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Original Article

Investigating the effectiveness combined treatment method (neurofeedback and methadone) on abstinence mechanisms in drug-dependent patients

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ABSTRACT

The study aimed to investigate and determine the effectiveness of a combined treatment method (neurofeedback and methadone) on the level of abstinence mechanism in drug-dependent patients using a semi-experimental method. For this purpose, 20 male drug-dependent patients aged 25-45 years, referred to 10 addiction treatment centers and clinics in Bojnourd city in 2025, 80 people, 40 of whom were randomly selected and after administering the Martin Goleman Abstinence Mechanism Questionnaire (1992), were randomly assigned and placed into two control and experimental groups. Patients in the experimental group received 25 sessions (for 6 weeks, 4 hours each week) of neurofeedback therapy and methadone at the same time, and patients in the control group did not receive any specific treatment. At the end of the period, patients in both groups were evaluated using the Martin Goleman Abstinence Mechanism Test (1992). The results of the analysis of covariance indicated that the experimental group showed a decrease in the abstinence mechanism variable (Martin Goleman 1992) of drugs at the end of the period compared to the control group. Therefore, this combined treatment method can be effective in reducing the abstinence mechanism of opioid-dependent patients.

Keywords: Combined treatment method, Abstinence mechanism, Drugs.

Introduction

In today's world, substance abuse is the saddest tragedy that affects the lives of many people in biological, psychological and social dimensions. Long-term drug use not only has a destructive effect on the economic and social status of sufferers, but also plays a decisive role in all aspects of their family life (Narimani, Hashemi, Mashinchi and Fotohi Bonab, 2009). Drug addiction is a chronic and recurrent mental illness that is accompanied by severe motivational disorders and loss of behavioral control (Dallas, David, Joly, 2010). The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (2013) considers the presence of one of the cognitive, behavioral and physiological symptoms that people continue to use despite significant problems associated with abuse as an important feature of substance abuse disorder. This diagnostic set also suggests that substance use disorder produces an underlying change in brain circuitry (especially in individuals with severe disorders) that may persist after detoxification (Diagnostic and Statistical Manual of Mental Disorders, 2013).

Another variable related to drug addiction and influential in treatment is the abstinence mechanism. Abstinence or coping self-efficacy refers to an individual's confidence and trust in their ability to abstain from substance use in stressful and problematic situations and is also one of the primary predictors of abstinence, drug and cigarette cessation, and treatment outcomes can be predicted based on this abstinence mechanism (Wang, Anthony, & Zigmon, 2004). Abstinence self-efficacy beliefs affect how individuals think, how they deal with problems, emotional health, decision-making, coping with stress, and depression (Bandura, Lackey, 2003).

Specific or situational self-efficacy refers to the persistence to perform a specific task at hand, which is a good predictor of

abstinence from substance use in high-risk situations (Dolan, Martin, & Rohsano, 2008). Abstinence self-efficacy is a variable that indicates progress in the recovery process of addicts in treatment interventions (Jafari, Shahidi, & Abedin, 2009).

During the abstinence period, an individual may encounter difficulties that make it prone to relapse to drugs in order to cope with stressful situations and temptations that arise as a result of negative emotions (Norman, Schiffman, & Jowaltney, 1997).

Over the past 20 years, individuals' self-efficacy beliefs have attracted much attention in education and psychology, and in recent years a field called general self-efficacy has emerged. General self-efficacy refers to an individual's perception of their abilities to perform tasks in various situations (Judd, Farez, & Bono, 1998); therefore, self-efficacy is a situation-related term and belief. Some researchers say that self-efficacy plays a mediating role between the environment and the performance of tasks related to self-efficacy (Eden, 1988, 2001).

Combined therapy: This is the combination of two independent treatment methods to examine the effect of interaction as a new treatment model

Neurofeedback: A safe and painless method that can be used to improve brain function and self-control in impaired ways. Neurofeedback is a technique in which individuals learn to change their brain wave patterns through operant conditioning (Master Pascoe, 2000). Neurofeedback training or neurofeedback is a task that trains the brain to increase its ability to optimally regulate its own functioning. This method is actually a learning strategy that enables people to change their brain waves (Leib, 2004). Methadone: A synthetic opiate that, after consumption, causes euphoria, pain relief, and other morphine-like effects (Jameson, Blaise, & LaVonde, 2002, 605-611)

Studies indicate that certain neurochemical mechanisms of the brain are involved in the abstinence mechanism of substance-dependent patients. Marvin proposes one of the most important theories in this field as Bloom's cascade theory in explaining substance dependence disorder. This theory believes that genetic abnormalities have led to disorders in neurochemical processes, which leads substance-dependent patients to a vicious spiral of craving and craving. In these patients, brain frequencies, followed by a certain biochemical factor, are locked and people are not able to perceive and feel reinforcement under normal conditions as healthy people do. These people can only activate that locked biochemical factor and receive the feeling of reinforcement by consuming substances. This disorder, which is named as reinforcement deficiency syndrome, is closely related to abnormalities in alpha-theta brain waves. In the etiology of drug dependence disorder, there are various theories on interpersonal factors, behavioral-psychological factors and biological-genetic factors (Zakariai, 2003). In recent years, the neurological aspects of the etiology of this disorder or disease have received attention. Over the past 30 years, much scientific activity has been carried out to explore the capacity of the mind to influence the body and to understand the ways in which the mind and brain influence and are influenced by the body and its functions, including the brain-mind connection (Lawrence 2002), Hammond (2006), Newton, Cook, Kaltchstein, Duran, Munroe, Ling, & Lachter (2003) and Alper, Principe, Kowalik, Rosenthal, & Roy (1998) have also shown that the cause of many frequent relapses of craving in substance-dependent patients is the persistence of neurological abnormalities in the brain.

In the treatment of drug dependence disorder, neurological research on the relationship between brain wave patterns, underlying thalamocortical mechanisms of the brain, and the individual's psychological states has shown that creating desirable changes in the rhythm and frequency of brain waves, using neurotherapeutic methods, can create desirable changes in the neurological states of individuals (Sterman, 1996). Neurofeedback training is one of these neurotherapeutic methods that has been studied extensively abroad regarding its efficiency and effectiveness in cognitive and psychological disorders (Hammond 2006, Lawrence 2002, Newton et al. 2003).

This method is based on the accepted theory of the mind-body connection, which involves training the mind to function in desirable ways in order to experience healthy physical, behavioral, cognitive, and emotional states and to increase the brain's ability to rebuild, change, and heal itself in a natural way (Demos, 2005).

Most research on addiction has been conducted on tobacco and alcohol addiction, with the aim of anticipating crisis situations and dealing with problems in specific cases (Mottersill, McDowell, & Roser, 1988; Rist & Waltz, 1983). Coping self-efficacy is an individual's belief in their abilities to cope with stress and problems, which influences behavior through four processes: cognition, motivation, self-stimulation, and environmental selection (Bandura, 1997), all of which may improve or stabilize psychological stress (Bennett & Bandura, 2004). Studies show that coping self-efficacy influences cognitive factors and influences how people think about psychological stress. Several approaches believe that cognitive factors may be involved in the development of life disorders and stresses (Bruin, Dalgish, & Joseph, 1996; Ehlers-Wollerk-Vorteboom, 1998; Horowitz, 1976; Bollman, 1992), in which Bollman (1992) refers to beliefs about self-worth; and Ehlers (2000) have focused on people's perceptions and appraisals of threats, especially threats related to psychological harm and the dissemination of information in harmful cases. Studies show that the ability to cope with problems is positively related to the ability to manage oneself in times of crisis (Sislak, 2008). General self-efficacy refers to an individual's ability to manage new situations, initiate efforts, and persist with goals when one has several choices (Schwartz, 1994; Scherer & Adams, 1983; Ten Wessen, 2004). In her cross-cultural study, Luzinska (2005) found that people with high self-efficacy in young and

satisfied individuals also scored higher on measures of personal performance in areas such as being intelligent, physically healthy, academically successful, and coping with problems. While some researchers (Judd, Stanley, & Murphy; 1977) have considered general self-efficacy to be the same as self-esteem due to the high correlation between these two variables, some psychologists (Zimmerman & Keller, 2005, Shen et al., 2004, Gass & Schwalbe, 1986) have distinguished between self-esteem and general self-efficacy. Specifically, self-esteem refers to a general sense of self-worth (Coopersmith, 1967; Rosenberg, 1979), while general self-efficacy refers to a cognitive assessment of one's abilities to initiate, persist, complete a task, and achieve a goal (Zimmerman & Keller, 1983; Scherer & Adams, 1983). Training in emotion-focused and problem-focused coping skills helps individuals develop self-efficacy, and high self-efficacy can make individuals more aware of substance abuse and act as a barrier to it (Dolan-Martin and Rouhsano, 2008). Jafari, Shahidi, and Abedin (2009) also concluded in their study on addicted adolescents that metacognitive and cognitive therapies are effective in improving individuals' self-efficacy in abstaining from drug use, and that individuals' self-efficacy can increase after follow-up and intervention.

Lawrence (1989) has presented a scale for self-efficacy of smoking-related behaviors in adolescents. In this 36-item scale, three factors (opportunity to smoke, emotional pressures, and peer influences) were examined during the initiation of smoking. The correlation between the test-retest results of this scale and the construct, content, and criterion validity of this scale were also declared valid. Waltney, Schiffman, and Norman (2001) examined the variability of self-efficacy in abstaining from smoking in different situations.

In this study, in order to identify specific situations for the possibility of relapse, a 75-item questionnaire on self-efficacy in situations with the possibility of relapse was developed. Specific situation factors such as negative emotions, positive emotions, limited constructive (preventive) situations for smoking, wasting time, situation, and food situations appropriate to the community, low arousal, and desire and craving for consumption were examined. The results of this study showed the internal and predictive validity of this questionnaire in abstinence situations. Wang, Anthony, Sigon, Monjon, Badger, and Higgins (2004) examined the associations between abstinence and coping self-efficacy during outpatient treatment of cocaine-dependent patients. Data were collected from a sample of 126 individuals.

Abstinence was assessed by urinalysis and coping self-efficacy was measured using a modified Situational Confidence Questionnaire (SCQ). Results of this study showed that initial abstinence and SCQ scores predicted subsequent abstinence and confidence during treatment and post-treatment prevention. Badr and Moody (2005) examined self-efficacy as a predictor of smoking cessation among Kuwaiti adults. Data were collected from a sample of 657 all-male smokers using a 16-item self-efficacy scale. Factor analysis using Varimax rotation examined the four main factors in this scale (mood changes, relaxation, stress, and self-concept) among smokers.

The results of this study showed that self-efficacy could be the first predictor of smoking cessation, taking into account the monthly income of individuals. In a longitudinal study, Bardman, Keeley, Maivo, et al. (2005) examined self-efficacy and motivation in a smoking cessation treatment program with a 6-month follow-up. The results showed that smokers who failed to quit reported lower self-efficacy and motivation compared to smokers who succeeded in quitting.

Given the valuable scientific advances in neurological and psychological studies, but due to the cost, difficult and difficult cooperation of the statistical community, and the complexity of the conditions, treatment and research studies in the field of drug-dependent disorders and diseases have witnessed few studies in this field. Most studies in the field of drug dependence abroad have focused on the field of alcohol and in other fields, they have paid less attention to the variable of the abstinence mechanism. Most studies have been conducted on a case-by-case and limited basis. Especially studies in Iran with the aim of investigating this new method, namely neurofeedback, have rarely been conducted, and most studies have investigated the same approach, namely methadone. This method proves the existence of neurological problems in this substance dependence disorder and confirms the use and effectiveness of neuropsychological interventions, including neurofeedback, in improving this disorder.

Considering the limitations of studies in the field of the application of this method in treatment and reduction of the abstinence mechanism, this field is a question for scholars and researchers. According to experts, neurofeedback therapy is considered an exemplary method that uses two fields of psychology (the perspective of operant conditioning) and neurology (brain functions). It deserves special attention and attention from experts in psychology, psychiatry, neurology, and neuroscience. In this study, the question is whether this method can be used as a separate method to improve patients' abstinence mechanisms? Or should it be used alongside other conventional methods, including drug therapy? And which method or approach is more effective and efficient? And this study sought to determine whether the neurofeedback educational-therapeutic method was effective in treating drug-addicted patients?

Materials and Methods

The present study was a quasi-experimental study with a pre-test-post-test design with a control group. The study population consisted of all male patients addicted to opiate drugs (opium, opium syrup, and heroin) aged 25 to 45 with an educational level between 11th and 16th grade, who referred to 10 addiction treatment centers and clinics in Bojnourd in 2025. The study sample consisted of 40 drug-dependent patients who were selected by simple random method from among the

patients available for referral, and were initially selected completely randomly and replaced in groups by matching.

Instrument

In order to collect data, the self-efficacy questionnaire for drug abstinence was developed by Martin Goleman in 1992 to measure personal efficacy and has 20 items that measure the ability to avoid emotional, social, and distress-inducing situations of use. Responses to each item are on a five-point Likert scale. Goleman reported its reliability using Cronbach's alpha method in 1995 at about 0.91 and evaluated its validity in relation to the studied subgroups and reported it as valid. Jafari, Shahidi and Abedin (2009) reported the reliability of this tool in Iran using split-half method and Cronbach's alpha as 0.54 and 0.78, respectively.

Results and Discussion

In the pre-test phase, 40 subjects were matched into two groups based on their abstinence mechanism scale scores, and one of the groups was randomly selected as the experimental group. 20 subjects in the experimental group received neurofeedback and methadone simultaneously, and 20 patients in the control group received only placebo drug treatment. The combined treatment period in the experimental group lasted 6 weeks (4 hours per week), while the patients in the control group spent this period on the waiting list. The treatment program for both groups continued under the supervision of addiction clinic specialists. Neurofeedback training was based on a common and proven treatment protocol with the SMR sensorimotor protocol in the C region (located in the central strip of the cerebral cortex and alpha and theta in the P region, in fact in the parietal region of the cerebral cortex) - which is based on the international 20-10 model - for 20 minutes each using the Villstas model neurofeedback device. This device is a tool that receives waves from 3 electrodes connected to the scalp and other parts of the cerebral cortex and ears and transmits them to a software system inside the computer. Villstas is actually hardware that acts like an amplifier of electrical current. Because the waves produced by the brain, which are received through electrodes connected to the person's head, are weak and imperceptible, this device amplifies them and transmits them to the computer in the form of stronger and more observable electrical waves. Then, the received waves are entered into the neurofeedback software in the computer and converted into a sine wave. The necessary analysis is performed on it based on the treatment protocol. The relevant waves are recorded in the initial assessment session to be amplified or suppressed based on the intended treatment protocol. In the C-area, the feedback provided was of the audio-visual type. The wave thresholds are adjusted in such a way that in 80% of the cases, the suppressed bands are kept below the threshold, and reinforcement (feedback) is received. If the client can place the amplified band (wave) above the threshold 90% of the time and in two consecutive attempts, the threshold changes according to the program to approach the optimal threshold (Wilson, Pepper, and Moss, 2006). In the P-area, the feedback was only in the form of sound (relaxation). In this protocol, the client closes his/her eyes and listens only to the sound that is being played (Nosrat Abadi, 2007).

The three axes related to these tasks are theta, alpha and beta waves and an additional axis to control delta. The thresholds were adjusted so that the individual's alpha and theta were at least 60% above the threshold and theta was above the threshold in 20% of cases (Fahrion et al. 1992). At the end of the period, the patients were re-evaluated using the abstinence mechanism questionnaire. The results obtained in the pre-test and post-test of the two experimental and control groups were analyzed using SPSS.

To investigate the effect of using methadone and combined treatment methods on the abstinence mechanism of drug-dependent patients, the assumptions of this test were examined before performing repeated measures analysis of variance. The significance level of the M BOX test for the abstinence mechanism variable was greater than 0.05, and since this value is not significant, the assumption of homogeneity of variances is confirmed. On the other hand, since Bartlett's Test for this variable was less than 0.05, which is used to measure the correlation of the three stages of the tests. Considering the multivariate test capability of the design (according to the test and according to the test and separate group), considering the significance of Wilks' Lambda in both stages above, it can be said that the design variables have the ability to be multivariate, in other words, the interactive effect of the three stages of the test on the group is significant. The significance levels of Shapiro-Wilk and Levine tests for the substance abstinence mechanism variable were greater than 0.05. Therefore, the assumption of normality and homogeneity of variance error is also confirmed.

Table 1. Results of examining Mauchly's sphericity hypothesis in the mechanism of substance abstinence

Hin-felt correction	Significance level	df	Approximate chi-square	W Mauchly	Between-group effect
0.69	0.0005	2	53/75	0.48	Substance abstinence

The results of the above table show that the Mauchly sphericity assumption is not met for the avoidance mechanism variable. Accordingly, the Hein-Felt epsilon correction is used for the values of this variable. The results of the two-way repeated measures analysis of variance are given in the following tables.

Table 2. Results of the two-way repeated measures analysis of within-subjects effects in the mechanism of substance abstinence

Test power	Parabolic eta squared	Significance level	f	Mean squares	df	Cube of squares	Source of changes	Variable
1	./87	.0005	545.23	37394.52	1.39	52000.22	Test	Avoidance mechanism
1	./72	.0005	67.57	4634.23	4.17	19332.87	Test Group membership	

As shown in the table above, there is a significant difference between the mean scores of the substance abstinence mechanism in the three stages of pre-test, post-test and follow-up (p: .0005). Other results show that the interactive effect of the three stages of the test and group membership on the abstinence mechanism variable is significant (p: .0005). This means that group membership and the test interactively and simultaneously affect the mean of the abstinence mechanism, and the difference in the mean of the subjects in the methadone, neurotic, combined (methadone and neurotic) and control groups is significant in the three stages of pre-test, post-test and follow-up. The interactive effect of the test and group membership is 0.72. This means that 72 percent of the difference observed between the groups is due to receiving or not receiving treatment and administering the test. The statistical power was also 1.

Table 3. Results of the two-way repeated measures analysis of between-subjects effects in the mechanism of substance abstinence according to group membership

Test power	Parabolic eta squared	Significance level	f	Mean squares	df	Cube of squares	Variable
1	0.46	0.0005	21.81	3060.60	3	9181.81	Avoidance mechanism

The results of the table above also show that there is a significant difference in patient abstinence based on membership in the methadone, neurofeedback, combination (methadone and neurofeedback) and control groups (p:0005 – f: 21.81 – eta:46). The comparison of the adjusted abstinence means in the table below shows that in substance abstinence, the mean scores of the subjects in the methadone, neurofeedback and combination groups increased from pre-test to post-test and decreased from post-test to follow-up (it decreased significantly, while in craving this change was less in the follow-up phase).

Table 4. Modified mean of avoidance mechanism based on group membership and test

	Test group	mean	Standard error	95% confidence interval	
				Lower limit	Upper limit
Control	per	39.250	1.926	35.413	43.087
	pass	39.450	1.951	35.565	43.335
	Follow-up	38.000	2.066	33.885	42.115
Neurofeedback	per	36.600	1.926	30.763	38.437
	pass	84.250	1.951	80.365	88.135
	Follow-up	44.450	2.066	40.335	48.565
Methadone	per	37.200	1.926	33.363	41.037
	pass	70.700	1.951	66.815	74.585
	Follow-up	42.350	2.066	38.235	46.465
Combined	per	29.500	1.926	25.663	33.337
	pass	83.800	1.951	79.915	87.685
	Follow-up	47.300	2.066	43.185	51.415

Given the significance of the difference in the means in the abstinence rate in the groups, the LSD post hoc test was used to compare the two groups. According to Table 13, the subjects in the control group had lower abstinence scores than the subjects in all three experimental groups (methadone-neurofeedback-combination) and this difference was significant; also, among the experimental treatment methods, only this difference between the two treatment groups (methods) of methadone and neurofeedback is also significant.

Table 5. Post-test of the avoidance mechanism for groups*

Significance level	Difference in averages		
00/0	-15.53	Neurofeedback	Control
00/0	-11.18	Methadone	
00/0	-14.63	Combined	
04/0	4.35	Combined	Methadone

*< 0.05P

The results of this part of the calculations show that the group factor or the intervention performed on the experimental group is statistically significant on the abstinence mechanism scale. As a result, it can be said that the intervention variable caused a difference in this scale between the experimental and control groups. Therefore, the increase in the amount and intensity of the abstinence mechanism of drug-dependent patients receiving the combination was significant compared to the patients in the control group.

Conclusion

Regarding the efforts and educational and therapeutic research of many researchers in recent years on drug dependence disorder, we continue to witness the growing statistics of this phenomenon and the psychosocial damage that new treatment methods and approaches have failed to address. The results of this study showed that combination therapy increased the abstinence mechanism in patients dependent on opioids. These

results are consistent with studies conducted (Bandura, Lackey 2003), Dolan, Martin, and Rouhsano (2008), Jafari, Shahidi, and Abedin (2009), Goldstein (2004), Wang, Anthony, Zigmon, et al. (2004), Schiffman et al. (1997), Holstein, and others (2014). It is also consistent with the internal studies of Dehghani et al. (2015), Jiraei et al. (2015), Ghaderi et al. (2015), and Rostami (2005). In these studies, the combined educational-therapeutic method was effective in increasing the rate and intensity of patients' abstinence mechanisms.

Since abstinence self-efficacy or coping self-efficacy refers to an individual's confidence and assurance in their ability to abstain from substance use in stressful and problematic situations, and this is also one of the primary predictors of abstinence and cessation of substances and cigarettes, which can also predict treatment outcomes (Wang, Anthony, Zigmon et al., 2004). In explaining the findings of this hypothesis, it should be said that during the abstinence period, an individual may encounter problems that make them prone to relapse to substances in order to cope with stressful situations and temptations that arise as a result of negative emotions (Schiffman et al., 1997), and that neurofeedback therapy will be more effective due to its impact on normal cognitive processes (Wang, Anthony, Zigmon 2004); Therefore, it is clear that if a person can achieve the ability to become aware of their internal states and control them, they will be able to prevent the occurrence of these types of thoughts. Given that abstinence self-efficacy is aimed at (self-control), an increase in the abstinence rate of patients as a result of this type of treatment method (neurofeedback) can be expected to a large extent. Because neurofeedback is based on the accepted idea of the mind-body connection and involves training the mind to act in an optimal way in order to improve behavioral, physical, cognitive and emotional functions; in fact, it increases the mind's ability to rebuild, change and heal itself (which is required by the complex process of abstinence) (Demos, 2005).

In accordance with these findings, a study at the University of California compared the neurofeedback treatment method with traditional treatment (Minnesota 12-step treatment) for substance dependence disorder, and the results showed that cessation and non-participation in treatment by patients in the control group was higher than in the experimental group. Also, the success rate of the experimental group in improving and not returning to substance use was higher than the control group. The present study faced some limitations, including that psychological-neurological studies have their own complexities and that controlling confounding variables is practically impossible.

On the other hand, ethical considerations in research in the field of humanities have prevented the study of completely homogeneous groups. However, despite this, this study was able to control other variables effective in the treatment of drug dependence disorder by using a placebo in the group and to some extent determine the changes made in the dependent variables, namely the reduction in the patients' abstinence mechanism resulting from the effectiveness and efficiency of the combined treatment method.

Acknowledgments:. None

Conflict of interest: None

Financial support: None

Ethics statement: None

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