Evaluation of Impulsivity in Substance Abusers before and after Methadone Maintenance Therapy

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Abstract

Objective: The aim of this study was to investigate the impact of methadone maintenance therapy on the levels of impulsivity in substance users. **Method:** The method of this study was the quasi-experimental, pre-test-post-test single-group design. The statistical population of the study consisted of substance abusers who referred to two addiction treatment clinics in Sari during the second six months of 2015. The sample consisted of 30 substance abusers who were selected by convenience sampling method. The participants were evaluated before and 45 days after methadone maintenance treatment. Barratt Impulsivity Scale, Balloon Analogue Risk Task (BART), and Go-No-Go Test were employed to measure the impulsivity of the participants. **Results:** The results of t-test showed a significant reduction in the total score of impulsivity and cognitive impulsivity in the Barratt scale and a significant decrease in the impulsivity indices in the balloon analogue risk task and the Go-No-Go Test after methadone maintenance. **Conclusion:** According to the findings of this study, methadone maintenance therapy is an effective strategy in reducing the level of impulsivity of substance abusers. Methadone maintenance therapy can be used in situations where the reduction of the impulsive behavior in substance abusers is the objective at the abstinence period.

Keywords: impulsivity, maintenance therapy, methadone maintenance

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Research on Addiction Quarterly Journal of Drug Abuse
Presidency of the I. R. of Iran
Drug Control Headquarters
Department for Research and Education
Vol. 11, No. 44, Winter 2018
http://www.etiadpajohi.ir

Introduction

"Addiction" and substance-related disorders are among the most important current issues in the area of public health (Nutt, Robbins, Stimson, Ince, & Jackson, 2006). The harmful effects of this disease not only affect the perpetrators, but also affect their families, the state, and the society as a whole (Ersche et al., 2012). Related research in this regard has become so widespread in the last decade that various angles of these disorders, such as neurobiology (e.g., Meier et al., 2012), the identification of the involved brain structures (e.g., Ersche et al., 2012), and the discovery of neuropsychological mechanisms (e.g., Robbins, Gillan, Smith, de Wit, & Ersche, 2012) have received researchers' attention. The results of these studies have also changed the classification of these disorders. In the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders for Substance-related Disorders, two separate categories were presented. First, "substance abuse", which is defined as a frequent and intermittent use of a substance in spite of its negative and undesirable consequences. Second, "substance dependence", which refers to the continued use of the substance in spite of the negative consequences of it continuously and compulsorily. However, in the fifth edition of this manual, the mentioned categories were merged into a single category, entitled "addiction and substance-related disorders" because of the absence of any specific boundary between drug abuse and dependence (Hasin et al., 2013).

In total, due to the detrimental economic, psychological, and social effects of addiction, this disorder has been regarded as the main objective of various health strategies. In this regard, impulsivity is one of the most important factors that has been found to be effective in the drug abusers' therapeutic outcomes, and their behavioral and personality traits (e.g., Allen, Moeller, Rhoades, & Cherek, 1998; de Wit, 2009; Weafer, Mitchell, & de Wit, 2014). Impulsivity, as one of the features of human normal behavior refers to one's tendency to perform impertinent and unpredictable behavior, which nevertheless can be involved in a range of neuropsychiatric disorders (Robinson et al., 2009; Powers et al., 2013). Moeller, Barratt, Dougherty, Schmitz, & Swann (2001) merged biological, psychological, and social definitions and then defined impulsivity as the availability of a previous tendency to carry out rapid and unplanned reactions to internal and external stimuli without considering the negative consequences of these behaviors for the self and others. Despite the highlight of some adaptive and functional aspects of impulsivity, the dominant position in psychology views this construct as an ineffective attribute that is associated with delinquent behaviors, self-harm (such as suicide), or behaviors that are not accepted by the norms of a community (Verdejo-Garcıa, Lawrence & Clark, 2008). From this perspective, impulsivity can be considered as the main nucleus for the incidence of various symptoms in a wide range of psychiatric disorders (Lane & Cherek, 2000; Hollander & Evers, 2001). An increasing volume of research findings in

recent years has shown that there are high levels of impulsivity in patients with behavioral disorders, bipolar disorders, and borderline and antisocial personality disorders compared with those without a history of mental illness and other psychiatric disorders (Muller et al., 2001; Mathias et al., 2002; Mobini, Grant, Kass, & Yeomans, 2007; Powers et al., 2013). The relationship between these disorders and impulsivity is partly due to the way these disorders have been conceptualized, i.e. the loss of behavioral inhibition as a common element in all these disorders. Substance abuse and addiction disorders are not excluded from this general rule.

The review of the related literature shows that the risky and impulsive decision-making are significantly more frequent in drug abusers than those in non-injured people. Verdejo-Garcıa et al. (2008) showed that impulsivity has a clear relationship with substance abuse disorders. In this regard, Fox, Axelrod, Paliwal, Sleeper & Sinha (2007) also observed that cocaine-dependent individuals reported difficulty in emotional management and impulse control during the first week of drug use abstinence than the control group. With the continuity of the abstinence, cocaine-dependent people underwent difficulty only in impulse control. Li, Milivojevic, Kemp, Hong & Sinha (2006) also found that stimulant and alcohol users typically obtain higher scores in self-reporting impulsivity tools and show a weaker performance in cognitive measures of inhibition control such as, long time stops. In general, it can be argued that patients with addiction opt for short-term rewards due to impulsivity and despite being aware of the long-term consequences of drug use (Jentsch & Taylor, 1999; Grant, Contoreggi, & London, 2000; Zhornitsky et al., 2012; Bell, Foxe, Ross, & Garavan, 2014). This decision-making disorder is not limited to the improper selection of narcotics and its scope is extended to the daily decisions made by the addicted person (Khodadadi, Keramati, Dezfouli, Safa'ea, & Ekhtiari, 2010).

Regarding the important role of impulsivity in the persistence of addiction and substance abuse, it seems that therapeutic strategies should take effective steps particularly in reducing the impulsivity levels in addicts. One of the important pharmaceutical treatments that has been widely used in the treatment of addiction is methadone maintenance therapy (Ball & Ross, 2012; Peles, Adelson, & Shaul Schreiber, 2014). The aim of this therapeutic approach is to reduce the rate of harm to the patient. Methadone is prescribed for the patient in the long-term form to the extent that s/he can substitute it for narcotics consumption; in this way, the patient takes methadone instead of narcotic substances, which impose terrible damages and harms on him/her (such as hepatitis and AIDS) (Masson et al., 2013). Since methadone does not lead to tolerance and there is no need to increase its dose in the long run (Torrens, Fonseca, Castillo, & Domingo-Salvany, 2013), there is a high possibility that the patient's psychological relationship with narcotics also diminishes after the physical disconnection of the patient to narcotic drugs and, thereby, the patient will have a better foresight for permanent drug withdrawal (Pournaghash

Tehrani, 2008). A review of the related literature suggests that there is little information available today about the cognitive disorders of drug-dependent individuals after drug use withdrawal. To the best of the current researchers' knowledge, no systematic studies have been still done to investigate the effects of methadone maintenance therapy on the levels of impulsivity in substance abusers. However, this information can be more effective in the enhancement of clinical treatments. The results of other studies conducted on the effects of this therapeutic approach on substance abusers' cognitive functions have also been contradictory (Nejati, 2015).

According to the above-mentioned points, the purpose of this study was to investigate the effect of methadone maintenance therapy on the levels of drug use in drug users. Accordingly, the main question of the present study is formulated as follows: Can methadone treatment reduce impulsivity levels among substance abusers?

Method

Population, Sample, and Sampling Method

The method of this study was the quasi-experimental, pre-test-post-test single-group design. The statistical population of this study consisted of the 24-to-55-year-old substance abusers who had referred to two addiction treatment clinics (Milad and Dr. Yaghoubi Cnters) in Sari during the second six months of 2015. With regard to the coordination conducted with the officials and ease of access to samples from the two mentioned clinics, 30 male substance abusers with the mean age of 36.37 and standard deviation of 5.21 were selected as the sample units through convenience sampling method. The entry criteria for the inclusion of participants in this research were: a) The participants' consents to participate in the research; b) The minimum education degree of high school diploma; c) History of no medical and psychiatric illness other than drug abuse; and d) No consumption of benzodiazepines and opiates. After attracting the participants, the research instruments were administered to each of them individually before the receipt of methadone maintenance therapy and 45 days after it.

Instruments

1. Barrat Impulsivity Scale: This scale was constructed by Barrat (1994) and consist of 30 items. It assesses the methods of thinking and acting based on a four-point Likert scale (from rarely/ never = 1 to almost always = 4) in three subscales, namely non-planning, motor impulsiveness, and cognitive impulsiveness. The total score of this scale is calculated from the sum of the three subscales' scores, which determines the respondent's overall impulsivity level. The psychometric properties of this scale have been confirmed by its administration to in a sample with 744 general people (380 female and 364 male) and 216 patients with anxiety and mood disorders (123 female and 93 male). The Cronbach's alpha coefficients of the subscales of non-planning, motor impulsiveness, cognitive impulsiveness, and the total scale have been respectively reported equal to 0.87, 0.90, 0.79, and 0.91 for the general

population; equal to 0.81, 0.83, 0.75, and 0.88 for the patient's sample. These values are indicative of the acceptable internal consistency of this scale. The correlation coefficients between the scores of 107 subjects in the general population of the study in two intervals (four weeks) were respectively obtained equal to 0.73, 0.80, 0.78, and 0.83 for the subscales of non-planning, motor impulsiveness, cognitive impulsiveness, and the total scale ($p < 0.001$). These coefficients are indicative of the retest reliability of Barrat Impulsivity Scale (Besharat, 2007). The construct validity, convergent validity, and discriminant validity of Barrat Impulsivity Scale were calculated by the simultaneous administration of Beck Depression Scale, Beck Anxiety Scale, Positive and Negative Affect Schedule, and Mental Health Inventory to the two groups. The results of Pearson correlation coefficients showed that Barrat Impulsivity Scale had a negative correlation with positive affect and psychological well-being from 0.43 to 0.57 ($p < 0.001$) and had a positive correlation with depression, anxiety, negative affects, and psychological distress from 0.48 and 0.61 ($p < 0.001$). These results confirm the convergent and discriminant validity of Barat Impact Scale (Besharat, 2008). The results of exploratory factor analysis also confirmed three factors for the Barat Impulsivity Scale (Besharat, 2007).

2. Balloon Analogue Risk Task: In this test, a balloon appears on the computer screen, which the person can inflate by pushing the button below it. There are two boxes on the screen, one of which is called temporary box and the other one is called the permanent box where the inventory of each box is displayed on the screen. Each time that the balloon inflates, some money (here 50 tomans) is settled into the person's temporary box. Instead of blowing more balloons, the person can press the "collect money" key. At this time, a new balloon will be replaced, and the amount of money that had been obtained from blowing the balloon will be settled into the permanent box (the total number of balloons is limited to 30 ones). With each balloon pump, the money of the temporary box increases, but if the balloon pops, the money of the temporary box will be lost. Here, although the person adds a sum to the temporary box with pumping the balloon, s/he puts the entire money available in the temporary box in jeopardy. Balloons pop in an uncertain spot, and this makes it possible to make decisions in high-risk situations. People with a high-risk decision tend to ignore the risk of balloon busting and pump it more in order to get more money from it. In this test, the following values are considered as test scores. The adjusted score is equal to the average number of pumped balloons that have not been popped. This variable is the main score of the test and the risk-taking index of the subject. The non-adjusted score is equivalent to the average number of all the balloons being pumped and, indeed, the number of times balloons burst and the maximum and minimum number of pumps of a balloon (Hopko et al., 2006). Nejati (2013) indicated that this test was reliable for risk assessment and impulsivity.

3. Go-No-Go Test: This test is widely used to measure behavioral inhibition (Erika et al., 2007). This test consists of two sets of stimuli in such a way that

individuals must respond to a set of these stimuli (GO) and no respond to another set of stimuli (NO Go). Since the number of GOs is usually greater than that of the Go-No stimuli, there is a higher readiness to respond to the Go stimuli in the person (Warburg, & Logan, 2008). The proper non-inhibition or commission error means performing a motor response when unplanned stimuli are provided. Three separate scores are obtained from this test, namely percentage of commission errors, percentage of inappropriate inhibition, and reaction time. In the study carried out by Ghadiri, Jazayeri, Ashayeri, & Ghazi Tabatabai (2006), the reliability of this test was obtained equal to 0.87. In the present study, a computerized version of this test was used in which the Go trigger was a geometric triangle shape and was displayed among other geometric shapes (NO Go) in the middle of the monitor screen for 500 milliseconds. Individuals should respond to it as soon as possible by pressing the space button on the keyboard, but they should refrain from providing response if they observed other geometric shapes. In the beginning, 30 attempts were made (on trial) so that the respondents could practice and be made fully aware of the test and location of the response key. Then, 100 major attempts were made, out of which 70 ones were Go triggers in order to provide a robust response. All participant's responses and response time were recorded in the software.

Results

The descriptive statistics of the research variables are presented in Table 1.

Table 1: Descriptive Statistics of Research Variables for Each Test Type

Variables	*Components*	*Before treatment*		*After treatment*	
		Mean	*SD*	*Mean*	*SD*
Impulsivity	Total impulsivity	73.93	10.17	67.16	13.26
	Non-planning	26.16	5.84	25.39	5.36
	Motor impulsivity	25.42	5.35	24.38	4.16
	Cognitive impulsivity	22.35	3.83	17.39	4.93
Balloon risk task	The number of pumping the popped balloons	14.81	5.17	9.46	7.28
	The number of pumping all balloons	31.49	10.83	28.67	9.13
	The number of saving balloon money	19.16	6.18	23.19	5.36
	Maximum number of pumps for one balloon	49.71	9.16	44.25	10.26
	The minimum number of pumps for one balloon	2.16	1.73	2.84	2.16
Go-No-Go	Average time of correct response	363.11	29.17	324.36	38.29
	Average time of erroneous response	184.37	13.67	134.29	18.74
	Error response	16.73	5.9	9.39	6.37

To analyze the research data and compare the scores of participants in these tests and their sub-scales before and after methadone therapy, dependent t-test was used and the results are presented in Table 2.

Table 2: T-test Results for Comparison of Participants' Scores Before and After Methadone Therapy

Variables	*Components*	*N*	*t*	*Df*	*Sig.*
Impulsivity	Total impulsivity	30	7.59	29	0.0005
	Non-planning	30	1.17	29	0.131
	Motor impulsivity	30	1.27	29	0.111
	Cognitive impulsivity	30	4.26	29	0.0005
Balloon risk task	The number of pumping the popped balloons	30	3.49	29	0.011
	The number of pumping all balloons	30	0.473	29	0.652
	The number of saving balloon money	30	-2.69	29	0.017
	Maximum number of pumps for one balloon	30	1.59	29	0.103
	The minimum number of pumps for one balloon	30	1.52	29	0.131
Go-No-Go	Average time of correct response	30	5.93	29	0.001
	Average time of erroneous response	30	5.53	29	0.001
	Error response	30	3.74	29	0.001

As it has been shown in Table 2, there is a significant difference in all subscales of Barrat Scale, except non-planning and motor impulsivity; indeed, the difference lies in cognitive impulsivity and the total impulsivity among substance abusers before and after methadone therapy. According to these findings, the levels of total impulsivity and cognitive impulsivity in substance abusers after methadone treatment have decreased significantly. In the balloon risk task, there was a significant difference between the participants in this study before and after methadone therapy in two main components of this test, i.e. the number of pumping the popped balloons and the number of saving balloon money. In this regard, the preponderance of the number of pumping the popped balloons in the pretest and the significant increase in the number of saving balloon money after the methadone therapy can be representative of the reduction of risk-taking and impulsivity in the sample units of this study. In addition to the above-mentioned points, the results in all three indexes related to impulsivity in the Go-No-Go test also indicate significant differences in the performance of drug abusers before and after treatment with methadone. According to these results, in line with Barrat Impulsivity Scale and Balloon Analogue Risk Task, the impulsivity rate of the sample units after methadone therapy was significantly reduced compared with the pretest stage.

Discussion and Conclusion

The purpose of this study was to investigate the effectiveness of methadone maintenance therapy in drug abusers' impulsivity. As the results of this study

suggest, methadone maintenance therapy reduces the levels of impulsivity in drug abusers. These results can be regarded in some ways to be in line with the research findings, which indicate a reduction in substance abusers' risk behaviors, such as hepatitis and HIV after methadone maintenance treatment (Mason et al., 2013). In addition, the results of this study showed that the reduction of impulsivity levels after methadone treatment in all three variables used in this study (for measuring impulsivity) indicate a defect in the inhibition control system of drug abusers and its relationship with impulsivity. Hence, the results of this study are consistent with those of previous studies (Jentsch, & Taylor, 1999; Grant et al. 2000; Verdejo-Garcıa et al. 2008; Zhornitsky et al. 2012; Bell, Foxe, Ross, & Garavan, 2014). From this perspective, it can be argued that patients with addiction opt for short-term rewards due to impulsivity and despite being aware of the long-term consequences of drug use. These impulsive behaviors are also among the main causes of narcotic drug use. Considering the reduction of substance abusers' impulsivity in this study, it seems that regular and long-term methadone use prevents relapse into drug use by influencing the inhibition control system and improving the decision-making status of patients. Similarly, related studies have also shown an improvement in the mental and physical condition and also the social function of methadone-treated patients (Ball, & Ross, 2012; Peles et al., 2014).

The analysis of the results of various dimensions of impulsivity indicated that the highest effect of methadone maintenance therapy has been on reducing substance abusers' cognitive and motor impulsivity. Although, in Barrat Impulsivity Scale, participants' scores before and after methadone therapy were not significant in the subscale of motor impulsivity, the performance of participants before and after methadone therapy was significantly different in Balloon Analogue Risk Task and Go-No-Go Test. In fact, an improvement in the mean response time of the participants in this research can be attributed to the fact that their motor impulsivity was affected by methadone therapy.

The results of this study can be presented at theoretical and practical levels as follows. At the theoretical level, the findings of the current research confirm the relationship between impulsivity and substance abuse as well as the causative pathological conceptualization of drug use disorders. At the level of practical implications, it can be claimed that the findings of this study lead to effective clinical therapies for drug abuse. From this perspective, methadone maintenance therapy is an effective strategy to reduce the addictive behaviors of substance abusers. However, some limitations of this study should also be taken into account. The statistical population of this study raises some limitations with regard to the generalization of the current research findings. The samples were selected as volunteers via convenience sampling method and, thereby, care and discretion should be exercised in generalizing the findings to other research populations. From among the other limitations of this study, it can be referred to the time interval of impulsivity after methadone treatment. It is suggested that

future studies consider longer intervals to examine the effects of methadone maintenance therapy on reducing drug abusers' impulsivity. In total, although this study was a preliminary study in the field of determining the efficacy of methadone maintenance therapy on reducing substance abusers' impulsivity, the results showed that methadone maintenance therapy can be used in cases where the reduction in the impulsive behaviors among substance abusers is the main focus during the withdrawal period.

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