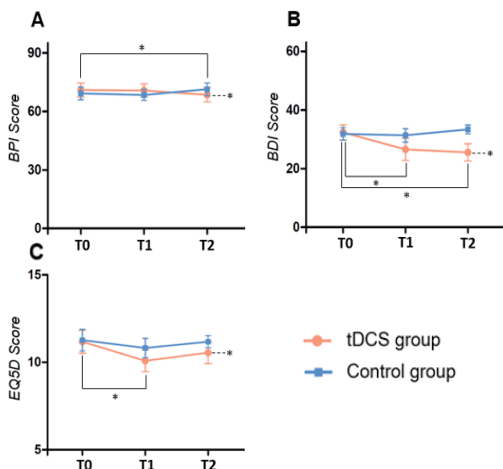


Figure 1. The score changes in the tDCS group and sham group at T0 (before intervention), T1 (immediately after intervention), and T2 (one week after the completion of intervention) for BPI (A), BDI (B), and EQ-5D (C). It is worth noting that a downward trend in the EQ-5D graph indicates an improvement in the quality of life.

Conclusion

This study examined the effect of tDCS on pain, depression, and quality of life in CPSP patients, but found no significant improvement compared to the sham group. However, the tDCS group analysis showed significant changes, and the effect on pain varied depending on the lesion. These findings suggest that tDCS may have potential as a pain therapy tool and can help predict patient reactions to stimulation, and may also inform the study of other non-invasive brain stimulation techniques.

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