



Original Article

Comparing the effectiveness of Transcranial Direct Current Stimulation (TDCS) and cognitive behavioral therapy on craving, mood, and smoking addiction

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Abstract

Introduction: Craving is a complex behavior and one of the important factors for the continuation of smoking. This research was conducted to compare the effectiveness of Transcranial Direct Current Stimulation (TDCS) and cognitive behavioral therapy (CBT) on craving, mood, and smoking addiction in smokers.

Materials and Methods: In this experimental study, 12 smokers who referred to medical centers in Mashhad-Iran, were selected by the convenient sampling method and assigned to TDCS (6 cases) and CBT (6 cases) groups randomly. They received the intervention during 8 sessions. They fulfilled the Questionnaire on Smoking Urges, Positive and Negative Affect Schedule and Fagerstrom Test for Nicotine Dependence, before and after the intervention. The data were analyzed using Wilcoxon test, Mann-Whitney U test, and Kolmogorov-Smirnov test.

Results: The results showed that both TDCS and CBT treatments significantly reduce smoking craving ($P < 0.05$), but TDCS reduces craving greater than CBT ($P < 0.01$). Also, TDCS improves positive and negative affect significantly, while CBT only improves negative affect in smokers ($P < 0.05$). Besides, TDCS causes more improvement in negative affect ($P < 0.01$). TDCS reduces smoking addiction ($P < 0.05$), while CBT was not effective in this regard.

Conclusion: Compared to cognitive behavioral therapy, transcranial direct current stimulation has a greater effect on craving, mood, and smoking addiction.

Keywords: Cognitive behavioral therapy, Craving, Mood, Smoking, Transcranial direct current stimulation

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Introduction

Tobacco is the most common narcotic used in adults with mental illnesses, and its prevalence is two to four times to the general population (1). Smoking has very dangerous economic, social, cultural and political consequences. In

general, cigarettes are considered a green light for using other substances (2). Many smokers are interested in quitting. It is said that about 70% of smokers quit at least once in their lifetime (3). Due to the fact that people experience symptoms of smoking cessation,

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including cravings, relapse after a short period of time is common (4). Craving is a complex behavior and one of the important factors for the continuation of smoking (5).

Current treatments for smoking addiction often include physical therapy and medical therapy. Transcranial Direct Current Stimulation (TDCS) is an example of the physical therapy (6). TDCS is a method to modulate brain activity. Its low current includes 1-2 mA and has two electrodes. The first electrode is placed on the scalp in the cortical areas and the second electrode can be placed on the scalp or on the arm or leg. The anode increases cortical excitability and the cathode decreases cortical excitability (7). These effects are observed directly during stimulation and after that in the motor and visual cortex, which increase the activity of this part and even language learning (8).

In one research, by examining the effect of TDCS on the Frontal Parietal Temporal (FPT) region of smokers, the number of cigarettes used and the smoking addiction are significantly reduced (9). In another study, the researchers examined the effect of TDCS on mood and smoking addiction in nicotine-dependent smokers after nocturnal cessation. Anode stimulation in the left Dorsolateral Prefrontal Cortex (DLPFC) was shown to reduce negative symptoms in smokers after nocturnal cessation. This reduction was influenced by the positive correlation with the level of nicotine addiction (10).

Another treatment used for substance addiction is Cognitive Behavioral Therapy (CBT). The effectiveness of CBT has been well demonstrated for addiction, and now CBT is the main treatment approach for alcohol, stimulants, cannabis, and cigarette addiction (11). Extensive research has been reported regarding the effectiveness of CBT in the field of substance abuse. In one research, the researchers compared CBT and the combination of CBT with Contingency Management (CM) for smoking cessation and showed a higher prevalence of abstinence rates at the end of CBT treatment than the combined method. Also, in the CBT group, more subjects completed the treatment period (12). In another study comparing CBT and Health Education (HE), subjects with a history of recurrent major depression and smoking, showed more abstinence in the CBT group compared to the HE group (13). It seems that both TDCS and

CBT approaches have been effective on substance addiction, but studies have less investigated the effect of TDCS on smoking, especially craving. In addition, its effectiveness has not been investigated compared to CBT, which is a traditional and approved treatment for smoking cessation. Thus, the present study compared the effect of two therapeutic methods, TDCS and CBT, on smoking craving.

Materials and Methods

The current research has been registered in the Iranian clinical trial site with IRCT 20101130005280N51 code. The statistical population of this research included smokers who referred to three substance rehabilitation centers in Mashhad-Iran in 2014. In each center, after preparing a list of these people, 4 cases were selected by simple random method of sampling. Among these 4 cases, 2 cases were randomly assigned to the TDCS group and 2 cases were assigned to the CBT group (Totally, 6 cases in TDCS group and 6 cases in CBT group). The inclusion criteria included aged 18-60 years, using more than 10 cigarettes per day for at least 2 years without the use of narcotics, benzodiazepines, methamphetamine, and alcohol. The exclusion criteria included having medical diseases, psychiatric disorders, and pregnancy. TDCS treatment method was performed based on the provided protocol for 8 sessions (3 sessions per week). First, the F3 and F4 points were marked on the head, then the anode electrode with dimensions of 5 cm x 7 centimeters was placed on point F3 and the cathode electrode with the same dimensions was placed on point F4. These two points were stimulated with a constant current of 2 mA for 20 minutes (14). The content of cognitive behavioral therapy sessions was based on the provided protocol and includes 8 therapy sessions, which were held 2 sessions per week (15).

Research instruments

A) *Fagerstrom Test for Nicotine Dependence (FTND)*: This test is a short scale with 6 options that evaluates the dependence level on nicotine (16,17), which includes the time of smoking the first cigarette in the morning, the number of cigarettes smoked daily, the highest number of cigarette smoked daily, the frequency of smoking, the manner of smoking during illness, and smoking in forbidden places (18). It is scored in the range of 0-10. The higher scores

indicate higher dependence. This test has good internal consistency (17,18) and also has high test-retest reliability (19). In one research on 118 smoking male students of Tehran University, Cronbach's alpha was reported as 0.83. There is a significant negative relationship between this test and the disturbance tolerance scale with a correlation coefficient of -0.65, which indicates the validity of the criterion of this test (20).

B) Positive and Negative Affect Schedule (PANAS): This 20-item self-assessment tool is designed to measure two mood dimensions, positive affect, and negative affect (21). Each subscale has 10 types of items in which 10 types of positive feelings and 10 negative feelings are presented in words. Items are rated by subjects on a five-point scale (1: very low to 5: very high), in which subjects are asked to evaluate their feelings in four dimensions: past, future, present, and generally. The range of scores for each sub-scale is 10 to 50. This tool has good internal consistency and discriminative convergent validity (22). The reliability of the test has been reported 0.68 for the positive affect subscale and 0.71 for the negative affect subscale through retesting with an interval of 8 weeks (23). Abolghasemi obtained Cronbach's

alpha coefficients of 0.56, 0.68, 0.49 and 0.59, respectively in the past, present, future and general dimensions for this scale (24).

C) Questionnaire on Smoking Urges-Brief (QSU-Brief): This 10-question questionnaire is rated by the subject on a 5-point scale (1: very low to 5: very high). It is used to measure smoking cravings. The Cronbach's alpha of this tool was reported 0.8 (25). Unfortunately, its reliability and validity have not been carefully evaluated in Iran. In the present study, the content validity of the test was confirmed by psychological and psychiatric experts who worked in the field of smoking cessation.

Results

The average age of people under 30 years is 23.70 years and the average age of people over 30 years is 41.25 years. The average number of smoking years for people with less than 10 years of smoking history is 7.65 years and for people with more than 10 years of smoking history is 19.21 years. Regarding the number of cigarettes smoked daily, the average consumption of less than 20 cigarettes is equal to 17 and the average consumption of more than 20 cigarettes is equal to 28. Table 1 presents the demographic variables.

Table 1. The demographic characteristics of the participants in the two groups

Variable	Grouping	Frequency (%)
Age (Year)		
Less than 30	TDCS	5 (41.66)
	CBT	3 (25.00)
More than 30	TDCS	2 (16.66)
	CBT	2 (16.66)
Smoking history (Year)		
Less than 10	TDCS	3 (25.00)
	CBT	5 (41.66)
More than 10	TDCS	1 (8.33)
	CBT	3 (25.00)
Number of cigarettes smoked daily		
Less than 20 cigarettes	TDCS	3 (25.00)
	CBT	3 (25.00)
More than 30 cigarettes	TDCS	4 (33.33)
	CBT	2 (16.66)
Education level		
Less than diploma	TDCS	2 (16.66)
	CBT	2 (16.66)
Diploma	TDCS	1 (8.33)
	CBT	3 (25.00)
Associate degree	TDCS	2 (1.66)
	CBT	0 (0.00)
Bachelor's degree	TDCS	1 (8.33)
	CBT	1 (8.33)

Table 2 shows the mean and standard deviation of smoking cravings and mood (positive and negative affects) and the results of

the Wilcoxon test to investigate the effect of treatment methods on these variables.

Table 2. Mean and standard deviation of smoking craving, mood, and results of Wilcoxon Test

Variable	Group	Stage	Mean	SD	Z	P
Smoking craving	TDCS	Pre-test	36.66	4.54	-2.22	0.026
		Post-test	17.33	2.73		
	CBT	Pre-test	36.00	4.47	-2.04	0.041
		Post-test	33.66	5.20		
Mood						
Positive affect	TDCS	Pre-test	35.50	6.12	-2.2	0.028
		Post-test	59.00	10.71		
	CBT	Pre-test	35.16	6.21	-1.38	0.167
		Post-test	36.50	6.38		
Negative affect	TDCS	Pre-test	37.66	7.60	-2.2	0.027
		Post-test	21.66	3.01		
	CBT	Pre-test	42.60	6.86	-2.23	0.027
		Post-test	36.00	8.96		

According to the above table, both TDCS and CBT treatment methods significantly reduce smoking cravings. Also, the TDCS method improves the positive affect of smokers significantly, but the CBT method does not have a significant effect on the positive affect. On the other hand, both treatment methods significantly improve the negative affect of smokers. Mann-Whitney U test was used to compare the effectiveness of TDCS and CBT on research variables. The result showed that the TDCS method leads to more improvement in smoking craving ($P= 0.004$), negative affect ($P= 0.006$), and positive affect ($P= 0.005$) compared to CBT.

According to the results of addiction level the, the TDCS method is effective in reducing smoking addiction ($P= 0.03$), but CBT has no effect on smoking addiction ($P= 0.06$). In the TDCS group, before the treatment, 3 smokers had moderate dependence and 3 smokers had high dependence. After the treatment, 4 of them had low dependence and 2 others had moderate dependence. In the CBT group, before the treatment, 2 smokers had moderate dependence and 4 smokers had high dependence. After treatment, 2 of them had low dependence and 4 smokers had moderate dependence.

Discussion

The present study aimed to compare the effect of TDCS and CBT treatment methods on craving, mood, and smoking addiction. The results showed that the TDCS and CBT

significantly reduce the smoking craving. The TDCS method improves both mood subscales (positive and negative affect) and the CBT method improves negative affect. The TDCS method has a greater effect on the smoking craving and the mood than the CBT method, and it also leads to a reduction in smoking addiction, while the CBT method has no significant effect on smoking addiction.

The result of the present study about the effect of CBT on reducing the smoking craving is consistent with the research by Çelik and Sevi. They showed that CBT reduced the craving for substances (26). Also, Morean et al., and McClure et al. concluded that CBT led to effective smoking cessation, which the results of the present study are consistent with the results of these studies. It seems that CBT helps people identify the conditions that cause cravings and control inappropriate reactions in these conditions such as immediate, and thoughtless reactions (27,28). Also, the results of the current research on the effectiveness of CBT on craving and mood are consistent with the study conducted by Mollazadeh and Ashouri. They showed that CBT, both individually and in groups, can improve mental health, cravings, impulsivity, mood, depression, and anxiety in addicted people (regardless of the type of substance used and the duration of treatment sessions) (29). But these results are inconsistent with the study by Narimani on the effect of CBT on smoking addiction (30). This inconsistency can be

caused by the difference in the studied samples and the number of subjects or the difference in the accuracy of the tools used in these two studies. In the present study, 6 subjects received treatment, but in Narimani's study, 4 subjects received treatment. In the present study, a questionnaire was used to collect information, while Narimani collected information using a clinical interview. The results of the present study on the effectiveness of TDCS on mood, craving and smoking addiction in smokers confirm the results of Meng et al.'s research. They indicated that TDCS led to improved mood, reduced smoking cravings, and reduced smoking addiction (9). Also, in another research, they showed that TDCS leads to a reduction in the number of cigarettes used by smokers. In addition, cathode stimulation leads to a two-fold decrease in smoking symptoms compared to anode stimulation (31).

Generally, this research showed that TDCS treatment has a greater effect on craving, mood, and smoking addiction compared to CBT. Since in the TDCS method, the cerebral cortex is directly stimulated, while the CBT method emphasizes on changing behavior, the difference in the results and greater effectiveness of TDCS seems natural, because research showed that TDCS is a powerful tool in increasing the ability of brain processing, and this feature increases the effectiveness of other trainings and treatments at the same time. Despite numerous studies on smokers with the CBT method and several recent studies on the effectiveness of TDCS on smokers, it seems that no research has been conducted that compares the effects of these two methods, and the present study is a pioneer in this regard and its results can help future clinicians and researchers. The current research was conducted on the small sample size, which

limits the generalization of the results. Conducting similar research on wider samples that can use more accurate sampling methods can be useful. In addition, the subjects of the current research were men, who may be different from women in being affected by TDCS and CBT treatment methods. As a result, comparing the results of the above treatment methods on female and male smokers can provide more accurate information to clinicians and researchers. Conducting studies that qualitatively examine the effectiveness of TDCS on smokers will make the results of this research more accurate. Also, investigating the effects of the relatively new TDCS method on other addictive substances can provide a new perspective in the treatment of people suffering from addiction to different types of substances. Finally, comparing this method with medical therapy and other medical and psychological treatments will determine which treatment will be most effective so that clinicians can get rid of confusion in this field and get an effective and affordable treatment in terms of time and cost.

Conclusion

This research showed that TDCS treatment reduces smoking craving and smoking addiction. Also, it changes positive and negative affect in smokers, but CBT can only reduce cravings and improve negative affect, and could not affect positive affect and smoking addiction.

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