

Studying and comparing the effectiveness of brain stimulation over the skull through TDCS direct electrical current and matrix to reduce craving of methamphetamine

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Abstract

Purpose: the purpose of the present research was to study and compare the effectiveness of brain stimulation over the skull through TDCS direct electrical current and matrix to reduce craving of methamphetamine.

Method: the statistical population of the research included 45 individuals who have been selected by random sampling from addict people who randomly referred to the Khorshid and Miad addiction clinics of Kermanshah. They have been placed randomly in three groups of 15. First of all, pre-test was implemented for all three groups (assessment questionnaire of momentary craving of drugs), then treatment approach of brain stimulation over the skull was done by using direct electrical current (it included 15 daily sessions of 10 minutes with 2 mA on dorsal-lateral prefrontal cortex), and matrix treatment protocol was done on the for the second group (it included 24 daily sessions of one hour), and the third group as Control group received no treatment, post-test (assessment questionnaire of momentary craving of drug) was implemented for three groups at the end of all sessions.

Analysis: covariance analysis and post hoc Bonferroni test have been used in the present research.

Findings: findings indicated the effectiveness of both therapeutic models on reducing the craving of methamphetamine. Also, the results showed that matrix method was more effective on reducing the level of craving methamphetamine than brain stimulation over the skull by using direct electrical current.

Keywords: brain stimulation over the skull by using direct electrical current or TDCS, matrix, craving, methamphetamine.

Introduction:

Substance abuse is one of the acute social issues all over the world. On the other hand, the creation of synthetic, dangerous and laboratory materials added to the problems of intervention with substances. Methamphetamine is one of these dangerous substances. Amphetamines and methamphetamines have similar mechanism in the body. Both amphetamine and methamphetamine lead to release monoamine transporters, i.e. dopamine, serotonin and norepinephrine and increase the level of these transporters in synaptic space (Fterson and Lenton, 2011). Methamphetamines especially increase the release of dopamine in the stratum. It includes a choky nucleus, putamen and ventricular striatum and also, it is full of dopamine receptors. Ventricular striatum includes the nucleus accumbens which is an important area in the study of addiction. More than this, dopamine is considered as a transporter of pleasure in all addictive substances (Gavvo and Wang, Hey, Lei and Wang, 2003), however, today it is considered as an effective transporter for craving. Craving leads to continue substance uses (Solomon, Koorhav, Ferrar and Mingot, 2007). Craving has an important role in returning after treatment, keeping consumption and dependence to substances. In treatment process of addicts, in the level of abstain, there is a strong desire for re-experiencing the effects of psychoactive substance. So, diagnosis and treatment of this clinical disorder is very important as one of the factors to fail the treatment (Abramz, 2000). One of the important craving theories is incentive susceptibility pattern which is known as the pattern of neural adaptations. It considers the craving from involvement of the neural circuitry as neural substrate and the brain's reward system. Most of pathophysiological studies considered craving as a dysfunction in neural networks around brain areas such as amygdala, choky nucleus, anterior cingulate, orbital cortex areas of forehead and dorsal-lateral prefrontal cortex (DLPFC) (Gorge et al., 1996; Paskal, Leon et al., 1996; Marine, 2003). Dorsal-lateral prefrontal cortex region which interferes in incentive, reward and decision-making cycle, is one of the related areas of craving and any defect in the activities of this area would effect on its incidence (Kamperdon et al., 2007). In our country, the use of opiates and dependence to them based on cultural and geographic reasons has historical roots but in the last decade, using methamphetamine has become a serious problem in public health. In this situation, the image of substance use in Iran is changing to concomitant administration of drugs and stimulants. Despite understanding serious problems related to the methamphetamine abuse in the world in the way of public health, there have been established no drug treatment yet. Lack of specific drug treatment for detoxification of this substance would clear the importance of psychotherapy and the effect of psychotherapists in the treatment of methamphetamine abuse. In cognitive-behavioral psychotherapy, the therapists try to make some behavioral changes toward a life without substance use and moving away from their dangerous side effects. Finally, they guide individuals to a healthy life through changing their life style. Recently, matrix pattern is used in psychological treatment of dependence to stimulants. Matrix therapeutic method is a non-pharmacological treatment in glass dependents, and except in rare cases it does not require hospitalization. Despite psychological interventions, there is high split rate for these patients. In the last decade, there is strong attempt for effective medical therapy for these patients, however, published studies in this field was not very promising (Alkashef et al., 2008). One of the ways to solve these dysfunctions in cerebral areas or brain reward pathways is therapeutic invasive and non-invasive methods. Brain stimulation over the skull by using direct electrical current (TDCS) is considered as one of these methods. It is a non-invasive method in which poorly direct current would be applied to the scalp and make long-

term changes in the polarity of cortical neurons in neuronal depolarization and hyperpolarization and it also effects on nerve receptors (Nitsch et al., 2003). Professor Pascal Leone et al. (2007) have studied the effect of TDCS method on risky decision making. They stimulated the brain activity in lateral - posterior prefrontal cortex (DLPFC) as stimulating the right side and inhibiting the left side or vice-versa and they found that the subjects' risky behaviors have been reduced. Most of conducted TDCSs were not done in the format of clinical researches in Russian and it was used for treatment of alcoholism, pain and depression or a combination of these problems (Figner, 1973). The results of a research based on studying the effect of direct electrical stimulation in cerebral cortex to control craving alcohol indicated that a significant reduction was observed in alcohol craving of patients who received activated stimulation of TDCS (Bigo, 2008). It is suggested in some studies that a modification in brain activities in lateral - posterior prefrontal cortex (DLPFC) led to reduce the rate of impulsive activity by using TDCS (Fective, 2007, E. B. Kenj, 2006). However, according to conducted studies, still no research has been carried out about the formation of methamphetamine craving by TDCS. The purpose of the present research was to identify the effect of brain stimulation over the skull by using direct electrical current or TDCS on the level of methamphetamine craving and to compare it with cognitive-behavioral method (matrix).

The research questions:

- 1) Is the brain stimulation over the skull by using TDCS direct electrical current effective on reducing methamphetamine craving?
- 2) Is matrix method effective on reducing the level of methamphetamine craving?
- 3) Is there a significant difference between the method of brain stimulation by using electrical current or TDCS and matrix method in reducing the level of methamphetamine craving?

Sample size and sampling

45 individuals have been selected randomly from addicts who referred to Khorshid addiction clinic of Kermanshah. They have been placed randomly in three groups of 15 individuals. Pre-test was implemented for all three groups. Then therapeutic protocol of brain stimulation over skull by using direct electrical current or TDCS was applied on the first group and matrix therapeutic protocol was applied on the second group. The third group received no treatment. Post-test was implemented after finishing therapeutic protocols.

Inclusion and exclusion criteria: inclusion criteria included the age range of 20-50, completing informed consent form and recognizing methamphetamine consumer by psychiatrist of the clinic. Exclusion criteria included experience of repeated magnetic stimulation therapy for any kind of disorder, having metal, prosthesis, and implant in the skull or heart pacemaker, experience of head injury or tetanus in patient or his family members, having a history of bipolar disorder or psychotic symptoms, pump for patients with acute heart diseases, increased tetanus because of increase in intracranial pressure, experiencing epilepsy and loss of consciousness for 5 minutes and patients with the possibility to commit suicide.

Measuring tools

Assessment questionnaire of momentary substance craving 1: it was developed with focus on craving as a motivational state by Franken, Handriks and Van Den Brink (2002). It assesses craving in the present time and includes 3 factors (tendency toward craving, desire to consume and negative reinforcement, pleasure and intensity of lack of control) and has 14 items. The basic form of questionnaire was created by Lowe (1998) to assess alcohol craving (DAQ). Franken has made the questionnaire of heroin craving based on alcohol craving questionnaire in 2002. Ziaberi has utilized this questionnaire in Iranian society about glass craving.

Matrix therapeutic protocol: it was prepared due to the matrix institute treatment program in California. It is considered as an intensive and outpatient treatment in sessions of 24 hours which includes sessions such as (Makeri, 2014):

Brain stimulation over the skull by using TDCS direct electrical current:

TDCS: is a simple device which is fed with 9-volt battery and generates a poor electrical current that may change from 0.5 to 4 mA. But the current intensity that is usually used in treatments is in the range of 0.5 to 2 mA. In the present research, direct electrical current has been used in 15 sessions of 10 minutes with 2 mA in dorsal-lateral prefrontal area by the therapist.

Data analysis: covariance analysis and Benferroni's post hoc test were used in the research.

Research results

Checking the first question: is brain stimulation over the skull by using TDCS direct electrical current effective on reducing methamphetamine craving?

Table 10-4: summary covariance analysis of the effect of brain stimulation over the skull by using direct electrical current or TDCS

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Source of change	SS	MS	F	sig	Eta
Pre-test	1.093	1.093	0.037	0.850	0.001
Group	5314.820	5314.820	178.016	0.000	0.868
Error	806.107	29.856			

The results of covariance analysis test after adjusting the effect of pretest in table 10-4 indicates that there is positive effect on the method of brain stimulation over the skull by using direct electrical currents of TDCS on studied addicts. Significant effect of this method has been confirmed and by considering Eta coefficient can mention that this method explains 86% variance post test score of TDCS method after adjusting the effect of pretest.

Checking the second question: is matrix effective on reducing the level of methamphetamine craving?

Source of control	SS	MS	F	Sig	Eta
Pre-test	84.075	84.075	6.787	0.015	0.201
Group	8161.707	8161.707	658.875	0.000	0.961
Error	334.458	12.387			

The results of covariance analysis in table 12-4 after adjusting the effect of pre-test indicates that matrix has a positive effect on studied addicts. The significant effect of the use of this method has been

confirmed and by considering eta coefficient, it can be said that matrix method explains 96% variance of post test score after adjusting the effect of pre-test.

Checking the third question: Is there a significant difference between the method of brain stimulation by using electrical current or TDCS and matrix method in reducing the level of methamphetamine craving?

Table 13-4: covariance analysis to compare three groups of electrical current, matrix and control group

Source of changes	Sum of squares	Degree of freedom	Mean of squares	F statistic	Level of significance
Intergroup	44/9534	2	4767.22	206.38	0.000
Intragroup	970.13	42	23.09		
Total	10504.57	44			

It is observed in table 13-4 that the level of significance of test is 0.000. Since the level of significance is smaller than 0.05, it reveals that the mean of methamphetamine craving is different in three groups. Benferroni's post hoc test is utilized to study the differences in the mean of methamphetamine craving.

Table 14-4: Benferroni's post hoc test to study the differences between mean

		Distance				confidence
groups		Mean differences	Error deviations	Level of significance	Lower bound	Higher bound
TDCS	Matrix	6.66	1.755	0.001	2.29	11.04
	Control	-27.00	1.755	0.000	-31.38	-22.62
Matrix	TDCS	-6.66	1.755	0.001	-11.04	-2.29
	Control	-33.66	1.755	0.000	-38.04	-22.29
Control	TDCS	27.00	1.755	0.001	22.62	31.38
	Matrix	33.66	1.755	0.000	29.29	38.04

As it is observed in table 14-4, level of significance of all tests are smaller than 0.05, in other word it is confirmed that there is difference between groups. Also, it is interfered from the difference between mean of TDCS method and mean of matrix method that is 6.66 that matrix method has greater effect on reducing the level of methamphetamine craving. As well as, some great numbers such as 27.00 and 33.66 indicate that there is great difference between mean of the level of craving in control group and the TDCS and matrix group.

Discussion and conclusion

The results of the present research showed that the brain stimulation over the skull by using direct electrical current (TDCS) is effective on reducing methamphetamine craving. It is consistent with findings of pervious researches in the effectiveness of the brain stimulation over the skull by using direct electrical current on reducing craving (Fletenstin and Sie, 2008; Topert, Brwon, Barata and Brown, 2004). Stimulants such as cocain and methamphetamine lead to direct increase of the level of dopamine in the circuit of meso-limbic cortex (international organization of substance abuse, 2002; Fletenstin and Sie, 2008). Making long-term changes in cortical excitability can be an explanation for useful obtained results among individuals who abuse methamphetamine by the brain stimulation over the skull by using direct

electrical current on dopamine neurotransmitter. So, studying the involvement of different brain regions has been noted more than before. Bilateral involvement of specific regions such as thalamus, choky nucleus, anterior cingulate cortex, orbitofrontal cortex, pupa, nucleus accumbens, and dorsal-lateral prefrontal cortex are considered in physical pathology of craving. Dorsal-lateral prefrontal activity has been reported in several studies (Bonson, Grant, Contorgiy, Likenz and Metkalf, 2002; Topert, 2004; Garavan, Penquvans, Bloom, Chou, and Spriy, 2000). Meanwhile, dorsal-lateral region of prefrontal has an important role as a region in relationship with pharmaceuticals and non-Pharmaceuticals craving (Kamprodon et al., 2007; Bogio, Feregni, Berempo, Monsoot, Rosa, 2005; Bogio, Solenti, Fecto, Morbat, Meka, 2008; Broodi, Mendelcorn, London, Childres, Lie, 2006; Feregni, Ligouri, Fegti, Paskal Leone, and bogio, 2008). Dorsal-lateral prefrontal cortex is a region which interferes in rewards, motivation and decision making, as well as it is an area to integrate motivational and cognitive information and creating preventive behaviors of tempting signs (Goldstin and Volko, 2002). Various mechanisms are explained for the effect of brain stimulation over the skull by using direct electrical currents in dorsal-lateral prefrontal cortex. First of all, stimulation in dorsal-lateral prefrontal cortex may lead to release dopamine in subcortical regions of the choky nucleus (Fits Jerald, Daska Lakis, Houy, Farzan, Hopton, and Kooper, 2008), secondly it leads to direct stimulating the goal areas and to spread the effect of stimulation to the opposite hemisphere cortex and it stimulates subcortical activities in attached neural network to stimulate areas (Kopraddon, Martins-Rega, Alonso, Shie and Paskal Leone, 2007). The study of Komprodon et al. (2007) indicated that dorsal-lateral activity of prefrontal cortex in right hemisphere increases in response to craving symptoms. On the other hand, some studies refer to the activity of left hemisphere in craving (Goldstin and Volco, 2002; Amiaz et al., 2009) as well as, the results of the present research show that matrix method has effect on reducing methamphetamine craving. Most of conducted studies suggested 50% effectiveness of matrix method in improvement of addicts craving that can confirm appropriateness of this method (Choner and Gersol, 2008). In fact, most of therapists combined important features of matrix method to create a useful method for changing addicts' behavior. They emphasize on clear purposes to change people's interpretation of their position through this treatment method. They try to help clients to distinguish serious and realistic problems from imaginary or exaggerated problems. They also help clients to change their impressions from last events, current issues and future possibilities. On the other hand, changing attitudes is an ability to manage emotions and inhibit them. Training therapy can increase individuals' cognitive abilities in coping with risky situations and also provide necessary behavioral skills in dealing with such situations by matrix method and through combining cognitive and behavioral skills. The results of the research show that matrix method has greater effect on reducing the level of methamphetamine craving through brain stimulation over the skull by using direct electrical current (TDCS). No treatment method can be successful in the field of addiction by itself. Appropriate therapeutic approach should be able to effect on different aspects at the same time and have no problem in past therapeutic methods such as reversibility and shallowness by considering the complexity of the aspects of mental health. So, in the present research, an appropriate psychotherapy could response to most of needs of patients with addiction to methamphetamine in the period of treatment, and matrix pattern has been selected from therapeutic methods. As matrix method is adjusted with their daily life and behaviors, it is considered as an appropriate therapeutic approach for these clients. Active presence of experimental group in group sessions of the research indicates that patients could make a good relationship with this therapeutic method and become satisfied. Providing appropriate assignments caused them to deal with

some examples of their life and become aware of them. They would find how to reach a positive result and have better control on their belief and feelings by passing the treatment stages and applying some skills and make them automatic through practicing those skills in time duration. The more frequency of this process leads to decrease the possibility of being tempted and long-term effects of substance use in the future.

The research suggestions

- Since the effect of brain stimulation over the skull by using direct electrical current (TDCS) and matrix method have evaluated the level of Methamphetamine craving among males, it is suggested to study females in this field as well.
- In the present research, the effect of brain stimulation over skull by using direct electrical currents (TDCS) and matrix method on the level of methamphetamine craving have been studied. It is evident that its effect can be studied on other drugs craving.
- More widespread performance of this research led to provide a clearer image of the brain stimulation over skull by using direct electrical currents or TDCS and matrix method on the level of methamphetamine craving.

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