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Effects of Repetitive Transcranial Magnetic Stimulation (rTMS) on Craving in Substance Use Disorder Patients

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Abstract

Background: Substance abuse has a variety of causes. It consists of environmental, biological, sociocultural, and biological aspects.

Aim: This study's main goal was to investigate how recurrent high-frequency transcranial magnetic stimulation (rTMS) affected people with substance use disorders' desire (DLPFC).

Methods: This interventional study was conducted in the El Hussein Hospital outpatient clinic through 6 months. This study was conducted on 30 including. All patients were divided into two groups: the sham group included 15 patients and the active group included 15 patients.

Results: The follow-up desire to use substances ranged from 4 to 7 in the sham group with a mean and SD of 5.8 and 0.71, while it ranged from 3 to 4 in the active group with a mean and SD of 3.33 and 0.36, with a statistically significant difference ($p < 0.001$) between the two groups.

Conclusion: In conclusion, the findings of this investigation support the hypothesis that a course of rTMS over the left DLPFC may be an effective strategy for lowering desire in patients with substance use disorders. Our present research helps develop additional add-on medications for opioid cessation therapies.

Keywords: Addiction, Craving, Repeated transcranial magnetic stimulation (rTMS)

1. Introduction

Substance abuse has a variety of causes. It covers environmental, sociocultural, biological, and psychological aspects. Some mental health conditions make people more likely to consume illegal drugs; for instance, people with ADHD have a higher likelihood of doing so as adults. Cannabis is the substance that is most frequently abused in the United States. Data on substance use and its consequences throughout time have been acquired by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the National Institute on Drug Abuse (NIDA), and the Services Administration for Mental Health and Substance Abuse (SAHMSA). People who abuse one substance are more prone to

abuse another, according to studies. Studies from 2012 show that the lifetime prevalence of alcohol use disorder was 8% and the lifetime prevalence of illicit substance use was 2–3%. With a frequency of 13.5% over the course of a year and a prevalence of 24.6% over the course of a lifetime, disability had a significant relationship.

All of the compounds covered here, while distinct in many ways, have three things in common that make them significant for public health and safety. First, they are all frequently used and abused: In the United States, 61 million people reported binge drinking in the previous year, and more than 44 million reported using an illegal or non-prescribed medication. Recent research has also demonstrated that long-term addicts' cue-induced demand for heroin, cocaine, or methamphetamine is markedly

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reduced by HF rTMS of the left DLPFC. However, other studies have not been able to detect any effects of rTMS of DLPFC on individuals' alcohol intake or cravings. The majority of clinical rTMS research on substance use disorders uses HF rTMS. The goal of HF rTMS is to improve frontal neural circuit activity. The withdrawal stage of substance use disorders is characterized by frontal neural circuit hypoactivity. This is associated by reduced dopaminergic transmission and executive control networks. Clinical studies have demonstrated that DLPFC-targeted HF rTMS lowers cue-induced cravings. This study looked at a group of people with substance use disorders to see how repeating high-frequency transcranial magnetic stimulation (rTMS) affected their desire (DLPFC).

2. Patients and methods

This study was carried out on patients with substance use disorder from the El Hussein Hospital outpatient clinic through 6 months.

Inclusion criteria: Patients diagnosed with substance use disorder according to DSM V criteria and age between 18 and 60 years.

Exclusion criteria: Red flags include using anti-craving drugs at admission, having a personal or family history of epilepsy, having recently undergone neurosurgery, having pacemakers or other electronic implants, having metal or magnetic objects in the brain, having unstable medical conditions, experiencing psychotic episodes, delirium, being disoriented, having severe cognitive dysfunction, and the patient's refusal to receive treatment. Patients received the following procedures: The short version of the Substance Use Craving Questionnaire and a semi-structured psychiatric interview are used in the first stage to evaluate craving. Second stage: application of rTMS. Evaluation of desire at the end of 10 rTMS sessions is the third stage.

Design: Random groups of participants received either active or fictitious stimulation.

Every weekday, 10 rTMS sessions were used.

Setting: Single-site, outpatient, randomized, double-blind, sham-controlled.

Participants: Thirty male substance use disorder patients from the El Hussein hospital outpatient clinic.

Intervention: Ten rTMS sessions per day were delivered over the DLPFC using a standard figure-8 coil. We activated 20 trains per day at 100% of the motor threshold.

A 15-s inter-train interval and 50 pulses at 10 Hz are present in each train.

Measurements: Craving to substance is measured using the short version of the Substance Use Craving Questionnaire.

2.1. Statistical analysis

The information was all gathered, dissected, and measurably assessed using SPSS 26.0 for Windows (SPSS Inc., Chicago, IL, USA). The terms used to portray the subjective information were number and rate. Quantitative information was depicted using the reach (least and greatest), mean, standard deviation, and middle. Each measurable correlation used a two-tailed significance test. A *P* value of 0.05 indicates a huge distinction, *P* 0.001 means an exceptionally massive contrast, and *P* > 0.05 signifies no distinction.

3. Results

Table 1 shows demographic characteristics among the study groups. Regarding sex, all cases in both groups were males. The mean of age in the Sham group was 37.87 with an SD of 11.33; the mean of age of subjects in the active group was 34.27 with an SD of 10.68 with no statistically significant difference (*P* = 0.378) between the two groups.

Table 2 shows substance use years of the study groups. Substance use years in the sham group ranged from 2 to 24 with a mean ± SD of 12 ± 6.77, while in the active group the substance use years

Table 1. Demographic characteristics of the study groups.

	Sham group (n = 15) n (%)	Active group (n = 15) n (%)	Test of Sig.	<i>P</i>
Sex			-	-
Male				
n (%)	15 (100%)	15 (100%)		
Female				
n (%)	0 (0%)	0 (0%)		
Age (years)				0.378
Mean ± SD	37.87 ± 11.33	34.27 ± 10.68	t = 0.911	
Median (IQR)	37 (29.5–43)	36 (26–41)		
Range (min–max)	43 (19–62)	36 (19–55)		

Table 2. Substance use years of the study groups.

	Sham group (n = 15)	Active group (n = 15)	Test of Sig.	P
Substance use years			t = 1.326	0.21
Mean ± SD	12 ± 6.77	8.4 ± 8.37		
Median (IQR)	13 (6–16)	5 (3–9.5)		
Range (min–max)	22 (2–24)	27 (1–28)		

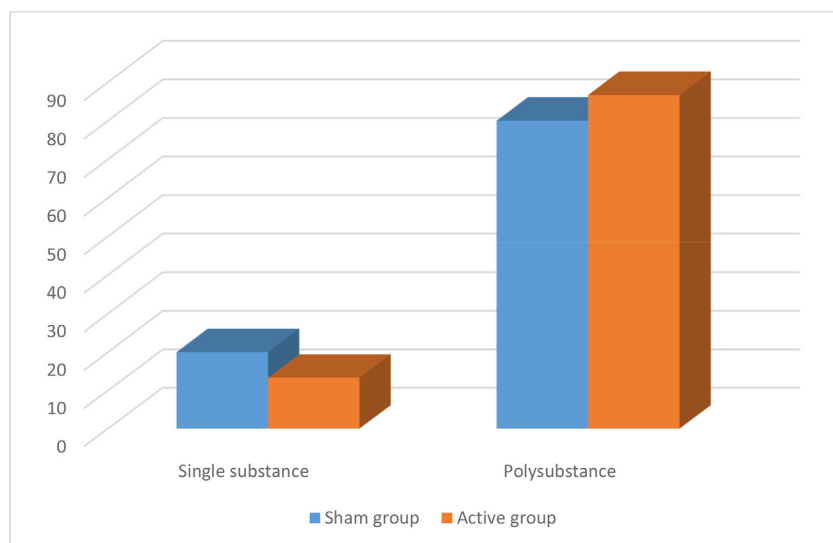


Fig. 1. Bar chart showing the difference between the study groups regarding the number of substance.

ranged from 1 to 28 with a mean \pm SD of 8.4 ± 8.37 with no statistically significant difference ($P = 0.21$) between the two groups.

In the sham group, 20% cases were on single substance, and 80% were on polysubstance, while in the active group, 13.33% cases were on single substance, and 86.67% were on polysubstance with no statistically significant difference ($P = 0.624$) between the two groups (Fig. 1).

Table 3 shows screening day short version of the Substance Use Craving Questionnaire among the study groups. Screening day short version of the Substance Use Craving Questionnaire in the sham group ranged from 4 to 7 with a mean \pm SD of 6.23 ± 0.83 , while in the active group the Screening day short version of the Substance Use Craving Questionnaire ranged from 4 to 7 with a mean \pm SD

of 6.72 ± 1.01 with no statistically significant difference ($P = 0.1577$) between the two groups.

Table 4 shows the research groups' Substance Use Craving Questionnaire short form from the tenth TMS session. In the sham group, the 10th TMS session short version of the Substance Use Craving Questionnaire ranged from 3 to 5, with a mean SD of 4.93 1.33, while in the active group, it ranged from 2 to 4, with a mean SD of 3.73 1.83, with a high statistically significant difference ($P = 0.049$) between the two groups.

Table 5 shows the follow-up Desire to Substance Use among the study groups. In the sham group, the Follow-up Desire to Substance use ranged from 4 to 7 with a mean \pm SD of 5.8 ± 0.71 , while in the active group it ranged from 3 to 4 with a mean \pm SD of 3.33 ± 0.36 with statistically significant difference ($P < 0.001$) between the two groups.

Table 3. Screening day short version of the Substance use Craving Questionnaire among the study groups.

	Sham group (n = 15)	Active group (n = 15)	Test of Sig.	P
Screening day short version of the substance use craving questionnaire			t = 1.452	0.1577
Mean \pm SD	6.23 \pm 0.83	6.72 \pm 1.01		
Median (IQR)	5 (4–7)	5 (4–7)		
Range (min–max)	4 (3–7)	4 (3–7)		

Table 4. Tenth TMS session short version of the Substance Use Craving Questionnaire in the study groups.

	Sham group (n = 15)	Active group (n = 15)	Test of Sig.	P
10th TMS session short version of the Substance Use Craving Questionnaire			t = 2.05	0.049
Mean ± SD	4.93 ± 1.33	3.73 ± 1.83		
Median (IQR)	4 (3.5–4.5)	5 (4–5.5)		
Range (min–max)	2 (3–5)	2 (2–4)		

Table 5. Follow-up Desire to Substance use among the study groups.

	Sham group (n = 15)	Active group (n = 15)	Test of Sig.	P
Follow-up Desire to Substance use			t = 12.017	<0.001
Mean ± SD	5.8 ± 0.71	3.33 ± 0.36		
Median (IQR)	5 (5–6)	3 (3–4)		
Range (min–max)	3 (4–7)	1 (3–4)		

4. Discussion

Repetitive transcranial magnetic stimulation (rTMS), which comprises theta burst stimulation (TBS) and deep TMS (dTMS), has emerged as a promising treatment for substance abuse due to its potential to lessen craving.¹ The main aim of this study was to evaluate the effect of repetitive high-frequency transcranial magnetic stimulation (rTMS) of the left dorsolateral prefrontal cortex (DLPFC), on craving in a group of substance use disorder patients. This interventional study was conducted in El Hussein Hospital outpatient clinic through 6 months. This study was conducted on 30 patients. All patients were divided into 2 groups: the active group had 15 patients, while the sham group had 15 patients. When we compared the demographic characteristics of the two study groups, we found that there was a significant difference between the sexes of the two groups that were being compared. In the sham cluster, the common age was forty eight.93 3.63 years, whereas within the active cluster, it was 51.33 2.69 years. Whereas the active group's substance use years ranged from 26 to 36 and had a mean of thirty two.27 2.69, the sham group's years of substance use ranged from 24 to 35 and had a mean of thirty.13 3.09, with no statistically significant distinction ($P = 0.053$) between the two groups. The visual analog Scale (VAS) and also the substance use desire form are the two separate instruments we have got designated to use during this study to quantify cravings. The present study found no important variations between the two studied groups in terms of VAS on the screening day. The VAS when TMS is within the sham cluster ranged from 3 to 6, with a mean American state = four.2 1.01, whereas within the active cluster the screening day visual analog scale when TMS ranged from

three to six, with a mean American state = four.47 0.83. In the tenth TMS session, we tend to discover that the VAS score was significantly lower within the active TMS cluster compared with the sham group; the active group's VAS score decided to be between a pair of and four with a mean American state of two.53 0.64 ($P = 0.001$). This study demonstrates a major distinction between the two analyzed teams as regards mean scores on the Substance Use Desire form on the screening day. Substance use desire form scores ranged from thirty one to sixty two within the Sham cluster with a mean American state of fifty.2 7.25 and from 39 to 46 within the active cluster with a mean American state of forty two.73 2.91 ($P = 0.002$).

After the tenth TMS meeting, we observed that the dynamic rTMS gathering's Substance Use Survey score had resolutely fallen, although the hoax gathering's score had stayed the same. Within the joke bunch, the reach was 37–65 with a mean and variance of forty nine.8–6.96, whereas within the dynamic gathering, the reach was 25–38 with a mean and variance of thirty four.33–3.66, transfer concerning associate an exceptionally measurably large distinction ($P = \text{zero.001}$) between the two gatherings. As way because the review gatherings' subsequent desire to utilize medicine, we tend to found that the hoax gathering has gone from a pair of to nine, with a mean and variance of four.73 1.83, whereas the dynamic gathering has gone from four to nine, with a mean and variance of half-dozen.93 1.33, with a genuinely tremendous distinction ($P = 0.001$) between the two gatherings. In accordance with our discoveries, Lolli et al.² studied a pair of designated 62 hard drug purchasers and haphazardly relegated patients to either a functioning rTMS bunch (32 people) or a joke treatment bunch (30 subjects). They found that when treatment at T1, when compared to

the end of rTMS treatment, the seriousness of cocaine-related signals interceded wish (VAS top) basically diminished within the rTMS-treated bunch ($p < 0.03$). To wrap things up, rTMS patients' psychology impulsivity estimates improved, but the two gatherings' worsening appraisals did additionally.

Also, in concurrence with our outcomes Martinez et al.³ explored whether the recurrence of excitement (high versus low) would influence the decision to self-direct cocaine. The review revealed that the decisions for cocaine diminished between meetings 2 and 3 in the high recurrence bunch. There was no impact of rTMS on cocaine self-organization in the low recurrence or joke gatherings. In this way, they reasoned that high recurrence rTMS to the prefrontal cortex might act as an expected treatment for CUD.

In accordance with our outcomes Madeo et al.⁴ surveyed the drawn out result of dreary transcranial attractive feeling in a huge companion of patients with cocaine-use jumble. The analysis revealed that it took 91 days from the beginning of treatment to reach the primary pass (resumption of cocaine use). Most patients' rTMS was recontrolled over the course of follow-up, first from week to week and then from month to month. The decrease in the frequency of rTMS encounters was not accompanied by an increase in cocaine slips. The review concluded that rTMS treatment is accompanied with long-lasting declines in cocaine use in a significant way because the mean recurrence of cocaine use was 1.0 day/month (middle 0). Liu et al.,⁵ who looked at how HF rTMS affected impulsivity in patients with methamphetamine difficulties, corroborated our findings (Mama).

Overall, HF rTMS of the left DLPFC considerably decreased the patients with Mama subordinate stop-signal response time and latency (SSRT). To reduce impulsivity and signal-activated craving in people with drug use confusion, they proposed that extra HF rTMS of the left DLPFC would be a highly effective strategy.

In contrast to hoax, reciprocal rTMS of the prefrontal cortex (PFC) at 10 Hz did not significantly affect cocaine use, according to Bolloni et al.,⁶ However, when we took into account the passage of time, patients undergoing dynamic TMS treatment showed a consistent reduction in cocaine consumption. The dispute may be brought up by variations in the tested treatment regimen and test features. The goal of the current study was to assess the evidence for rTMS's anti-craving and consumption-decreasing effects on individuals with addiction to alcohol, nicotine, and illegal drugs. The Zhang et al.⁷ systematic review and meta-analysis supported this. Results showed that excitatory rTMS

of the left dorsolateral prefrontal cortex (DLPFC) significantly decreased desire as compared with sham stimulation. A strong positive connection between the total number of stimulation pulses and effect size was also found in meta-regression among studies that used excitatory left DLPFC stimulation ($P = 0.01$). PET imaging may be useful in future in studying the relationship between changes in striatal dopamine and behavioural improvement in heroin users after rTMS treatment.⁸ Furthermore, rTMS may lead to enhanced cognitive restraint and less impulsivity, which may help lessen appetite.

4.1. Conclusion

In conclusion, the findings of this investigation support the hypothesis that a course of rTMS over the left DLPFC may be an effective strategy for lowering desire in patients with substance use disorders. Our research helps to develop additional add-on treatment for opioid cessation therapies.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of interest

The authors declared that there were no conflicts of interest.

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