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SURVEY THE EFFECT OF ELECTRICAL STIMULATION OF THE BRAIN BY USING A DIRECT CURRENT (tDCS) TO IMPROVE DEPRESSION PATIENTS AFTER MYOCARDIAL INFARCTION IN YAZD CITY

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ABSTRACT

Depression is a common cognitive impairment after myocardial infarction. These people are often having incomplete recovery despite of intensive medical treatments. Direct electrical stimulation of the brain, which is a technique that used to stimulate the brain of patients with neurological and psychiatric problems. The aim of this study is to examine the effects of electrical stimulation of the brain in the dlpc area to improve depression in infarction patients and durability of its effects. In this cross-sectional study, 30 male patients with depression after myocardial infarction and a mean age of 53-52 years was selected. Depression score of these patients was compared in four separate periods, the pre-treatment, post-treatment dummy, and two months after the treatments. At first each patient during the 10 sessions received artificial electrical stimulation [20 minutes] and then received the anode and cathode stimulation that each of them was accomplish simultaneously [2 mg mpr- 20 minutes] to the left and right side of frontal cortex perry. Data analyze was conducted by using wilcoxon statistical test and spss software (program). The data analyses indicated that there is meaningful difference in the results of the tests in before and after therapy. This manifests the fact that tdc device can reduce the symptoms of depression in heart attack patients. [$p = 0.000$ and $z = - 4.234$] and also there wasn't a significant difference in the results of the tests after active treatment and after two months of therapy. So this indicates the fact that the results of tdc device are still stable after two months. [$p = 0.227$ and $z = 1.209$]. According to the results of this study, it seems that direct electrical stimulation in to the left and right frontal perry cortex, cause sustainability decrease in the rate of depression in depressed patients after a heart attack.

Keywords: *Direct Electrical Stimulation, Depression after Myocardial Infarction, Perry Left and Right Frontal Cortex, Dlpfc (Dorsolateral Prefrontal Cortex)*

INTRODUCTION

Depression is a common mental disorder that can be classified as mood disorders. Several factors are mentioned in the etiology of depression, including biological factors [such as physical illness, hormonal disorders, certain medications] psychosocial factors and inheritance (Kaplan and Sadock, 1995). Depression is a common disabling condition, that often after experience after a heart attack [Myocardial Infarction: MI] (Schrader *et al.*, 2004; Serrano *et al.*, 2011; Thomas *et al.*,). Although both of these conditions have great increasing prevalence but the depression that is associated with a medical condition, has a higher prevalence today (Nicholson *et al.*, 2006). The impress of depression in cardiovascular diseases has been increasingly emphasized (Meneses *et al.*, 2007) and its negative effects on the patients with cardiovascular diseases have been widely mentioned in the studies (Mastrogiannis *et al.*, 2012). Depression after myocardial infarction occurs three times more than the general population (Lichtman *et al.*, 2008; Williams, 2011) and it will increases the risk of cardiovascular events and mortality (Barth *et al.*, 2010; Lichtman *et al.*, 2008; Pozueol *et al.*, 2009; Ruo *et al.*, 2003). Depressive symptoms approximately develop between 15 to 20% of patients after myocardial infarction (Barth *et al.*, 2010; Freedland *et al.*, 2003; Jiang *et al.*, 2005; Pozueol *et al.*, 2009; Ruo *et al.*, 2003). Some studies report that the prevalence of depression in 48 hours after MI is 7/60 percent. That the intensity of mild depression is 22.7%, 26% is for moderate depression and 12% show severe Depression (Hosseini *et al.*, 2006).

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In 1960, following the Byndmn experiments (Azkhosh, 2009) that reported the polarization effects of prolonged electrical stimulation of the motor cortex in animals, Led to the use of electrical stimulation in future studies, which was included the polarity of the brain in depressed patients. This change in membrane potential can increase or decrease the degree of neuronal firing, Depending on whether this stimulated respectively because depolarization or hyperpolarization in this cell (Baker *et al.*, 2010).

For the nature of completely non-invasive of DCS, Is still no report about serious side effects in use of this method, but generally before being used, recommended that skin complications such as itching, potential neurological complications result from stimulation of sensitive areas and specific health conditions [epilepsy, etc.] should be considered. Due to the use of extremely low flows in the tDCS and lack of contact with brain electrodes, various studies have indicated that this method is completely non-invasive and don't have (without) serious complications (Ekhtiari, 2010).

In recent years, direct current anode effects on rat brain tissue, such as the concentration of calcium ions, which cause an increase in cortical excitability and findings about brain flow during the electric treatment of sleep in the humans by Parivar and colleagues, was published in 1964, caused a new approach in the non-invasive brain stimulation by direct electrical current which reputation as tDCS. Infrastructure experiments of Nietzsche and Palvs (1967), explained the anode and cathode modulatory effects of tDCS on brain tissue that was surprisingly stable during stimulation. Electrophysiological effects remained until 90 minutes and sensorimotor and cognitive effects remained for 30 minutes that this effects caused by stimulation period of 20 to 30 minutes. These initial reports and other reports that come back from past 8 to 10 years, re-create interest for the use of noninvasive brain polarity for different neurological disorders patients.

Recent empirical studies, use cathode blocking effects of tDCS to create temporary chaos in the cortex. This allow researchers to evaluate the function of cortical areas. Similarly, several studies have demonstrated that the anodic tDCS could improve cognitive and sensorimotor tests (Jeffery *et al.*, 2007).

MATERIALS AND METHODS

Methods

The method of this article is cross-sectional study. Statistical population includes patients with myocardial infarction in city of Yazd that have major depressive disorder, Sample include 30 patients between 65-45 years old that suffering from depression after a stroke. These samples have participated voluntarily in this study.

Furthermore each individual complete a consent form to participate in this research. At first, based on the type of intervention the actual treatment takes place after the dummy treatment.

The following tests and instruments were used in this research:

Depression is a mental state associated with reducing of self-esteem, feelings of inadequacy, incompetence and poor perception from you. Beck Depression Inventory, between the questionnaires which is used to measure depression, [BDI] [Appendix 2] is the most appropriate tools for assessment of depression. These questionnaire contains 21 articles which measure physical, behavioral and cognitive symptoms of depression. Every article has 4 options scoring based on the 0 to 3 mark and have determines varying degrees of depression, from mild to severe. The maximum score on this questionnaire is 63 and the minimum is zero.

21 Articles of Beck Depression Inventory are as follows: Sadness, pessimistic, feelings of failure, dissatisfaction, feel guilty, expectation of punishment, self-aversion, self-accusation, suicidal thoughts, crying, irritability, social isolation, indecisiveness, imagine of physical change, difficulty in working, insomnia, fatigue, change in appetite, decrease of body weight, preoccupation, loss of sexual interest. The Comparison of Beck Depression Inventory with Hamilton questionnaire (1960) suggests that Beck Depression Inventory does not depend on the skill or intolerance of experimenter and further pays assess to psychological characteristics of depression rather than physical and psychological discomforts. Indeed Their Correlations with each other is 75%. These questionnaire has been evaluated by many people over the years and is known as a best questionnaire for determined of depression (Azkhosh, 2009).

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Due to the importance of these tools in the diagnosis of clinical intervention, widely psychometric studies have been conducted about its psychometric properties. For introducing the most important meta-analysis of these researches, we can point out the one that was performed in 1988 by Steer, and Garbin. Beck and his colleagues with reviewed the researches which had used this tool Found that by using Retrial method, coefficient validity of them has been variable from 0.48 Up to 0.86 that it's based on the distance between the number of implemented and the type of population that tested. Beck *et al.*, (1996) retest again reliability coefficient of test and was obtained 0.93 during a week. Also various studies have been conducted about the validity of the Beck Depression questionnaire.

Average correlation of Beck Depression questionnaire, with the Hamilton Psychiatric Rating Scale [HRSD], Zung Self-Rating Scale, Depression subscale of MMPI, multi-scale characteristics of depression and SCL-90, is more than 0.60. Within the country, several studies have been conducted to measure the psychometric properties of these tools. Between of These researches maybe we can point out to the Tashakori and Mehryar research that was conducted in 1994. They obtain the reliability scale of that as 0.78 in Iran. In the other researches including the research of Partoy (1976), Vahabzadeh (1974) and Chegini (1381), the Beck reliability reported high and that was variable from 0.70 Up to 0.90 (Azkhosh, 2009).

Respondents in this case, to understand the provisions (articles) of this research must have the ability to read as a person is in fifth or sixth grade. They should answer to each Article based on a four-point Likert scale that is from zero to three. In these tests, the minimum score are zero and the maximum of that are 63. By summing up individual scores in each of the items, score can be obtained directly. The following scores can be used to indicate the overall level of depression:

Table 3-1: To determine the level of depression

Determine the level of depression and strategic proposal	Total scores
You are not depressed	10-1
your depression is mild	16-11
It is better to consult with a psychiatrist as soon as possible	30-17
your depression is severe, do not forget to consult with a psychiatrist	40-30
your depression is severe and very dangerous, do not forget to consult with aMore than 40 psychiatrist	

Important Note: Regardless of your total scores, if in answer to the question 9, you have given yourself a score of 2 or 3, be sure to consult by a psychiatrist as soon as possible.

It should be noted that score less than four, indicating potential denial of depression. On the other hand, very high scores even among severely depressed persons Indicate potential exaggeration of depression, or possibility of edgy or exhibit personality disorders. Score eighteen suggested by some researchers as cut-off point. It is said which this score identified and classify correctly almost the 92% of patients that have major depressive disorder (Marnat, 2008).

Initially, 30 patients with Depression that at least one year past from previous myocardial infarction, and ranged in age from 45 to 65 years, were selected. For the diagnosis of Depression, meantime that confirmed by clinical psychologist, Beck depression diagnostic test was used too. Patients with a score higher than 17 in the test had depression and were attended to this research.

RESULTS AND DISCUSSION

Findings

In this research, 30 male patients that had heart attack were selected. The average age of patients was 52-53 years.

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Table:

Test time	Minimum	Maximum	Average	Standard deviation
Before treatment	17	41	24.77	6.981
After, dummy treatment	17	40	24.6	6.415
After, active treatment	6	27	16.7	6.115
Two months after treatment	6	27	16.5	5.923

As can be seen on above table, mean(average) scores of Beck test in the pre-treatment is 24.77, After dummy treatment is 24.6, after Active treatment 16.7 and Two months after treatment is 16.5. Above points shown in figure 4.1.

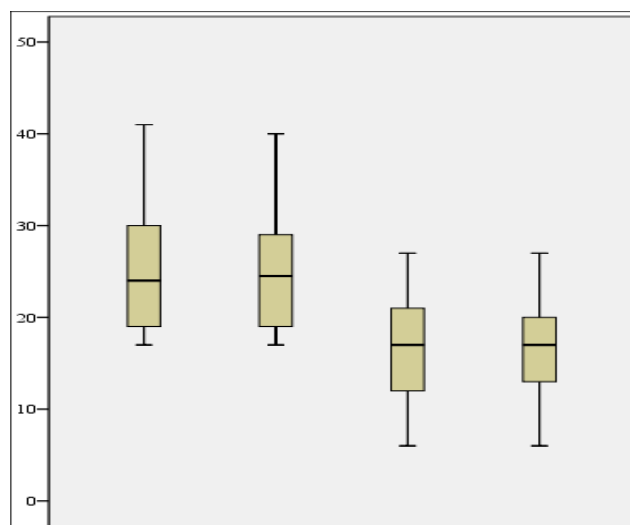


Diagram 4-1: A box plot of Beck test based on the test time

Based on Wilcoxon statistical test, between the results of the tests before treatment, after dummy treatment, after active treatment and two months after active treatment; the following results were obtained:

Table 4-2: Descriptive statistics for before treatment--after dummy treatment

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	8 ^a	9.63	77.00
Positive Ranks	9 ^b	8.44	76.00
Ties	13 ^c		
Total	30		

a. After dummy treatment < before treatment

b. After dummy treatment > before treatment

c. After dummy treatment = before treatment

Table 4-3: Wilcoxon test results for after dummy treatment - before treatment

Test statistics ^a	
Z	-.025 ^b
Asymp. Sig. [2-tailed]	.980

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

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Between the results of the tests for before treatment and after dummy treatment there was no significant difference. This indicates the fact that tDCS device don't have any particular psychological impact on patients in terms of Rates of effectiveness in improving depressive illness [$P = 0.98$, $Z = -0.025$].

Table 4-4: Descriptive statistics for before treatment - after active treatment

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	23 ^a	15.87	365.00
Positive Ranks	4 ^b	3.25	13.00
Ties	3 ^c		
Total	30		

a. After active treatment < Before treatment

b. After active treatment > Before treatment

c. before treatment = after active treatment

Table 4-5: Wilcoxon test results for before treatment - after active treatment

Test statistics ^a	
Z	-4.234 ^b
Asymp. Sig. [2-tailed]	.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Between the results of the tests for before treatment and after active treatment there is no meaningful difference; this manifests the fact that tDCS device can reduce the symptoms of depression in the heart attack patients. [$P = 0.000$, $Z = -4.234$]

Table 4.6: Descriptive statistics related to the after treatment - two months after active treatment

Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	10 ^a	8.00	80.00
Positive Ranks	5 ^b	8.00	40.00
Ties	15 ^c		
Total	30		

a. After two months > after active treatment

b. After two months > after active treatment

c. After two months = after active treatment

Table 4.7: Results of the Wilcoxon test after treatment - two months after active treatment.

Test statistics ^a	
Z	-1.209 ^b
Asymp. Sig. [2-tailed]	.227

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Between the results of the tests for after active treatment and after two months of active therapy there wasn't a significant difference. This represents the fact that the results of the tDCS device are still stable after two months [$P = 0.227$, $Z = -1.209$].

Consequences

Depression after myocardial infarction (heart failure) is one of the most common injuries of cognitive ability in people. Sad and depressed mood, lack of interest or pleasure, significant change in weight or

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appetite, insomnia or hypersomnia, fatigue or loss of energy, feelings of futility or guilt, reducing the ability to think or concentrate are the main symptoms of this disorder. Nowadays, many methods have been proposed for the treatment of depression, but it looks that these treatments however are inadequate. One of the most effective treatments is treatment with direct current electrical stimulation of the skull. This way will pass an electricity with a weak, short current polarity into the cortex through a pair of electrodes. And according to the polarization or the polarity of direction of electricity, excitability of the brain can be increased by anode or can be decreased by stimulating cathode (Fregni *et al.*, 2005).

Most of the initial studies on direct current electrical stimulation in humans have been conducted on the brain's cortex. Because controlling of the brain excitability changes is much easier in compared with other parts of brain. The brain has two hemispheres. Each part of hemisphere has different functions and damaging them may cause disease. Depression is a disease caused by damage to the left hemisphere. The Study of Baker *et al.*, (2005) represents a linear positive relationship between the degree of activation of the left hemisphere, especially in the left frontal cortex and cure depression. They concluded that the left hemisphere is extremely significant for depression. Other studies showed that tDCS over a part of left frontal cortex accelerates the recovery of depression and slows the progression of depression (Baker *et al.*, 2010).

Thus, according to the important role of the left hemisphere, particularly the prefrontal cortex, we assessed the effectiveness of direct current electrical stimulation of the prefrontal cortex in patients with depressive disorder in Persian.

Monti *et al.*, (2008) measured the cognitive function before and immediately after tDCS of the left front temporal areas affected by a computer-controlled activities and concluded that the cathode tDCS over left front temporal areas can improve the depression in patients with chronic depression (Naeser *et al.*, 2010). It appears that the anodic tDCS enhances the ability of cortical excitability and generally improves the Patients' cognitive ability and depression through stimulation of the left frontal cortex that is similar to our study. Other studies have shown that the position of the left hemisphere cortical effect in alleviating depression. It is likely that improvements in cognitive function following treatment of depression are at least partially dependent on small areas of the left hemisphere (Monti *et al.*, 2008). This study is in agreement with the results of our research, but like many other studies, it has examined the durability of treatment effects.

Fury *et al.*, (2011) in his study found an overall improvement in depression by stimulating anode compared to false stimulation of left frontal [1 mA, 20 minutes a day for 5 days], but no significant difference was found between the two groups at one month after treatment (Fiori *et al.*, 2011). However, our results suggest that the therapeutic effects of tDCS have remained two months after treatment. According to the results of this study, it appears that the durability of the therapeutic effects of tDCS increases by increasing the intensity, the number of treatment sessions and application of the cathode and anode electrodes simultaneously.

Recent studies have suggested that patients with depression often show some impairment in their active memory (Butefisch *et al.*, 2008). Trynno *et al.*, (2010) and Bailey *et al.*, (2011) study showed that the DLPFC stimulation by tDCS can effect on active memory, risk behavior, decision-making and the emotional response to visual stimulus in healthy individuals. In addition, stimulation of the prefrontal cortex by tDCS has been demonstrated that the implementation of a learning activity will affect the classification. So convincingly it has been shown that tDCS could affect the functions of the prefrontal cortex (Beeli *et al.*, 2011; Zaehle *et al.*, 2011). In bug *et al.*, (2008) study, during 10 days and 20 minutes, they stimulated DLPFC area in patients and the stimulating effects was observed until 30 days after treatment. In addition, Fregni *et al.*, (2006), during 5 days and 20 minutes, stimulated M1 and DLPFC areas in patients with fibromyalgia and the stimulation treatment effects were observed up to three weeks which this confirms the results of this study on Durability of treatment effects up to two months.

Our results showed that 10 sessions of 20 minutes at a time with 2 mA anode and cathode in the left and right DLPFC area dramatically improve depression in depressed patients after myocardial infarction compared with the dummy tDCS. These effects were also observed in two months after treatment.

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Thus, by increasing the number of treatment sessions, and increasing the flow rate, durability of the therapeutic effect of tDCS can be increased and it can be used as one of the complementary therapies in the treatment of depression following myocardial infarction in patients in the future.

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