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Original Article

Investigating the effectiveness of Transcranial Direct Current Stimulation (tDCS) on the treatment of anxiety disorder in chronic renal dialysis patients

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Abstract

Patients undergoing hemodialysis experience various problems related to the complications of the disease such as physical, economic, social and psychological problems that can be the cause of mental disorders in such patients. The aim of this study was to investigate the effectiveness of tDCS brain electrical stimulation on the treatment of anxiety disorder in chronic renal dialysis patients. This quasi-experimental study was performed on 30 male hemodialysis patients with records in the Kidney Patients Support Association and private centers in Tehran. Patients were selected by convenience sampling and were randomly divided into an experimental (n = 15) and a control (n = 15) groups. The patients in the experimental group underwent the effect of electrical stimulation of tDCS brain with an intensity of 2 mA in 10 sessions of 45 minutes. Data collection tool included Depression, Anxiety and Stress Questionnaire (DASS-21). The data were analyzed using SPSS software (version 21) through analysis of covariance. The results showed that the mean score of anxiety before the intervention in the experimental and control groups was not significantly different ($p > .05$); however, after the intervention, the difference in the experimental group was significantly smaller than the control group ($p < .001$). Also, the mean score of anxiety in patients in the experimental group after the intervention was significantly lower than before ($p < .001$). No significant difference was found in the control group ($p > .05$). The results revealed that the effectiveness of brain electrical stimulation has an effect on reducing anxiety and stress in hemodialysis patients.

Keywords

Transcranial direct current stimulation, anxiety, chronic renal disease, dialysis.

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Introduction

Chronic renal failure is a progressive and irreversible destruction of renal function that has several complications and disorders due to its systematic effects. The main treatment for the last stage of renal failure is hemodialysis and finally kidney transplantation (Mollahadi et al., 2010). Today, 2-3% of the world's population suffers from chronic kidney disease, and every 7 years, the number of people with kidney disease doubles. The number of annual deaths due to this disease in the world is 60,000 (Parvenu et al., 2010) and in Iran, the number of hemodialysis patients increases by about 15% annually (Monfared et al., 2009). Patients with chronic renal failure, in addition to numerous physiological changes, face many psychological stresses. On the one hand, due to the awareness of the severity of their disease, these patients are forced to endure the stresses associated with exhausting medical procedures, including dialysis, and on the other hand, their psycho-social function is severely affected by the prolongation of the disease; So that most of them suffer from mental disorders such as: social relations disorders, anxiety and depression (Tagay et al., 2007). On the other hand, inability to concentrate for a long time, burning sensation in the body, restless legs syndrome, drooping legs and even complete paralysis, are among the complications in the nervous systems of dialysis patients (Luckman and Sorensen, 1997). These factors are associated with many psychological stresses. In turn, it can disrupt the psyche and personality of patients; So that most of them are not adapted to problems and tensions and suffer from behavioral changes such as: anxiety, depression and isolation (Baraz et al., 2006).

Mental health is one of the social needs because the proper functioning of a society requires people who are in

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good health and mental health (Movahed Abtani, 2009). One of the most important reasons for the importance of mental health research is the high prevalence, disability and very severe and long-term of some mental disorders (Najarasel, 2005; Nairi and HajBagheri, 2006). The World Health Organization defines health as "the state in which a person is psychologically, emotionally, and socially capable of living in harmony with themselves and the environment" (Tyson, Wilson, Crohn, Brylsford, & Laos, 2010; Monteiro, Pereira, & Sarmento, 2015). Stress, anxiety and depression as components of mental health can have negative effects on health, quality of life, academic achievement and patients' readiness to accept their professional roles that pay attention to it and its consequences and also adopt appropriate strategies. It is especially important to get rid of it (Kim Young, 2015).

Anxiety includes feelings of insecurity, helplessness, and physiological arousal. In general, anxiety is a diffuse, very unpleasant, and often vague feeling of anxiety that is accompanied by one or more physical sensations such as nausea, chest tightness, palpitations, sweating, headache, etc. (Gamun et al., 2005). Anxiety is a natural emotion in humans, which everyone experiences in certain situations of life. Many people become nervous and anxious when they have trouble at work, before trying or making sensitive decisions. However, people with anxiety disorders have irrational fears and excessive anxiety about everyday situations (Kim Young, 2015).

According to the results of the study of Malahadi et al. (2019) regarding the rate of depression, anxiety and stress in dialysis patients, 63.9% of patients were anxious, 60.5% were depressed and 51.7% were stressed (Mollahadi, 2010). Anxiety is an important factor in reducing treatment adherence. Lack of participation of anxiety patients in treatment adds to their medical problems and endangers their health and ultimately leads to their premature death (Afshar et al., 2010). Anxiety also prevents adherence to recommended diets and treatments and has a negative effect on self-care and treatment outcomes. Patients with higher social support and lower levels of anxiety have higher levels of self-care (Mollaoglu, 2006). Therefore, maintaining mental health and controlling depression, anxiety and stress in these patients is very important. The results of a study showed that between depression, anxiety and stress and non-adherence of hemodialysis patients to the diet

There is a significant correlation between recommended and even necessary treatments, and this can endanger the patient's health and accelerate his death (Yurtkuran et al., 2006).

Treatment for depression, anxiety, and stress includes both pharmacological and non-pharmacological interventions. Given the many problems and complications of drug therapy, it makes sense to use non-pharmacological methods that can reduce depression, anxiety and stress in patients with chronic renal failure. Due to the high cost and side effects of drug methods, stress and dependence on these drugs, non-drug methods can be used to control patients' anxiety, depression and stress (Bagheri et al., 2003).

So far, various non-pharmacological methods such as complementary medicine have been studied to reduce anxiety and depression in various diseases and conditions, including acupuncture and acupressure and tDCS (Tayebi et al., 2015). Some of these methods, while useful, have their own limitations.

Cranial electrical stimulation (tDCS) therapy is one of these treatment options. TDCS involves the use of low-voltage stimulation (often 2 mA) through electrodes attached to the scalp, in which tDCS works by changing the firing threshold of cortical neurons so that nerve cells near the anode electrode (pole) (Positive) become very similar to fire and begin to function, and cells near the cathode (negative pole) become less like fire. Anodic tDCS in the left hemisphere can increase brain activity in patients. In a study by Schneider et al. it was shown that stimulation of tDCS in the DLPFC region could improve language learning. Stimulation in areas of the brain can also improve cognitive function and language responses in autistic individuals. In this study, the effectiveness of tDCS stimulation was tested in two scales, the CARS Childhood Autism Scale and the Autism Assessment Checklist (ATEC). TDCS is a safe and non-invasive method of brain stimulation in which a magnetic field induces an electric field in the cerebral cortex. This electric field causes depolarization of neurons. An effective tDCS device was first developed in 1985 by Anthony Baker at the University of Sheffield in the United Kingdom. This device was designed as a neural diagnostic device; which activates cortical motor neurons and subsequently evokes potential in muscle tissue (Bess et al., 2014). The human brain can be safely stimulated non-invasively by strong magnetic fields. These fields cause a current to flow in the stimulated tissues; which leads to the stimulation of brain neurons. More focus on TMS was created when it was used to image different areas involved in vision, memory, and muscle control (Baker et al., 2017).

Hemodialysis patients are at high risk for disorders such as stress, anxiety and depression, among which the effective role of tDCS electrical stimulation of the brain as a therapeutic approach may be effective in reducing the symptoms of depression, anxiety and stress in these patients. The results of various studies have shown that male dialysis patients are more anxious than female patients (Mardani Hamooleh and Heydari, 2009). Ahmadizadeh and Rezaei (2016) showed in their research that electrical stimulation of direct transcranial current of the brain has a positive and significant effect on depression, anxiety and rumination in patients with post-traumatic stress disorder. Wonderhassel et al. () Showed that by stimulating the brain, psychiatric symptoms such as depression, anxiety, and rumination could be reduced to some extent.

Given that stress, anxiety and depression cause problems in patients' personal lives (Kim Young, 2015, Pederson, 2013), due to the high prevalence of depression, anxiety and stress in hemodialysis patients, especially in men, and ease in Availability, no need for special equipment, low cost and no side effects, this

study was performed to evaluate the effectiveness of tDCS electrical brain stimulation on the treatment of anxiety disorder in patients with chronic renal dialysis. The results of this research will be useful and useful for all psychologists, counselors, clinics, universities, educational instructors. In addition, the results of this type of research can be a breakthrough for researchers and psychology students who will do research in this field.

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Method

Participants

In this quasi-experimental study with pre-test-post-test design and control group, among male hemodialysis patients (ESRD) with a file in the Association of Kidney Patients and Private Centers in Tehran in 1399 who met the inclusion criteria, 30 people volunteered were chosen. Randomly selected patients were divided into experimental (n = 15) and control (n = 15) groups (Delavar, 2011). The whole intervention process in the clinic was performed individually and ethically, after the end of the research, the control and control groups were informed of the research results.

Inclusion criteria include: confirmation of diagnosis by a specialist, severe and very severe anxiety based on the DASS-21 questionnaire (anxiety above 8), and no other chronic diseases such as: orthopedic, rheumatological and neurological, ability to communicate and cooperate was willing to participate in the study and had at least one year of dialysis treatment history.

The method was that first all hemodialysis patients completed the Depression, Anxiety and Stress Questionnaire (DASS-21); then, 30 patients who scored above 14 in at least one of the anxiety subscales of this questionnaire were selected. After explaining the objectives of the study, encouraging cooperation and obtaining informed consent, patients entered the study and were randomly divided into two experimental groups (15 N) and control (n = 15) and the score obtained from the questionnaire was considered as the pre-test score of patients. The patients in the experimental group were exposed to the electrical stimulation of tDCS brain with a intensity of 2 mA in 10 sessions of 20 minutes, weekly. In each session, the first 15 minutes were spent discussing how to do the treatment.

Instrument

Depression, Anxiety and Stress Questionnaire (DASS-21):

The data collection tool was the Depression, Anxiety and Stress Questionnaire (DASS-21) developed by Lovibond in 1995. This scale has 21 terms that evaluate each of the psychological structures of depression, anxiety and stress by 7 different terms. The score of each structure is obtained through the sum of the scores of the related questions. Each question is scored based on the Likert four-point range from not true of me at all (with a score of zero) to completely true of me (with a score of 3). Thus, the score of each subscale will be at least zero and at most 21. In Taybi et al.'s study, the reliability of the questionnaire using Cronbach's alpha for depression, anxiety and stress was 0.79, 0.72 and 0.80, respectively (Tayebi et al., 2015).

This scale is one of the most reliable tools for measuring the symptoms of negative emotions and its reliability and validity have been confirmed in numerous studies (Anthony, Billing, Cox, Anne and Swinson, 1998; Brown, Chorpita, Crotitch and Barlow, 1997; Besharat, 2005; Daza, Navi, Stanley & April, 2002; Loveband, 1998; Loveband & Loveband, 1995; Norton, 2007). Besharat (2005) reported Cronbach's alpha coefficients of the Stress Anxiety Depression Scale on the sample scores of the general population (n = 278) 0.87 for depression, 0.85 for anxiety, 0.89 for stress, and 0.91 for the entire scale. These coefficients were reported for clinical sample scores (n = 194) as 0.89 for depression, 0.91 for anxiety, 0.87 for stress and 0.93 for the whole scale. These coefficients confirm the internal consistency of the Stress Anxiety Depression Scale to a good extent. Simultaneous, convergent and diagnostic (differential) validity of the Stress Anxiety Depression Scale through simultaneous implementation of the Beck Depression Inventory, the Beck Anxiety Scale, the list of positive and negative emotions, and the Mental Health Scale for subjects and comparing the scores of the general and clinical population And was approved (Besharat, 2005). The results of Pearson correlation coefficients showed that there was a significant positive correlation between the subjects' scores on the Depression, Anxiety and Stress scales and the Beck Depression, Beck Anxiety, Negative Emotions and

Psychological Helplessness scores from 0.44 to 0.61 (P <0.001). And with Positive emotions and psychological well-being There is a significant negative correlation from 0.41 to 0.58 (p <0.001). These results confirm the simultaneous, convergent, and diagnostic validity of the Stress Anxiety Depression Scale.

Procedure

In this study, we tried to consider and implement the ethical codes proposed by the American Psychological Association (2003). At the beginning of the research, while providing sufficient explanations to the candidates to participate in the research about the importance, method, duration and conditions of the research and evaluations, their consent to participate in the research was obtained, and also tried to make all ethical considerations about not referring to The names and identities of the participants in the research should be observed when reporting the research results.

Data were analyzed using SPSS statistical software (version 19) and descriptive analyzes such as mean and standard deviation and independent t-test and analysis of covariance at the significance level of 0.05.

Results

Table 1 shows the mean and standard deviation of anxiety scores by group of participants. According to the information in this table, in the post-test, the mean anxiety scores of the control group are higher than the experimental group.

Table 1. Descriptive indices of research variables in post-test of control and experimental groups

Variable	Examination Group		Control Group	
Anxiety	Mean	Standard deviation	Mean	Standard deviation
	10.70	3.66	18.04	2.56

According to Table 2, the results of Kolmogorov-Smirnov test show that the data skew is not significant for any of the groups and the scores of anxiety variables are normal in both groups.

Table 2. Results of Kolmogorov-Smirnov test for anxiety variable

Variable	Kolmogorov Smirnov	Significance level
Control Group	0.743	0.639
Examination Group	0.817	0.516

On the other hand, due to the fact that the skew of data distribution was not significant in Kolmogorf-Smirnov test, so to test the questions, T-test, two independent samples for post-test scores and analysis of covariance were used. In the following, each of the research questions is examined below.

Table 3. T-test results for two independent groups on anxiety levels

Variable	Group	Number	Mean	difference in mean	t value	Df	Sig.
Anxiety	The experiment	15	10.70	-6.49	-17.92	298	0.000
	Control	15	18.04				

The results showed that the mean anxiety of patients in the experimental group after the test was 10.70 and the mean anxiety of patients in the control group was 18.04. Also, the value of t was -17.92 and the significance level was 0.000 (P <0.01). Given that the value of t is at the level of 01 /. It was significant, so it can be said with 99% confidence that there was a significant difference between the level of anxiety of patients in the experimental group and patients in the control group after the test. By referring to the mean anxiety of patients in the experimental group and patients in the control group in the post-test, and comparing them with each other, it was found that patients in the control group have higher levels of anxiety than patients in the experimental group in the post-test.

For examining the necessary assumptions for using covariance analysis, as mentioned, using the analysis of covariance test requires observing some basic assumptions, which are the normality of dependent variable and control scores, homogeneity of variance and homogeneity of regression lines. . In this study, these assumptions were examined.

Homogeneity of error variances for the two experimental and control groups: Homogeneity of error variance is one of the most important assumptions of analysis of covariance performed by Levine test. Table (4) uses the Levin test to test this hypothesis. As can be seen in this table, the value of F for the Levin test is not significant. This insignificance of Levin test indicates that the error variance between the control and

experimental groups is not significantly different from each other. Therefore, the second important assumption of the analysis of covariance is established.

Table 4. Levene's test to test the assumption of homogeneity of variance

The dependent variable	F value	The first degree of freedom	Second degree of freedom	The significance level
Anxiety	2.037	1	28	0.165

Parallel regression lines: There are different methods to test this assumption. One valid method is that there should be no interaction between the pre-test variable and the group. As shown in the table, the size of Armon f is not significant for the interaction between the group and the pre-test anxiety scores of the two groups. In other words, there is a condition of non-interaction. That is, the regression lines are parallel (Table 5).

Table 5. Investigation of group interaction and pre-test (parallelism of regression lines)

Source of variance	Total squares	Degrees of freedom	Mean cubes	Test F	The significance level
Anxiety pre-test group	1.829	1	1.829	0.205	0.654

Because all of these assumptions were met, the use of covariance analysis is unrestricted.

Table 6. Results of covariance test

Resources	Total squares	Df	MS	F	Significace	A small square
Modified model	2332.099	2	1166.050	129.366	.000	.906
Width of origin	.116	1	.116	.013	.911	.000
Anxiety pre-test	1601.966	1	1601.966	177.728	.000	.868
Group (independent variable)	532.347	1	532.347	59.060	.000	.686
Error	243.367	27	9.014			
Total	336272.000	32				
Modified plural	2575.467	39				

As shown in Table (6), the sum of the squares and the mean squares of the groups are 532.347 and F = 59.060, which is significant at the level of P 0.0 0.01. In other words, there was a significant difference between the groups after adjusting the pre-test scores and electrical stimulation of tDCS brain had a significant effect on the treatment of anxiety disorder in chronic renal dialysis patients. The partial square (effect size) for the effect of the independent variable on the dependent variable is 0.686, which indicates that 68% of the changes in the dependent variable are explained by the independent variable. That is, electrical stimulation of the tDCS brain was able to affect 68% of the anxiety rate of chronic kidney patients on dialysis.
F (1.27) = 59/060, P <0/01, PARTIAL ETA = 0/686

Discussion

Electrical stimulation of the brain tDCS is a safe and non-invasive method of electromagnetic stimulation of the brain. TDCS is actually the application of the induction principle to obtain electrical current at the surface of brain tissues. By placing a coil on the skull and passing a strong and variable current through it, a magnetic field is generated that penetrates into the skull without obstruction. As a result, this variable magnetic field induces a current inside the brain, and this current penetrates into the membrane of neurons and leads to the occurrence of action potential (Williams and Sazin, 2014). Electrical stimulation of the cerebral cortex can contract or inhibit a muscle, as well as explain why each part of the brain works. A non-invasive mapping technique, such as FMRI, allows researchers to see which parts of the brain are activated when a human does something. This is an important evidence of the role of that part in doing that work (Wells, Hamada, Rutwell, and Garfax, 2014). TDCS is a safe technique and has few known side effects. The use of electrical stimulation of the brain is in both diagnostic and therapeutic aspects and its use in the treatment of depression, migraine, chronic pain, addiction, etc. has been proven (Kalamji et al., 2018).
The whole human brain can be safely stimulated non-invasively by strong electric fields. These fields cause a current to flow in the stimulated tissues; which stimulates neurons in the brain. In mental disorders, focal brain activity is seen in many clinical syndromes. Repeated use of tDCS has been suggested as a treatment for selectively altering brain activity.

The results of the present study and other similar studies show that using low-risk, low-cost, easy methods and performing these methods by patients can help reduce their depression, anxiety and stress, and these methods can be used as a routine in nursing care in hemodialysis patients. To be taken. In the present study, due to the

limited statistical population, sampling was done in an accessible and voluntary manner. Also, the results of the study can be generalized only to male hemodialysis patients. These findings can expand our theoretical awareness of psychological problems, mental health, and psychological well-being.
In addition, the present results raise new questions and hypotheses that can be explored and researched later. For example, are these variables different in different regions of the country? Is this relationship different in other patients? What are the strategies to improve psychological well-being and symptoms of depression, anxiety and stress in kidney patients? In general, the results of the present study can guide more recent research to expand psychological knowledge in the field of resilience, hard work, psychological well-being and symptoms of depression, anxiety and stress in patients. At the practical level, the results of the present study can help psychologists and counselors to better diagnose the symptoms of depression, anxiety and stress in kidney patients and increase the awareness of specialists. In addition, the results of this study can be used in the treatment of psychological problems, depression, anxiety and stress in kidney patients.
It is suggested that such studies be performed in different groups in terms of demographic characteristics such as: gender and different age groups; Also, this study should be repeated with long-term follow-up to determine the long-term effects of the intervention and the stability of the results. It is suggested that the sample be made with a larger volume and taking into account the sex factor (separately) to achieve more complete results by studying both sexes.
Due to the high prevalence of depressive disorders, anxiety and stress in hemodialysis patients and the results of this study, which confirms the effectiveness of tDCS brain stimulation in the treatment of chronic kidney disease in patients with anxiety disorder, it is suggested that tDCS brain stimulation techniques be included. Low-cost and simple Dosaho has taken an effective step towards recovery and even prevention of depression, anxiety and stress in chronic diseases.

Conclusion

The aim of this study was to evaluate the effectiveness of tDCS brain electrical stimulation on the treatment of anxiety disorder in chronic renal dialysis patients. Findings showed that the effectiveness of electrical stimulation of tDCS brain had a significant effect on the treatment of anxiety disorder in chronic renal dialysis patients. The results of this study are consistent with the results of Maroon et al. (2016), Leo et al. (2017), Shizawa et al. (2018), Khezr et al. (2020). In general, the results of this study showed that tDCS can be used as a potential non-invasive treatment to reduce the anxiety symptoms of dialysis patients. But more studies are needed to determine the optimal stimulation parameters in order to maximize mood.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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