

Research Article**The Impact of Transcranial Direct Current Stimulation (tDCS) on Decreasing the Desire for Methamphetamine in Recovering Addicts Who Referred to Ilam's Taleqani Hospital in 2016**

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ABSTRACT:

Desire stage in the cycle of addiction is assumed to be a key element in the recurrence of abuse. The purpose of present research is to study the impact of transcranial direct current stimulation (tDCS) on decreasing the desire for Methamphetamine in recovering addicts who referred to Ilam's Taleqani hospital in 2016. Present research is quasi experimental. 40 persons participated in the study. They were divided into two experimental and control groups. Each group consisted of 20 persons. Experimental group the stimulations of anodal frontal 3 electrodes and cathodal right shoulder electrode during 20 sessions with on interval of 48 hours between sessions. Also control group received transcranial artificial current stimulations. We used SPSS software, version 16 to analyze data. The highest frequency of individuals relates to below 35 years age group with 39 percent and primary education with 36 percent. In addition, the assessment of induced desire in pre-test and post- test groups shows that the highest mean difference relates to the impact of tDCS in anodal frontal 3 stimulation ($P < 0.0001$). Results show that anodal frontal 3 stimulation meaningfully decreases the desire for Methamphetamine in comparison with cathodal right shoulder stimulation and control group. Since so far no study has been conducted regarding the impacts of tDCS on decreasing the desire for Methamphetamine, it is suggested to conduct further studied with larger sample size in other societies.

Key words: tDCS, Methamphetamine, Recovering Addicts, Ilam.

INTRODUCTION:

Addiction is drug dependence. Drugs contain all the compounds that cause changes in brain function and excitement, abnormal behavior, weakness and lethargy, angeriness, depression, false energy and impaired judgment and perception. Psychotropic substances use or consumption of opium that was called pleasure plant since the Sumerian civilization can be traced back in history to 7000 years ago [1]. Personality disintegration, destruction of the family, the increase of social crimes and other

types of damages, the decrease of work and job efficiency, the rise of unemployment, occupation of hospital beds, the drop of public health rate and dozens of other complications are all dependent on the number of addicts in the society so that addiction is considered as the fourth crisis in the world after nuclear crisis, the rise of population and the pollution of environment [2, 3]. The trend of drug abuse has changed relative to the past. First, today the average age of addicts has decreased relative to

previous years. Second, the pattern of abuse is moving from opium abuse as smoking to Methamphetamine as injection. Statistical results show the increasing growth of addicts in our society. Today drug abuse is one of the most important social damages. It not only endangers the health of the individual and society, but also provides mental and ethical degeneration [4, 5]. Unfortunately, the expansion of drug abuse scope in today's society is such that even thoughtful and educated people have been pulled to it [6]. Addiction treatment can be done in two ways: inpatient treatment and outpatient treatment. Outpatient treatment can be more effective and useful due to less need for equipment and investment as well as better and easier acceptance by patients, and many studies have shown the effectiveness of it [7]. In European and American countries, outpatient treatment of drug abuse is done in three abstinence, methadone maintenance and harm reduction ways [8]. In fact, the application of medication regardless of the dimensions of psychological, cultural and economic dependence of addict only relies on the removal of effective substance of drug while most of the experts believe that long- term psychotherapy and group therapy are more important for detoxified patients than detoxification itself. In addition, supplementary measures such as psychotherapy, group therapy, occupation therapy, exercise therapy, faith therapy and family therapy reduce recurrence rate from 25 percent to 2 percent [9]. Unfortunately, the concentration on medication causes the recurrence of disease in 80 percent of patients in less than 6 months [10]. The concept of desire for drug is one of the most important cognitive structures of interest in the knowledge of addiction. In fact, desire for drug can be considered as a personal experience and a multidimensional phenomenon that is associated with getting a pleasant feel or overcoming an unpleasant feel [11]. Therefore, the decrease of desire for drug plays an important role in the control of drug abuse complication. Methamphetamine is a stimulant drug of central nervous system that its consumption is increasing among youth and teenagers as one of

the ingredients of psychotropic pills [12, 13]. One of the most important side effects of Methamphetamine is psychotic disorders which causes a significant portion of psychiatric hospital beds allocates to patients with this disorder [14]. Transcranial direct current stimulation (tDCS) is one of the safe methods of treatment that has the least side effects. So far no severe side effect has been reported about the application of this method. Mild side effects have rarely been reported including very mild irritation at the electrodes site, fatigue and insomnia that have been resolved after 48 hours. As it was noted, the majority of patients had no side effect. According to the conducted researches, tDCS can adjust the perception of desire for drug via improving cortical excitability in the posterior- lateral area of frontal. The purpose of present research is to study the impact of tDCS methods on brain for decreasing the desire for Methamphetamine in recovering addicts who referred to Ilam's Taleqani hospital in 2016.

METHODS:

Present research is quasi experimental in which the answers of sample group to desire for drug questionnaire (DDQ) were analyzed in terms of psychometric indices. Statistical population of this research includes people with Methamphetamine abuse in Ilam city that referred to Ilam's Taleqani hospital for the treatment of Methamphetamine abuse. Now they are under treatment so that have passed at least one week of hospitalization and they have taken any effective drug in relation to the side effects of cutting dependence on Methamphetamine or any other drug during the seven days. So we randomly selected 40 men who referred to Ilam's Taleqani hospital for the treatment. Then, we collected demographic information and informed consent was obtained. Inclusion criteria include a diagnosis of abuse and dependence on methadone according to diagnostic statistical manual (DSM- V) by doctor at least for 12 months, avoidance of using any effective drugs at least for 1 week, responsiveness to induction of abuse signs and having at least primary education. In addition,

patients shouldn't have exclusion criteria including history of epilepsy, brain surgery, tumor and an effective hit to the head that led to unconsciousness. In this research, we used activadose inotophoresis that is made by Active Tek Company. In the first stage of interventions of this research, direct electronic current is received from a battery driven electric current generator of tDCS and transferred to a pair of 5×7 electrodes (35 cm²). Electrodes are made of carbon. They are inside a sponge cover that is soaked in a 10% NaCl solution. Anode electrode was on the posterior- lateral left area above the left eye and cathode electrode was on the right shoulder. A current was passed the brain with the intensity of 2 mA for 20 minutes during 20 sessions [15]. In the next step, control group received transcranial artificial current stimulation. The position of anode and cathode electrodes was similar to real stimulation for artificial stimulation. While current generator raises the current to 2 mA for 30 seconds, then it gradually reaches 0 mA for 30 seconds and power is turned off. But the electrodes were on the head of individual for 20 minutes and during 20 sessions and he was unaware that the device is off. To measure the created desire we used pictorial self- report test of measuring desire for Methamphetamine addicts [16]. In order to raise the level of accuracy of the results of research, a computerized test of computing the induction of consumption symptom (CCIC) was used. Its reliability was between 0.85- 0.88 and its Cronbach's alpha was 0.91 in the present research. The reliability of DDQ was between 0.13-0.79 and its Cronbach's alpha was 0.71 in the present research. In both sessions before and after the brain stimulation, induced desire was measured. After collecting data, we analyzed data using SPSS software version 16.

RESULTS:

Obtained results from demographic information showed that the highest frequency if individuals relates to age group of below 35 years with 39 percent and the lowest frequency of individuals relates to age group of above 50 years with 9 percent (table 1). Information about education level of individuals showed that the highest

frequency relates to individuals with primary education with 36 percent and the lowest frequency relates to individuals with middle school degree with 7 percent. Marital status of individuals showed that 66 percent of individuals are single and 34 percent of them are married. The complications of tDCS in anodal frontal 3 and cathodal right shoulder areas were as headache, vertigo, irritation of head, dizziness, drowsiness and nausea (table 2)($p>0.005$). Pre- test and post- test descriptive data of measuring induced desire in anodal frontal 3 and cathodal right shoulder stimulations showed that the highest mean difference in pre- test and post- test of measuring induced desire relates to anodal frontal stimulation (table 3)($p<0.005$).

DISCUSSION:

The use of electric current in small quantities for influencing brain function and creating the changes in it has attracted the attention of scientists since many years ago, but the history of using electric current and brain stimulation goes back to Roman and ancient Greek. Physicians of that period used a kind of fish for treatment of headache and other disorders that had the power of providing shock and electric rays. In this method, the fish was put on the forehead of the patient or the patient was asked to lie down on the live fish. Even in Iranian medicine Ibn Sina used a kind of fish with electricity to treat a series of diseases of the head. Transcranial direct current stimulation is a non invasive and safe treatment method in which brain stimulation is performed by electrodes that are on the head of patient. A very weak electric current is continuously and directly sent to the target cells in which the flexibility of neurons in the brain is stimulated. Mechanism of transcranial direct current stimulation (tDCS) is justified in several ways. First, through effects on ionic channels and the entry and exist of ions into and out of cells in the cerebral cortex. Second, through the effect on different neurotransmitters such as glutamate that has stimulatory effect and GABA that has inhibitory effects. Third, through the effect on RCBF that can influence the extent of regional

cerebral blood flow and oxy hemoglobin concentration of target regions. In fact, the effects of stimulation and continuation of this kind changes depend on duration of stimulation, the intensity of stimulation, the number of sessions and the position of cerebral damage [17 , 18]. tDCS can be effective in improving sensory disorders, memory disorders, speech disorders, different headache and migraine [19 , 20]. Indeed the movement of current in controller regions of heart and breathings rates in the brain stem can theoretically be dangerous. So that in the study of Monai et al (2016) reference electrode was in the legs of patient and the other electrodes were in the prefrontal cortex that a case of nausea and breathing problems were reported which the problems were resolved after discontinuation of the current [21]. In recent years, many researches have been conducted on the effectiveness of tDCS in the control of desire for drugs in addicts and have opened promising horizons to solve the problems that addictions therapists face them. The best method is a hybrid method in the treatment of drug abuse.

So far no research has been conducted on the implementation of brain electric stimulation method to reduce desire for drugs in Methamphetamine – dependent addicts. Present research studied the impact of tDCS on decreasing the desire for Methamphetamine in recovering addicts who referred to hospitals of Ilam. The results of complications such as headache, vertigo, irritation if head, dizziness and nausea show the similarity of complications in both experimental and control groups ($p > 0.005$), and the results of complications like drowsiness and head itching show the role of tDCS in the generation of these complications in both experimental and control groups ($p > 0.005$).

Due to the mild complications and no serious effects on the subjects they can be ignored. The result of comparison of cathodal right shoulder and anodal frontal 3 stimulation effects with control group showed that the extent of decreasing the desire in two cathodal right shoulder and anodal frontal 3 experimental groups was meaningfully higher than control

group. Indeed, these effects were more pronounced in the group that stimulation was used in anodal frontal 3. The results of research are consistent with the findings of Boggio (2008). He studied the impact of anodal frontal 3 and cathodal right shoulder stimulation on decreasing the desire for marijuana [16]. Also the results of present research are consistent with those of Dasilva et al (2013) research that studied the effects of tDCS on decreasing the desire in alcoholics [22]. Meng et al (2014) studied the effects of tDCS on decreasing the desire for cigarette in the individuals. The results show inefficiency of the methods in decreasing the desire for cigarette that are not consistent with the results of present research [23]. So far extensive studies have not been conducted on the impacts of tDCS on brain function so that in the research of Borgheresi et al (2013) that was done to study the effect of short- term physiotherapy along tDCS on difficulty of walking in Parkinson patients, it was determined that tDCS receiving patients had more significant improvement relative to control group [24]. In other studies the positive effects of tDCS on different kinds of Chronic pains and improvement of proficient performances have been proved [25, 26].

CONCLUSION:

According to the results of present research, we can note that the use of tDCS in anodal frontal 3 and cathodal right shoulder areas can have a significant impact on decreasing the desire for Methamphetamine in addicts. According to the fact that so far no research has been conducted on the effects of tDCS on decreasing the desire for Methamphetamine, it is suggested to conduct further studies in other societies with larger sample.

Conflict of Interests: Authors have no conflict of interest.

Ethical Considerations: This research project was approved by the ethics committee of Islamic Azad University Ilam, and name and Specifications of patient were kept confidential.

REFERENCES:

1. Mosakeni K, Jafarzadeh Fakhar M. The prevalence of risk factors in drug addiction and drug abusers. *J Sabzevar Uni Med Sci* 2008; 15(3):176-81.
2. Farhadinasab A, Manikashani KH. Substitution therapy with methadone and evaluation of depression in drug users in Hamadan. *J Ilam Uni Med Sci* 2008; 16: 44-50.
3. Havasian MR, Panahi J, Khosravi A. Correlation between the lipid and cytokine profiles in patients with coronary heart disease (CHD) (Review article). *Life Science Journal-Acta Zhengzhou University Overseas Edition* 2012; 9(4): 5772-7.
4. Dobson KS, Mohammad K. Psychometric characteristics of the beck depression inventory in patients with major depressive disorder in partial remission. *Soc Welfare Rehab Sci* 2006; 8(1): 82-7.
5. Galanter M, Kleber HD. *Textbook of Substance Abuse treatment*. (2nd ed.). American Psychiatric Press, Washington, DC 1991.
6. Shahbabaie A, Golesorkhi M, Zamanian B, Ebrahimipour M, Keshvari F, Nejati V, Fregni F, Ekhtiari H. State dependent effect of transcranial direct current stimulation (tDCS) on methamphetamine craving. *International Journal of Neuropsychopharmacology* 2014; 17(10): 1591-8.
7. Kaplan HI, Saddock BJ, Grebb JA. *Comprehensive textbook of psychiatry*. 7th ed. William and Wilkins; 1999.1055-57.
8. EMCCDA insights series Nr .3.2000.
9. Yegane B. Reducing the risk of recurred addiction from 25 to 2 percent with complementary therapy. Tehran: Iranian Students News Agency, 2007.
10. Sadegiye Ahari S, Azami A, Barak M, Amani F, Firuz S. Reviewing the causes of recurred addiction in patients who referred to centers introduced of Tehran welfare. *J Ardabil Uni Med Sci* 2004; 3(4): 36-40.
11. Rosenberg H. Clinical and laboratory assessment of the subjective experience of drug craving. *Clinical psychology review* 2009; 29(6): 519-34.
12. Comer SD, Hart CL, Ward AS, Haney M, Foltin RW, Fischman MW. Effects of repeated oral methamphetamine administration in humans. *Psychopharmacology (Berl)* 2001; 155(4):397-404.
13. O'Malley P. Ecstasy for intimacy: Potentially fatal choices for adolescents and young adults: update for the clinical nurse specialist. *Clin Nurse Spec* 2005; 19(2):63-4.
14. Shariat SV, Elahi A. Symptoms and course of psychosis after methamphetamine abuse: one-year follow-up of a case. *Primary care companion to the Journal of clinical psychiatry* 2010; 12(5): 7-12.
15. Arjmandnia A.A, Asbaghi M, Afrooz GH, Rahmanian M. The effect of transcranial direct current stimulation (tDCS) on improving working memory performance in children with mathematical disorder. *Journal of Learning Disabilities* 2016; 6(1): 141-7.
16. Boggio PS, Rocha RR, da Silva MT, Fregni F. Differential modulatory effects of transcranial direct current stimulation on a facial expression go-no-go task in males and females. *Neuroscience letters* 2008; 447(2): 101-5.
17. Fregni F, Boggio PS, Nitsche MA, Berman F, Rigonatti SP, Silva MT, et al. Anodal transcranial direct current stimulation of prefrontal cortex enhances working memory. *Exp Brain Res* 2005; 166(1): 23-30.
18. Boggio PS, Ferrucci R, Rigonatti SP. Effects of transcranial direct current stimulation on working memory in patients with Parkinson's disease. *J Neurol Sci* 2006; 249(1): 31-8.
19. Saeidmanesh M, Pouretmad H, Nilipour R, Ekhtiari H. Effects of transcranial direct current stimulation in patients with non-fluent aphasia disorder. *Audiol*. 2014; 23(2): 91-100.
20. Havasian MR, Panahi J, Ruzegar MA. Ilam Lipid and Glucose Study: A cross-sectional epidemiologic study. *Nova Journal of Medical and Biological Sciences* 2014; 2(5): 1-6.

21. Monai H, Ohkura M, Tanaka M, Oe Y, Konno A, Hirai H, Mikoshiba K, Itohara S, Nakai J, Iwai Y, Hirase H. Calcium imaging reveals glial involvement in transcranial direct current stimulation-induced plasticity in mouse brain. *Nature communications* 2016; 128(3): 159-60.
22. Da Silva MC, Conti CL, Klaus J, Alves LG, do Nascimento Cavalcante HM, Fregni F, Nitsche MA, Nakamura-Palacios EM. Behavioral effects of transcranial direct current stimulation (tDCS) induced dorsolateral prefrontal cortex plasticity in alcohol dependence. *Journal of Physiology-Paris* 2013; 107(6): 493-502.
23. Meng Z, Liu C, Yu C, Ma Y. Transcranial direct current stimulation of the frontal-parietal-temporal area attenuates smoking behavior. *Journal of psychiatric research* 2014; 54(1): 19-25.
24. Borgheresi A, Giovannelli F, Cozzi S, Antoniella L, Vanni P, Piccini C, Rosso V. 51. Effects of a short physical therapy program combined with transcranial direct current stimulation (tDCS) on freezing of gait in Parkinson's disease: Preliminary data from a randomized, sham-controlled study. *Clinical Neurophysiology* 2013; 124(11): 200.
25. Knotkova H, Greenberg A, Leuschner Z, Soto E, Cruciani RA. P 127. Evaluation of outcomes from Transcranial Direct Current Stimulation (tDCS) for the treatment of chronic pain. *Clinical Neurophysiology* 2013; 124(10): 125-26.
26. Parikh PJ, Cole KJ. Handling objects in old age: forces and moments acting on the object. *Journal of Applied Physiology* 2012; 112(7): 1095-104.

Table 1. Age Distribution of Participants.

Age Mean	Frequency	percent
below 35 years	7	35
between 35 to 40 years	3.2	16
between 40 to 45 years	4	20
between 45 to 50 years	3.6	18
More 50 years	2.2	11
Total	20	100

Table 2. The frequency of side effects of tDCS and the probability of each of the side effects.

Side Effects	Frequency of side effects in Frontal 3 Anodal	Frequency of side effects in Cathodal Right Shoulder	Possibility
Headache	8	10	0.654
Dizziness	6	5	0.279
Irritation Head	9	10	0.122
Pruritus Head	5	8	0.036
Confusion	6	5	0.279
Sleepy	10	8	0.006
Nausea	2	1	0.349

Table 3. Anodal frontal 3 and Cathodal right shoulder stimulations of experimental and control groups.

	Variable	Average	Standard deviation	Minimum	Maximum
Pre-Test	Cathodal right shoulder	24/55	21/648	5	100
	Anodal Frontal 3	25/70	9/453	13	45
Post-Test	Cathodal right shoulder	20/40	23/120	0	100
	Anodal Frontal 3	17/70	8/034	7	32