Journal of Fundamentals of Mental Health

Mashhad University of Medical Sciences

Psychiatry and Behavioral Sciences Research Center

Original Article

Evaluating the effect of transcranial light therapy on depression symptoms and quantitative electroencephalographic changes

Ahmad Alipour[1], *Hadis Ghaffari Khaligh[1], Mahdi Yazdan Sabet[1], Maryam Zamani[1], Mahdiyeh Sarraf-Razavi[2]

[1]*Department of Psychology, Payam Noor University, Tehran, Iran.*
[2]*Psychiatry and Behavioral Sciences Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.*

Abstract

Introduction: The present study aimed to evaluate the effect of transcranial light therapy on depression sympto ms and quantitative electroencephalographic changes.

Materials and Methods: In this clinical trial, six cases with depression were selected through convenient metho d and randomly divided into two experimental and control groups. Beck Depression Inventory and Quantitative Electroencephalographic Changes (QEEG) were performed in pretest and post-test. The treatment performed in 1 0 sessions (twice a week for 3 or 4 minutes). The forehead and F3 and F4 sites selected for stimulation. Data ana lyzed through descriptive statistics, Mann-Whitney U test, Wilcoxon, T test, and SPSS software.

Results: Delta wave amplitudes showed a significant difference between two groups in FP2 channel (P= 0.016). The results of Beck Depression Inventory showed a significant decrease in experimental group (P=0.03).

Conclusion: Based on the results of the present study, low-level light therapy can be considered as a promising treatment and an effective, affordable and low-cost method for depression disorder and cognitive function.

Keywords: Depression, Infrared light, Quantitative electro-encephalography, Transcranial light therapy.

Please cite this paper as:
Alipour A, Ghaffari Khaligh H, Yazdan Sabet M, Zamani M, Sarraf-Razavi M. Evaluating the effect of transcranial light therapy on depression symptoms and quantitative electroencephalographic changes. Journal of Fundamentals of Mental Health 2020 May-Jun; 21(3): 139-143.

Introduction

According to the World Health Organization, 300 million people in the world suffer from depression. 15% of the adults experience depression during their lifetime. The total economic burden of depression is estimated at $ 210.5 billion annually. There are different treatments to reduce the symptoms of depression (1). One of the low-cost and effective methods is light treatment. The positive effects of light therapy have been observed in a variety of clinical conditions (2). Effects of Near-Infrared (NIR) and photobiomodulation (PBM) on Hemispheric Emotional Valence (HEV) on patients with depression, anxiety, substance abuse (drugs and alcohol), traumatic brain injury (TBI), post-traumatic stress disorder (PTSD), pain relief, inflammation and edema, wound healing in deeper tissues and nerves, and prevention of tissue damage has been studied (3). Studies showed good results in functional and structural brain damage such as traumatic brain injury resulting in behavioral, cognitive, and biochemical changes using this treatment. LED light source, in red to near infrared wavelengths

***Corresponding Author:**
Department of Psychology, Payam Noor University, Tehran, Iran.
hadis.ghafari@gmail.com
Received: Dec. 11, 2019
Accepted: Mar. 15, 2020

with relatively low energy density has more benefits to therapy such as low cost, covering large areas by the possibility of various diode configurations, the possibility of generating multiple wavelengths, no heat generation, and less energy requirements. Thousands of people around the world use lasers and Transcranial Laser or LED Therapy LEDs as light sources for healing. Transcranial Light Therapy (TLT) is a subset of red light therapy which has a long history of healing in muscle injuries and pain. Significant results have been observed in the treatment of transcranial optic stimulation (TCLT or TLT) in patients with depression and anxiety, neurological diseases such as Parkinson's and Alzheimer's, and cerebral blood flow disorders. Transcranial optical stimulation (TLT) is a non-invasive, non-side-effect therapy approved by the FDA (US Food and Drug Administration) (2). Also, the effectiveness of this treatment and its outcome has been studied in patients with brain damage, stroke, PTSD, Major Depressive Disorder (MDD) and cognitive impairment (2,4-6). There are many evidence of intraocular light therapy for brain problems such as mild cognitive impairment, Parkinson's disease, migraine, stroke, mTBI with non-penetrating brain damage and persistent cognitive impairment, chronic brain injury, depression, anxiety, stroke, neurological disease, TBI, and improves memory function in old mice (7). For cranial therapy in major depressive disorder, both PBM and laser LEDs have been experimentally tested, although PBM is not FDA approved for the treatment of MDD (8). Near-infrared radiation is effective for depression and cognition. In patients with TBI, it has a positive effect on continuous attention, memory and executive functions, self-awareness, self-regulation, sleep and depression (9). In this study, we examined the effect of light using the treatment of transcranial light stimulation on improving performance and symptoms in patients with major depressive disorder.

Materials and Methods

The present study was conducted to investigate the effective of infrared light in the treatment of depression. This study was designed as a pre-test, post-test, in comparison with control group in Payame Noor University of Tehran, during 2017 until 2018. For this purpose, 6 cases (in both genders) with depression who referred to the consultative centers of Payame Noor University were selected and randomly divided into experimental and control groups. This plan is defined for the age group of 19 to 29 years. These cases received diagnosis of depression by psychologist or psychiatrist, and scored at least 30 on the Beck Depression Inventory (BDI). They did not use medication or other treatments during research process. Cases with a history of substance abuse in the last six months, suicidal or homicidal ideation, or people with unstable mental states as well as people with skin problems and rashes on the forehead were excluded. The cases evaluated through BDI and Quantitative Electroencephalographic Changes (QEEG) in pre-test and post-test.

Research instrument

A) Beck Depression Inventory (BDI): In this questionnaire, 21 questions were asked and each question consisted of four phrases. Each of these phrases in each question expresses a person's state. This questionnaire has a high validity. Internal coefficient (alpha coefficient) was 0.92, that validity varies with the retesting method by 0.75 per week and its material correlation varies from 0.30 to 0.76. Various studies have been conducted to measure the psychometric properties of this tool (10). Also, in Iran, its reliability coefficient was reported in the range of 0.70 to 0.90 (11).

B) Quantitative Electroencephalographic Changes (QEEG): The cerebral cortex is the center of the higher processes of the mind, the place where emotions are recorded, the beginning of voluntary actions, the decision-making, and the formulation of a plan. By placing a number of electrodes on the scalp, brain waves can be received, recorded, and then analyzed using a computer. QEEG is the device that does this. Because each mental and psychological disorder is caused by a malfunction in the brain and, as a result, more or less brain waves, the QEEG of the brain, which has a normal function, is different from that of a brain that has a functional problem. By comparing the numbers obtained for each wave and the result of QEEG obtained with the natural state, the type of problem can be identified.The light source has two NIR modules, each 6 cm in diameter. Each module

has seven LEDs with a power of 3w and a total of 21 w for each module and a total of 42 w for two modules in the device. The wavelength of LEDs is 800 to 810 nm. Each module was placed on one side of the forehead and on F3 and F4 areas. The experimental group stimulated 3 to 4 minutes, two days a week for ten sessions. The area of stimulation selected on the forehead (FP1, FP2), and F3, F4 channels. Data analyzed through descriptive statistics, Mann-Whitney U test, Wilcoxon, and T test using SPSS software.

Results

In term of demographic variables, the control group aged 21.30 years, and excremental group aged 22 years. All participants had a bachelor's degree.

The brain waves were examined in the forehead area. Brain waves were analyzed at F3, F4, FP1 and FP2 channels. The results of the analysis showed only significant changes in Delta waves in the FP2 site. The mean and variance of brain waves are presented in Table 1.

Table 1. The mean and variance of brain waves recorded in FP1, FP2 regions

Channel	Wave	Group	Mean	Variance	Error variance	P
Fp1	Delta	Experimental	24.87	19.92	5.76	0.082
		Control	30.35	17.59	5.41	
	Theta	Experimental	7.81	14.29	1.54	0.062
		Control	7.39	3.60	0.77	
	Alpha	Experimental	4.16	2.47	0.63	0.081
		Control	5.66	7.62	1.12	
	Beta	Experimental	5.45	1.98	0.56	0.063
		Control	11.57	91.27	3.90	
	High beta	Experimental	1.83	0.05	0.09	0.057
		Control	5.08	25.5	2.06	
	Beta 1	Experimental	1.52	0.36	0.22	0.0600
		Control	2.54	2.78	0.68	
	Beta 2	Experimental	1.27	0.13	0.14	0.063
		Control	2.34	3.56	0.77	
	Beta 3	Experimental	2.66	0.34	2.37	0.080
		Control	6.70	38.99	2.54	
Fp2	Delta	Experimental	12.92	12.65	1.45	0.015
		Control	21.74	55.31	3.03	
	Theta	Experimental	8.35	21.4	1.89	0.062
		Control	7.28	2.47	0.64	
	Alpha	Experimental	4.49	2.86	0.69	0.081
		Control	5.35	7.89	1.14	
	Beta	Experimental	7.05	17.83	1.72	0.077
		Control	7.63	15.92	1.62	
	High beta	Experimental	2.51	6.41	1.33	0.084
		Control	4.35	34.12	2.38	
	Beta 1	Experimental	1.62	0.278	0.21	0.055
		Control	2.07	0.71	0.34	
	Beta 2	Experimental	1.53	0.84	0.37	0.054
		Control	1.99	2.42	0.63	
	Beta 3	Experimental	3.60	9.39	1.25	0.091
		Control	9.23	22.51	6.13	

Table 2. Comparison of mean Delta wave on FP2 site between experimental and control groups

Delta FP2	
Mann-Whitney **U test**	3
Wilcoxon	24
Z	-2.402
P- Value (2-tailed)	0.016
P- Value (1-tailed)	0.015

To investigate the reduction of depressive symptoms, the results of BDI were used.

A summary of the changes in depression scores based on correlated T test for the two experimental and control groups is presented in Table 3.

The results showed a significant decrease in scores in the experimental group (t= 3.4, df= 2, *P*= 0.03) while the difference in scores in the control group was not significant (t= 2.2, df= 2, *P*= 0.07).

Table 3. Summary of changes in depression scores

Group	Phase	Mean	Standard deviation	df	t Stat	P	t
Experimental group	Pre-test	44.67	81.33	2	3.45	0.03	2.92
	Post-test	23.67	31.03				
Control group	Pre-test	26.33	70.33	2	2.27	0.07	2.92
	Post-test	20.33	30.33				

Discussion

Depression is a common disorder that disrupts people life. It burdens much costs for society. According to the prevalence of this disorder and probable increasing rate of patients in future, it is very important to find treatment options that are low-cost, affordable, and short-term. In this regard, light therapy is expanding.

The present study evaluated the effectiveness of light therapy by irradiating the skull for three to four minutes, in the FP1, FP2, F3 and F4 sites during 10 sessions. The results of this study showed significant decrease in depressive symptoms in experimental group. Also, the QEEG showed a significant change in the measure of Delta waves in Fp2 site. This area is associated with the power of judgment and inhibition of stimuli, which can be effective in improving depressive symptoms.

Generally, light therapy increases blood flow and oxygen concentration and the health of the cells in the treated brain areas.

The data contain information that LLLT is a neuropathic stimulant to improve behavior in a non-invasive manner. Several studies showed that depression is associated with abnormal blood flow in the cerebral cortex, and LLLT increases and improves blood flow. So, light therapy has been shown to improve depressive disorder (12,13).

The culmination of the effects is on the frontal cortex, which appears to respond to light therapy like an antidepressant. The results of this study are consistent with studies conducted on mice and humans. These studies show that LLLT improves mood and depressive symptoms (14). Research on people with a history of major depression and anxiety (including post-traumatic stress disorder and substance abuse) showed an improvement in depression and anxiety symptoms (15).

Other studies have showed increasing in positive emotions and decreasing depressive symptoms in patients after two weeks treatment by LLLT (16-18). Patients with brain injury also experienced a reduction in depression, anxiety, irritability, insomnia with LLLT (19,20). Other studies showed that infrared light improved deep depression without any medication (15).

A few results revealed depression symptoms was reduced at least 50% (8,15).

In another study, the results based on Hamilton Depression Rating Scale, and Hamilton Anxiety Rating Scale showed significant improvement in depressive symptoms after two weeks of treatment with NIR-PBM (8).

Light therapy (870 nm / 633 nm LEDs) is suited for depression and anxiety despite a history of resistant to treatment (12). Consist with the present study, one research showed light therapy in the forehead led to a significant reduction in anxiety in people with major depressive disorder (21). Also, review of studies related to light therapy showed an effective, efficient, and high-quality method of treatment as a new method of antidepressant treatment. It has been introduced as safe and easy method (22). This study was performed only to determine the effectiveness of the new light therapy method on reducing the symptoms of depression and brain waves, and for this purpose only a small group participated in the treatment.In order to comprehensively and completely examine the effects of this treatment, it is recommended that the research be performed on a larger group and that follow-up studies be considered.

Conclusion

Overall, according to the results of current study, low-level light therapy (LLLT) can be considered as a promising treatment and an effective, affordable and low-cost method for depression disorder and cognitive function.

Acknowledgment

We thank from all participants for their contribution in this study. The authors declare any conflict of interest.

References

1. Morin A. Depression statistics everyone should know. [cited 2018]. Available from://www.verywellmind.com.
2. Hamblin M, Demidova TN. Mechanisms of low level light therapy. Proceedings of SPIE - The International Society for Optical Engineering, 2014; 6140: 1-12.
3. Schiffer F, Johnston AL, Ravichandran C, Polcari A, Teicher MH, Webb RH, et al. Psychological benefits 2 and 4 weeks after a single treatment with near infrared light to the forehead: a pilot study of 10 patients with major depression and anxiety. Behav Brain Funct 2009; 5: 46.
4. Gustavo Rocha Peixoto dos Santos J, Luiza Costa Zaninotto A, Amaro Zângaro R, Costa Carneiro AM, Santana Neville L, Ferreira de Andrade A, et al. Effects of transcranial LED therapy on the cognitive rehabilitation for diffuse axonal injury due to severe acute traumatic brain injury: study protocol for a randomized controlled trial. Trials 2018; 19: 249.
5. Tuchin VV. Handbook of photonics for biomedical science. Florida: CRC press; 2010.
6. Naeser MA, Zafonte R, Krengel MH, Martin PL, Frazier J, Hamblin MR, et al. Significant improvements in cognitive performance post-transcranial, red/near-infrared light-emitting diode treatments in chronic, mild traumatic brain injury: Open-protocol study. J Neurotrauma 2014; 31(11): 1008-17.
7. Naeser MA, Saltmarche A, Krengel MH, Hamblin MR, Knight JA. Improved cognitive function after transcranial, light-emitting diode treatments in chronic, traumatic brain injury: two case reports. Photomed Laser Surg 2011; 29(5): 351-8.
8. Cassano P, Petrie SR, Hamblin MR, Henderson TA, Iosifescu DV. Review of transcranial photobiomodulation for major depressive disorder: targeting brain metabolism, inflammation, oxidative stress, and neurogenesis. Neurophotonics 2016; 3(3): 031404.
9. Naeser MA, Hamblin MR. Potential for Transcranial Laser or LED Therapy to Treat Stroke, Traumatic Brain Injury, and Neurodegenerative Disease. Photomed Laser Surg 2011; 29(7): 443-6.
10 Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: Psychometric properties. J Consult Clin Psychol 1988; 56(6): 893-7.
11. Azokhush M. [The application of psychological tests and clinical diagnosis]. 3rd ed. Tehran: Ravan; 2008: 226-4. (Persian)
12. Schaffer M, Bonel H, Sroka R, Schaffer PM, Busch M, Reiser M, et al. Effects of 780 nm diode laser irradiation on blood microcirculation: preliminary findings on time-dependent T1-weighted contrast-enhanced magnetic resonance imaging (MRI). J Photochem Photobiol B 2000; 54(1): 55-60.
13. Fahim C, Stip E, Mancini-Marie A, Mensour B, Leroux JM, Beaudoin G, et al. Abnormal prefrontal and anterior cingulate activation in major depressive disorder during episodic memory encoding of sad stimuli. Brain and cognition 2004; 54(2): 161-3.
14. Mental health daily. Transcranial photobiomodulation for depression: Near-infrared light and laser therapy. [cited 2016]. Available from: http://mentalhealthdaily.com
15. Schiffer F, Johnston AL, Ravichandran C, Polcari A, Teicher MH, Webb RH, et al. Psychological benefits 2 and 4 weeks after a single treatment with near infrared light to the forehead: a pilot study of 10 patients with major depression and anxiety. Behav Brain Funct 2009; 5: 46.
16. Barrett DW, Gonzalez-Lima F. Transcranial infrared laser stimulation produces beneficial cognitive and emotional effects in humans. Neuroscience 2013; 230: 13-23.
17. Disner SG, Beevers CG, Gonzalez-Lima F. Transcranial Laser Stimulation as neuroenhancement for attention bias modification in adults with elevated depression symptoms. Brain Stimul 2016; 9(5): 780-7.
18. Gonzalez-Lima F. Dose-response effects of low-level light therapy on brain and muscle. Proceeding of the 13th Annual International Conference on Dose-Response. Texas: The University of Texas at Austin; 2014.
19. Henderson TA, Morries LD. SPECT perfusion imaging demonstrates improvement of traumatic brain injury with transcranial near-infrared laser phototherapy. Adv Mind Body Med 2015; 29(4): 27-33.
20. Morries LD, Cassano P, Henderson TA. Treatments for traumatic brain injury with emphasis on transcranial near-infrared laser phototherapy. Neuropsychiatr Dis Treat 2015; 11: 2159-75.
21. Cassano P, Petrie SR, Mischoulon D, Cusin C, Katnani H, Yeung A, et al. Transcranial photobiomodulation for the treatment of major depressive disorder. The ELATED-2 pilot trial. Photomed Laser Surg 2018; 36(12): 634-46.
22. Askalsky P, Iosifescu DV. Transcranial photobiomodulation for the management of depression: Current perspectives. Neuropsychiatr Dis Treat 2019; 15: 3255-72.