

Abstract

Objective: This study aimed to investigate the effectiveness of alpha-theta neurofeedback in craving for drug use among methamphetamine-dependent (crystal) patients. **Method:** For this purpose, 20 crystal-dependent patients who were kept in a therapeutic community center in Mashhad were selected by convenience sampling method based on the diagnostic criteria of DSM-V and results of Symptom Checklist-90-Revised (SCL-90-R). A quasi-experimental research design along with pretest-posttest was used for the conduct of this study. At the beginning and end of the period, the two groups were evaluated through Self-Rating Scale of Craving for Methamphetamine. The patients in the experimental group received 4 weeks of neurofeedback training (5 sessions per week) in addition to group psychotherapy whereas the control group only received group psychotherapy sessions. **Results:** The experimental group showed an improvement compared to the control group in terms of desire and intention to substance abuse, negative reinforcement, and the total mean score of craving intensity. **Conclusion:** Therefore, this study showed that methamphetamine-dependent patients can improve their craving under the influence of neurofeedback.

Keywords: alpha/theta neurofeedback, methamphetamine dependence, craving, effectiveness

On the Effectiveness of Alpha-Theta Neurofeedback in Craving for Drug Use among Methamphetamine-Dependent Patients

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Introduction

Methamphetamine, whose crystallization in Iran is known as crystal, is one of the substances used by individuals. The use of this substance is prevalent in many countries, especially in young people as a stimulant. According to the official statistics of Iran's addiction (Naranjiha, Rafiee & Baghestani, 2005), which have been carried out as a rapid assessment situation in Iran, the frequency of methamphetamine was about 5.2% of all drug users. In recent years, the pattern of substance abuse in Iran has undergone significant changes with dramatic increases in the level of heroin crack and methamphetamine, which is evidenced in treatment centers and community levels. From among the factors effective in substance abuse, craving plays a more important role in the relapse and preservation of substance abuse and dependence. Craving is an uncontrollable desire for substance use, which, if not satisfied, brings about many psychological and physical problems (Ekhtiari et al., 2008). The patient's severe and inevitable craving for the continued use of drugs is a factor that is known to be the root of relapse and treatment failures (Kaufman, 2001; Rostami, Goudarzi & Bolhari, 2003). Studies have shown that certain neurochemical mechanisms of the brain are involved in the craving among the substance dependent patients. The high desire for the re-use of crystal in the users is very prevalent. Unfortunately, no approved drug has ever been introduced for the treatment of alcohol dependence to date. Since there is a very severe temptation for substance use after withdrawal, the strong need for the development of therapies and treatments focused on temptation and craving is felt (Ekhtiari, 2009). Thus, the achievement of a solution for the treatment of treating of craving after withdrawal helps these patients to a great extent.

A large number of studies have examined the effectiveness of neurofeedback treatment in the improvement of the status of drug and alcohol dependent patients. The results of these studies indicate that this method is effective in reducing symptoms and complications of drug and alcohol dependence (Hammond, 2006; Sokhadze, Stewart & Hollifield, 2007; Scott, Kaiser, Othmer & Sideroff, 2005; Frederick, Timmermann, Russell & Lubar, 2005; Masterpasqua & Healy, 2003; Peniston & Saxby, 1995; Fahrion, Walters, Coyne & Allen, 1992; and Passini, Watson, Dehnel, Herder & Watkins, 1977). Goldberg, Greenwood & Taintor (1976) proved the significant effect of alpha conditioning on the reduction of drug habits and drug use craving in four substance dependent patients under methadone treatment. Similar results have been obtained for alcohol-dependent patients in Peniston & Kulkosky's study (1989). The effect of Kelly (1997) and Kaiser, Othmer & Scott's alpha-theta neurofeedback training program (1999) in a nine-month course on alcohol-dependent patients resulted in a significant reduction in relapse rate in patients. Similarly, Bodehnamer & Callaway (2003) also confirmed these results in the treatment of crack-cocaine abuse. Raymond, Varney, Parkinson & Gruzelier

(2005) reported a higher rate of avoidance and abstinence in the patients treated with neurofeedback compared to the placebo group. Narimani & Rajabi (2012) conducted a study on 34 opiate dependent male patients and their findings suggested a significant improvement over anxiety, depression, and craving after 20 neurofeedback therapy sessions. In the same way, Sokhadze, Cannon & Trudeau (2008) came to the conclusion that the eclectic method of neuropsychological methods, conventional psychological therapies, and neurofeedback therapy had a significant effect on the improvement of cognitive functioning (such as executive control) and emotional functioning (such as craving, high sensitivity to drugs and symptom treatment, and executive control). Dehghani Arani, Rostami & Nadali (2013) reported the [positive effect of neurofeedback therapy during a 30-session period on the psychological abnormalities and drug use craving among twenty male patients dependent on methadone or buprenorphine. Rostami & Dehghani Arani (2015) compared the effect of the mixed method of neurofeedback and pharmacotherapy with discrete pharmacotherapy on addiction severity, mental health, and quality of life in crystalline methamphetamine-dependent patients (crystal). They administered the neurofeedback method on 100 patients under treatment during a 2-month period in thirty 50-minute sessions and found it effective in the treatment.

Despite all the scientific advances and efforts in the study of modern techniques in clinical topics, unfortunately, a limited number of studies have been done in this regard due to the costly nature and complexity of the specific conditions of substance dependence disorders. The majority of previous studies have investigated the application of neurofeedback techniques in the treatment of psychological complications and in the improvement of alcohol dependence disorders. However, few studies have assessed the craving of drug dependent patients as the main cause of relapses, especially in patients receiving methamphetamine and other stimulants whose consumption causes severe physical and emotional dependence in the individual. In this situation, the person will feel a strong desire for the repeated use of the substance after a number of consumption. Therefore, the aim of this study was to determine the effectiveness of neurofeedback with alpha-theta protocol in the reduction of craving in patients dependent on crystalline methamphetamine.

Method

Population, sample, and sampling method

A quasi-experimental research design along with pretest-posttest was used for the conduct of this study. The male patients with methamphetamine (crystal) dependence in the Mashhad Therapeutic Community Center who were undergoing group psychotherapy under the supervision of a neurologist constituted the statistical population of this study. From this population, the

number of 20 male and adult patients (21-45 years old) was selected via convenience sampling method in accordance with the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition and Symptoms Check List-90-Revised. The participants' IQ scores were at least 70 and they had high school diploma degrees. In the pre-test phase, 20 samples were matched according to the scores of the meth-amphetamine craving questionnaire and were assigned to two experimental and control groups. The control group received the group psychosocial therapy under the supervision of a therapeutic community while the experimental group received neurofeedback training in addition to the group psychosocial therapy. In fact, the neurofeedback therapy was offered in 20 sessions (for 4 weeks, 5 sessions per week, and 20 minutes for each session). The psychotherapy program was administered under the supervision of a neurologist for both groups of the patients.

Instrument

1. Neurofeedback device: The neurofeedback device used in the present study is a ten-channel Flex Comp Infiniti™ system that operates by battery. This device is, in fact, a tool for receiving waves from the electrodes attached to the scalp and transmitting them to the software system into the computer. This device is actually a hardware that works like a brain wave amplifier. Since the waves produced by the brain are received through the electrodes attached to the scalp, they are very weak and intangible, but are amplified by this device and digitized in the form of stronger electrical signals and are entered into Computer. Then, the signals are processed by the neurofeedback software and are converted into feedback forms. Feedback is performed based on the protocol therapy. In this research, theta ratio bandwidth (4-8 Hz) to alpha bandwidth (8-12 Hz) has been calculated and has been used as a feedback criterion.

2- Symptoms Check List-90-Revised: This is one of the psychiatric diagnostic tools (Derogatis, 1975). This 90-item questionnaire is qualified to assess the severity of psychological symptoms (Donaldson, Mueller, Donaldson & Sello, 2003), and is a reliable tool for the diagnosis, differentiation, and screening of psychiatric patients and alcohol addict (Mirzayi, 1980). This instrument consists of 9 sympathetic dimensions, namely hypochondria, obsessive-compulsive disorder, interpersonal sensitivity, depression, anxiety, aggression, phobic anxiety, paranoid ideation, and psychoticism; and three general indices of global severity index, positive symptom distress index, and the positive symptom total as well as a scale of additional questions. Derogatis (1992) and Derogatis, Lipman & Covi (1973) reported the internal consistency and re-test coefficients of this instrument between 0.73 and 0.98. Mirzai (1980) has reported the Cronbach's alpha coefficient of this scale to be equal to 0.70.

3. Desire for Drug Questionnaire: This questionnaire has been adapted by Derogatis, Lipman & Covi from Desire for Alcohol Questionnaire with the

multidimensional aim of assessing the craving phenomenon in the present time horizon among opioid users (Franken, Hendriks & Brink, 2002). This is a three-factor questionnaire whose items are scored based on a 7-point Likert scale. The three main components of this questionnaire include desire and intention to abuse, negative reinforcement, and control) (Moarefvand, Hassani Abharian & Ekhtiari, 2012). Research studies have proved the validity and reliability of this scale in assessing the craving rate among crack, heroin and meth-amphetamine users (Franken et al., 2002; Anton, Moak & Latham, 1995). The reliability and validity of the Persian form of this instrument have been evaluated and confirmed in the measurement of craving rate in with methamphetamine-dependent patients in Iran (Ekhtiari et al., 2008; Ekhtiari et al., 2010).

Procedure

After the random selection and assignment of the participants in the two groups, the experimental group received 20 sessions of neurofeedback therapy (for 4 weeks, 5 sessions per week, and 20 minutes each session). The alpha-theta in the PZ region (located in the acute cortical region of the cerebellum) was performed for 20 minutes using the aforementioned device. The neurofeedback process with the alpha-theta training protocol involves recording the activities of the alpha and theta bands in the electroencephalography signal, in the state where the subject is resting with closed eyes. This process is accompanied by the play of pleasant music, such as the sound of waves heating the coast and the sound of river flow where the dominant sounds of the waves heating the coast and of the river flow will change in proportion to the strengthening of the theta band relative to the alpha band. The purpose of the changes into the alpha and theta waves is to maximize the theta ratio to alpha (Egner, Strawson & Gruzelier, 2002). An increase in the theta/alpha ratio in the closed eye state is an indicator of a person's being in a state of deep relaxation, such as the first stage of sleep, meditation, or hypnosis (Vaitl et al., 2005). At the end of the course, the reassessment of patients was fulfilled using the methamphetamine craving questionnaire.

Results

The descriptive statistics of the demographic variables are presented in the following table.

Table 1: Descriptive statistics of the demographic variables for each group

Group	N	Age			Duration of use (year)			Duration of abstinence (year)		
		Range	SD	Mean	Range	SD	Mean	Range	SD	Mean
Experimental	10	22-45	7.32	35.30	1-8	2.30	4.80	1-4	1.29	2.10
Control	10	21-42	6.42	32.50	1-7	2.04	4.20	1-4	1.23	2.20

The descriptive statistics of craving scores are presented in the following table for each group and test stage.

Table 2: Descriptive statistics of craving scores for each group and test stage

Group	Mean		SD		Min.		Max.	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Experimental	52.10	36.70	11.90	11.49	38	21	69	55
Control	52.50	49.40	10.95	10.93	40	31	68	63

Multivariate covariance analysis should be used to evaluate the effectiveness of the integration of neurofeedback and group psychotherapy in the craving of methamphetamine dependent patients. One of the assumptions of using this analysis is the normal distribution of the data. The results of Kolmogorov-Smirnov test represented the satisfaction of this assumption ($P > 0.05$). Another assumption of using this statistical test is the equality of covariance matrices. The results of Box's test indicated that this assumption has been met ($P > 0.05$; $F = 1.08$; M Box = 3.7). Another assumption for using this test is the equality of error variances. The results of Levene's test indicated that this assumption has been met, as well ($P > 0.05$). Therefore, the results of multivariate covariance indicated the effectiveness of the intervention (Eta-squared = 0.695; $P < 0.05$; $F = 4.562$; Wilks's Lambda = 0.65). Univariate analysis of covariance was used to examine the patterns of difference as follows.

Table 3: Results of ANCOVA for examining the patterns of difference

Variable	F	Sig.	Eta-squared
Desire and intention to abuse	10.480	0.021	0.66
Negative reinforcement	5.970	0.03	0.32
Control	0.500	0.49	-

Discussion and Conclusion

The aim of this study was to investigate the effect of neurofeedback training on the reduction of craving in crystalline methamphetamine users. The results showed a decrease in craving as a result of the receipt of neurofeedback treatment among the methamphetamine-dependent patients. Since the majority of studies in this regard have been carried out in the form of case studies and there are a very small number of experimental studies with control groups, the findings have limitations in the generalizability and uncertainty about the non-confounding nature of the results on the effects of the threatening factors on the internal validity. Therefore, the present study is considered a new research project due to its pre-test-post-test design with a control group, especially in the area of dependence on methamphetamine substances.

Dehghani Arani et al. (2013) showed that alpha-theta neurofeedback therapy, in addition to the decrease of psychological anomalies, reduces the craving in male patients using methadone or buprenorphine. This finding is consistent with the result of the present study, which argues for the effectiveness of brain alpha-

theta training in reducing the craving for using crystalline methamphetamine among the patients. In a study on methamphetamine-crystalline dependent patients, Rostami et al. (2015) confirmed the effectiveness of neurofeedback training in the severity of addiction, mental health, and quality of life in comparison with the control group. The result of that study is consistent with that of the present study on the effectiveness of neurofeedback training in crystalline methamphetamine-dependent patients. Sokhadze et al. (2008) and Narimani et al. (2012), in this regard, reported a decrease in the temptation and craving among morphine-dependent individuals as a result of receiving neurofeedback in addition to the improvement of the patients' psychological status. However, these studies have not directly addressed the craving for use in patients. In the trial studies conducted in this area, Goldberg et al. (1976), Peniston et al. (1989), Pasini et al. (1997), Fahrion et al. (1992), Masterpasqua et al. (2003), Frederick et al. (2005), Raymond et al. (2005), Scott et al. (2005), and Hammond (2006) compared neurofeedback receivers with the control group in terms of the reduction of the psychological abnormalities among substance dependent patients. In these studies, the patients' craving has not been studied. The results of the present study supported the positive effect of neurofeedback method on the improvement of the craving and desire for substance use in patients with substance dependence. Considering the need for a comprehensive and stable treatment with minimal adverse effects, the use of this method as a complementary therapy for this disorder is suggested. The conduct of follow-up studies and assessment of the severity of drug craving in patients at certain intervals after the end of the neurofeedback course will determine the stability of the effects of this method over time, which is one of the limitations of the current study. Hence, it is suggested that a research in this area be carried out to cover this limitation. In addition, for the elimination of the effect of psychosomatic induction, it is suggested that future studies clarify the advantages of clinical neurofeedback by using placebo groups. Moreover, further studies should compare the effectiveness of group therapy and neurofeedback methods using a group of patients receiving neurofeedback without group psychotherapy. Also, this study was conducted solely on male participants; therefore, it was not possible to compare both genders in terms of the effect of this method. Therefore, it is suggested to investigate the effectiveness of neurofeedback training in crystal dependent women through the common treatment methods.

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