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Reducing anxiety in cancer patients using mindfulness-based stress reduction and transcranial direct current stimulation

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Original Article

Abstract

BACKGROUND: In the present study, electrical stimulation of the brain from the skull using transcranial direct current stimulation (tDCS) was integrated with a stress-based stress reduction program. The aim of this study was to compare the effectiveness of mindfulness-based stress reduction training with tDCS in reducing anxiety in adolescents with cancer.

METHODS: In this quasi-experimental study, the statistical population included all adolescents with cancer in Mahak Hospital in Tehran, Iran, in 2020. According to the inclusion and exclusion criteria, 40 people were selected and purposefully placed in 3 experimental groups and 1 control group. Patients were randomly assigned to experimental and control groups. The data collection tool used was the Penn State Worry Questionnaire (PSWQ). Members of the experimental group participated in sessions of a mindfulness-based stress reduction program and tDCS intervention. Members of the control group did not receive any intervention. To analyze the data, multivariate analysis of covariance (MANCOVA), repeated measures analysis of variance (ANOVA), and least significant difference post hoc tests were used ($P < 0.05$).

RESULTS: The mindfulness-based stress reduction program combined with tDCS was more effective than the separate use of these interventions and reduced anxiety in adolescents with cancer ($P < 0.05$). Mindfulness-based stress reduction program is more effective than tDCS intervention ($P < 0.05$). Mindfulness-based stress reduction programs are more effective than tDCS intervention ($P < 0.05$).

CONCLUSION: The use of a combination of mindfulness-based stress reduction therapy with tDCS is more effective than using each of these interventions separately and can be combined with the other standard treatment for these patients.

KEYWORDS: Anxiety; Cancer Patients; Mindfulness-Based Stress; Transcranial Direct Current Stimulation

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Introduction

Epidemiological studies show that the prevalence of cancer in most countries of the world is significantly high. In the United States, 70,000 adolescents and young adults are diagnosed with cancer each year.[1-3] In Iran, the number of children with cancer was 9 per 100,000 children per year, children of below 15 years of age, in 2008. Other studies have reported a prevalence of 1.4% for cancer in this age group.[4] Therefore, paying attention to the

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mental health of this group of adolescents is of considerable importance. Following a diagnosis of cancer, a person develops a crisis, interpersonal trust is compromised, and personal communication is disrupted due to uncertainty about the future, which in turn leads to psychological problems such as stress and anxiety.[5] There is scientific evidence for the association of cancer with anxiety attacks in people with the disease.[6,7] Anxiety attacks are a linguistic, verbal, and thought-provoking process that inhibits a vivid mental image associated with emotional and physical arousal. Worrying about interacting with physical symptoms will reinforce the symptoms. In addition, morbid and uncontrollable anxiety activates and perpetuates catastrophic thoughts, which, on the one hand, focus on individual inadequacy in the management of emotions and physical symptoms, and the dangerousness of the world on the other.[8] Because cancer causes psychological problems such as anxiety, it seems necessary to identify effective treatment approaches to improve these complications and the outcome of the disease. One of these effective treatment approaches is mindfulness training. Mindfulness is a concept that has its roots in the Buddhist tradition and represents awareness of all external and internal experiences in the present moment.[9] Since the 1970s, mindfulness has been used in therapeutic interventions for common psychological problems such as stress, anxiety, and depression.[10,11] In recent years, hybrid approaches have been developed to achieve effective treatment outcomes. In one approach, electrical stimulation of the brain from the skull using transcranial direct current stimulation (tDCS) is integrated into a stress-based stress reduction program that has been proven to be effective in some areas.[10-12] Although the use of these combination therapies has not been widely studied, scientific evidence suggests that the selection of these therapies as an integrated approach is based on the results of studies that have examined each of these therapies separately. Researchers have concluded that mindfulness-based intervention has a significant effect on stress, anxiety, and worry.[10] Moreover, the effectiveness of electrical stimulation of the brain from the skull using tDCS on stress and its related factors has been confirmed. Comparison of the effectiveness of neuropsychological and psychotherapeutic therapies and the combination of these interventions can be used to identify the best approach to improving the mental health of adolescents with cancer.[13] Therefore, the main question of the present study is whether mindfulness-based stress reduction training and mindfulness-based stress reduction combined with electrical stimulation of the brain using tDCS are effective in reducing anxiety in adolescents with cancer.

Methods

The present quasi-experimental study was conducted with a pretest-posttest design and a control group in terms of applied purpose and research method. The statistical population of the present study included all adolescents with cancer in Mahak Hospital in Tehran, Iran, in 2020. According to the inclusion criteria, 40 individuals were selected through purposive sampling. The selected participants were randomly divided into 3 experimental groups and 1 control group, and thus, there were 10 people in each group. The inclusion and exclusion criteria were considered in the inclusion of participants in the study. The inclusion criteria included the passage of 6 months since the diagnosis, age range of 8 to 12 years, and the ability to read and write (to complete the research questionnaires). Suffering from psychiatric disorders and unwillingness to participate in the study were the exclusion criteria. After reviewing the inclusion and exclusion criteria, eligible individuals were selected to participate in the study. It should be noted that all selected

patients, who were selected through available sampling method, had an equal chance of being in the control and experimental groups; the members of the sample group were randomly divided into experimental and control groups. First, 40 patients who were willing to participate in the study (voluntary presence) were selected, and then, using a chance bag, a list of patients' names was entered in the lottery and randomly divided into experimental groups and witnesses were present. In the experimental part, research questionnaires were distributed before and after the implementation of the stress reduction program based on mindfulness and electrical stimulation of the brain through the skull using tDCS in the experimental and control groups. After the participants were voluntarily and randomly divided into experimental and control groups, before performing the treatment, questionnaires were distributed among the participants in the pretest stage. Then, the mindfulness-based stress reduction program was performed as group treatment sessions and electrical stimulation of the brain from the skull using tDCS was performed individually in the experimental group, but the controls did not receive any treatment.

After the treatment sessions, questionnaires were redistributed among all members of the experimental group to measure the variables in the posttest phase.

Penn State Worry Questionnaire (1990): The Penn State Worry Questionnaire (PSWQ) was used to assess the anxiety of adolescents with cancer by Meyer et al. in 1990. This questionnaire has 16 items. The items are scored on a Likert scale ranging from 0 to 4 (strongly disagree to strongly agree); 11 items related to anxiety are scored positively and 5 items (10, 11, 8, and 371) are scored negatively and show the content of non-concern. Meyer et al. reported the obtained Cronbach's alpha for this scale to be 0.90 and the test-retest reliability coefficient to be 0.74.[14] Salehpoor et al. calculated the Cronbach's alpha coefficient to be 0.74.[15]

Method of intervention

The 2 interventions of mindfulness-based stress reduction program and electrical stimulation of the brain from the skull using tDCS were used. The third experimental group received both types of intervention.

Electrical stimulation of the brain from the skull: The tDCS method is a non-invasive procedure in which a weak direct current (1 to 4 mA) is applied to the scalp using long-term changes in cortical polarity following depolarization and hyperpolarization of neurons and the effect on neurotransmitters. In this test, a current of 2 mA is applied for 20 minutes through 2 anode and cathode electrodes in sizes of 5 in 7 in the area of posterior-lateral front forehead (3F) and posterior posterior-lateral forehead (4F). The electrode is soaked in salt water or special creams to establish a good connection between the electrode and the skull. The number of these treatment sessions was 10 sessions, each of which lasted approximately 20 minutes. The interval between sessions was 48 hours and the treatment generally lasted 30 days.

Mindfulness-based stress reduction: The mindfulness-based stress reduction program consisted of 8 sessions lasting 90 minutes based on the model of Kabat-Zinn.[16] The objectives of this program are 1) providing an opportunity to test and develop an understanding of individual responses to stress and a means of modifying it, 2) allowing groups to play an active role in their treatment process, and 3) teaching self-care choices that promote feelings of adequacy and mastery, 4) increasing the sense of well-being and wholeness during mindfulness and meditation practice, and 5) providing a safe and supportive group environment in which members can disclose their experience of cancer (Table 1).

After examining the hypotheses of the parametric test using specific tests (Kolmogorov-Smirnov test, Levene's test, Box's M test, and regression gradient test), the one variable analysis of covariance (ANCOVA) and post hoc test with minimal significant differences were used.

Table 1. Summary of the content of mindfulness sessions based on the Kabat-Zinn protocol

Meeting	Content
First	Pretest, communication and problem mining, discussion of mindfulness stress reduction training methods, discussion of meeting hours and durations, and how to proceed
Second	A brief overview of the previous session, discussion and training on relaxation, tension and relaxation of muscles, how to sit in relaxation, and muscles that should be relaxed
Third	A brief overview of the previous session, as in the previous session, body-relaxation for the muscles, in 9 groups of muscles, blindfolded and performed as follows, providing homework
Fourth	A brief overview of the previous session, breathing training, homework presentation
Fifth	A brief overview of the previous session, teaching body scanning techniques, presenting homework
sixth	A brief overview of the previous session, mindfulness training in three stages, homework presentation
Seventh	A brief overview of the previous session, complete mindfulness training in two stages, homework presentation
Eighth	Summarizing the issues that arose in previous sessions, conducting posttests, ending sessions

Data analysis was performed in SPSS software (version 21; IBM Corp., Armonk, NY, USA). In order to comply with ethical standards in the present study, we tried to satisfy the adolescents to participate in the research and assured them that all the information obtained from them would be kept confidential and that those who wished to be informed of their psychological state were given their own scores**.** The control group was assured that, after completing the research, they would be offered 8 sessions of mindfulness-based stress reduction program if desired. Moreover, teenagers could freely leave the study whenever they wanted (Thesis code: 10148063982522200001624211O6).

Results

Mean ± standard deviation of age of participants in experimental group 1 (10.30 ± 1.33), 2 (9.90 ± 1.19), and 3 (10.40 ± 1.26), and the control group (10.20 ± 1.32) was calculated and compared using analysis of variance (ANOVA). The results showed that there was no significant difference between the groups in terms of age (F = 0.28; P = 0.83). Therefore, it can be said that the four groups in this study are peers in terms of age. In total, 42.5% of participants (17 patients) were women and 57.5% (23 patients) were men. Chi-square test was used to compare the groups in terms of gender distribution of participants. The results showed that there was no significant difference between the four groups in terms of gender variable distribution; as a result, the groups are gender equal (χ^2 = 0.18; P = 0.67). Most of the participants in the present study had leukemia [35% (14 patients)] and lymphoma [35% (14 patients)]. Given that the type of cancer was likely to affect the variables, the tested subjects were placed in the groups in the same way. The results of chi-square test also show that there is no significant difference between the groups in this regard (χ^2 = 0.18; P = 0.67).

In the posttest phase, the mean anxiety of the participants in experimental group 3 showed a significant decrease compared to the other groups. In this section, research hypotheses are examined using statistical tests. ANCOVA was used to compare the effectiveness of the mindfulness-based stress reduction training and cranial electrical stimulation program using tDCS in reducing anxiety in adolescents with cancer.

The mean posttest score of the experimental group was compared with the mean of the control group and the pretest scores were used as a covariate variable. The use of this test requires assumptions that were tested before inferential analysis. For this purpose, the findings of Kolmogorov-Smirnov test show that the data of both experimental and control groups in the research variables at different stages of evaluation are not significantly different from the normal curve and the data distribution is normal (P > 0.01).

Table 2. Central indicators and dispersion of groups in the related variable

Variable	Group	Pretest (n = 40)	Posttest (n = 40)	Follow-up (n = 40)
		Mean ± SD	Mean ± SD	Mean ± SD
Anxiety	Experiment 1	46.90 ± 1.79	44.40 ±2.17	44.75 ±2.25
	Experiment 2	47.30 ± 3.86	46.40 ±2.83	46.01 ±2.71
	Experiment 3	49.30 ± 2.11	46.10 ±2.68	46.33 ±2.73
	Control	48.30 ± 3.36	48.40 ±3.30	49.01 ±4.79

SD: Standard deviation

Levene's test showed that the assumption of equality of error variances for the research variables was valid (P > 0.01). In addition, the interaction between the coefficient of variance and the independent variable in the experimental and control groups was not significant (P > 0.01), which indicates that the assumption of homogeneity of the regression slope was also established. The observance of the assumptions of the parametric test suggests that the use of ANCOVA is unrestricted. To compare the effectiveness of mindfulness-based stress reduction training, tDCS, and the combined method of mindfulness-based stress reduction training and tDCS in reducing anxiety in adolescents with cancer, multivariate analysis of covariance (MANCOVA) with post hoc test with minimal difference was used (Table 2).

The level of significance calculated for the value of F in all significance tests was less than the set alpha value (α = 0.05), so it can be claimed that the difference between the groups is significant. There is a significant difference between mindfulness-based stress reduction method and tDCS method in reducing anxiety (P < 0.05). In terms of the effectiveness of the studied interventions on anxiety, the combined method was more effective than the separate use of each method (Table 3).

The level of significance calculated for the value of F in the Wilks' lambda significance test was less than the set alpha value (α = 0.05); thus, it can be claimed that the interactive effect of time on the group is significant. In other words, there is a significant difference between the groups in the measurements made over time. The results of repeated measures ANOVA for the interaction of the effect of time on the independent variable showed that there is no significant difference between the posttest and follow-up stages regarding the anxiety variable (P < 0.05); as a result, it can be said that the results were stable (Table 4).

Discussion

In this research, reducing anxiety in patients suffering from cancer was considered using mindfulness-based stress reduction with transcranial direct current stimulation.

Findings of the present study showed that mindfulness-based stress reduction training is effective in reducing anxiety attacks in adolescents with cancer. This finding is consistent with the findings of Ahmadi et al.,[17] Lenze et al.,[18] and Delgado et al.[19] Increasing attention and awareness of emotions and positive practical desires is one of the positive aspects of mindfulness, and mindfulness

Table 3. Results of the one-way analysis of covariance with the least significant difference test

MS	F	P	References	Comparison	MD	SE	P
21.032	6.128	0.002*	MBSR	tDCS	1.789-	0.835	0.040*
				MBSR + tDCS	0.243	0.889	0.031**
-	-	-		Control	2.936-	0.870	0.199
			tDCS	MBSR	1.789	0.835	0.786
-	-	-		MBSR + tDCS	2.032	0.903	0.031*
				Control	1.148-	0.875	0.001**
-	-	-	MBSR+ tDCS	MBSR	0.243-	0.889	0.002**
				tDCS	2.032-	0.903	0.199
				Control	3.179-	0.875	0.001**

Table 4. Results of the repeated measures analysis of variance and the least significant difference test

MS	F	P	References	Comparison	MD	SE	P
20.571	7.548	0.017*	Pretest	Posttest	1.857	0.645	0.013*
				Follow-up	1.714	0.624	0.017*
-	-	-	Posttest	Pretest	1.857-	0.645	0.013*
				Follow-up	0.143-	0.143	0.336
-	-	-	Follow-up	Pretest	1.714-	0.624	0.017*
				Posttest	0.143	0.143	0.336

training increases feelings without judgment and helps individuals to be aware of their emotions and accept them.[20]

Emotional problems experienced by people with anxiety include a lack of awareness of their emotional states as well as an inability to regulate emotions. Emotional disorder occurs when people do not accept their emotional experience and avoid the emotions associated with that experience.[21,22] The findings of the present study showed that tDCS does not have a significant effect on reducing anxiety in adolescents with cancer. Contrary to these findings, De Raedt et al. showed that tDCS can have a direct effect on the rumination of undergraduate students.[23] Other studies have confirmed the effectiveness of tDCS on anxiety and stress.[24] To explain this finding and the inconsistency of the results of this part of the study with previous studies, we can point to the observation that the target population of this study, adolescents with cancer, seemed to have more acute problems than the general population. As a result, more interventions are needed to improve adolescents' anxiety and rumination. Furthermore, it seems that if the areas of brain stimulation are re-evaluated, other points for concern and rumination can be stimulated. Findings of the present study showed that mindfulness-based stress reduction combined with tDCS has a significant effect on reducing anxiety in adolescents with cancer. To explain this finding, we can point to the advantages and beneficial features of each intervention. There are basic clinical theories for tDCS that can be considered as an alternative treatment to medication, for example, in patients with low drug tolerance or those who have to take overlapping drugs.[25] Due to the problems that adolescents with cancer have, they require different drugs to relieve the symptoms of cancer, and the simultaneous use of psychiatric drugs may cause different side effects in these people. As a result, using alternative methods such as tDCS to improve psychiatric problems as well as a complementary approach to psychotherapy can be very beneficial.

Selection of larger samples in larger populations, and use of other standardized methods are needed for more detailed studies.

Conclusion

The findings of the present study indicate that although third-wave neuropsychological and psychotherapeutic methods are appropriate approaches to improving mental health in people with chronic diseases, the integration and combination of these approaches can increase the effectiveness of these approaches.

Conflict of Interests

Authors have no conflict of interests.

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References

1. Zebrack BJ. Psychological, social, and behavioral issues for young adults with cancer. Cancer. 2011; 117(10 Suppl): 2289-94.
2. Geue K, Sender A, Schmidt R, Richter D, Hinz A, Schulte T, et al. Gender-specific quality of life after cancer in young adulthood: A comparison with the general population. Qual Life Res. 2014; 23(4): 1377-86.
3. Warner EL, Kent EE, Trevino KM, Parsons HM, Zebrack BJ, Kirchhoff AC. Social well-being among adolescents and young adults with cancer: A systematic review. Cancer. 2016; 122(7): 1029-37.
4. Mohagheghi MA, Mosavi-Jarrahi A, Malekzadeh R, Parkin M. Cancer incidence in Tehran metropolis: The first report from the Tehran Population-based Cancer Registry, 1998-2001. Arch Iran Med. 2009; 12(1): 15-23.
5. Antoni MH, Dhabhar FS. The impact of psychosocial stress and stress management on immune responses in patients with cancer. Cancer. 2019; 125(9): 1417-31.
6. Choi JH, Kim ES, Lee YJ, Cho KB, Park KS, Jang BK, et al. Comparison of quality of life and worry of cancer recurrence between endoscopic and surgical treatment for early gastric cancer. Gastrointest Endosc. 2015; 82(2): 299-307.
7. Aronson KR, Wagstaff DA, Farace E, Muscat J, Belani C, Almokadem S, et al. A week in the life of lung cancer survivors: Daily reports of stress, worry, mood, and symptoms. J Health Psychol. 2016; 21(10): 2269-82.
8. Sanaeenasab N, Moradi A, Hasani J. Casual relations between worry, worry attacks among patients with PTSD. Adv Cogn Sci. 2017; 18(4): 38-49.
9. Nila K, Holt DV, Ditzen B, Aguilar-Raab C. Mindfulness-based stress reduction (MBSR) enhances distress tolerance and resilience through changes in mindfulness. Ment Health Prev. 2016; 4(1): 36-41.
10. Spijkerman MP, Pots WT, Bohlmeijer ET. Effectiveness of online mindfulness-based interventions in improving mental health: A review and meta-analysis of randomised controlled trials. Clin Psychol Rev. 2016; 45: 102-14.
11. Baheshmat S, Hashemi-Razini H, Khaledi A. Identifying the effective factors on depression in patients with multiple sclerosis using structural equation modeling approach: The role of stress, self-esteem, and mindfulness. Chron Dis J. 2019; 7(2): 80-6.
12. McCallion EA. Mindfulness-based stress reduction and transcranial direct current stimulation as an intervention for chronic pain management [PhD Thesis]. Albuquerque, NM: The University of New Mexico; 2017.
13. Lu C, Wei Y, Hu R, Wang Y, Li K, Li X. Transcranial direct current stimulation ameliorates behavioral deficits and reduces oxidative stress in 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine-induced mouse model of Parkinson's disease. Neuromodulation. 2015; 18(6): 442-6.
14. Meyer TJ, Miller ML, Metzger RL, Borkovec TD. Development and validation of the Penn State Worry Questionnaire. Behav Res Ther. 1990; 28(6): 487-95.
15. Salehpoor G, Kafi SM, Hatamiyan HR, Mohammadpoor K, Rezaei S. Validation of Persian Version of the Penn State Worry Questionnaire among Multiple Sclerosis Patients. Knowledge Health. 2017; 12(1): 16-27.
16. Kabat-Zinn J. Mindfulness meditation for everyday life. Teaneck, NJ: BetterListen; 2013.
17. Ahmadi s, Mirzaiyan B, Maddah mT. Efficacy of mindfulness-based cognitive therapy on worry and cognitive avoidance in anxious students of universities. Journal of Psychology New Ideas. 2017; 1(1): 1-10.
18. Lenze EJ, Hickman S, Hershey T, Wendleton L, Ly K, Dixon D, et al. Mindfulness-based stress reduction for older adults with worry symptoms and co-occurring cognitive dysfunction. Int J Geriatr Psychiatry. 2014; 29(10): 991-1000.
19. Delgado LC, Guerra P, Perakakis P, Vera MN, Reyes del Paso G, Vila J. Treating chronic worry: Psychological and physiological effects of a training programme based on mindfulness. Behav Res Ther. 2010; 48(9): 873-82.
20. Brown KW, Ryan RM. The benefits of being present: mindfulness and its role in psychological well-being. J Pers Soc Psychol. 2003; 84(4): 822-48.
21. Werner KH, Goldin PR, Ball TM, Heimberg RG, Gross JJ. Assessing emotion regulation in social anxiety disorder: the emotion regulation interview. J Psychopathol Behav Assesst. 2011; 33(3): 346-54.
22. Williams M, Penman D, Kabat-Zinn J. Mindfulness: An eight-week plan for finding peace in a frantic world. New York, NY: Harmony/Rodale; 2012.
23. De Raedt R, Remue J, Loeys T, Hooley JM, Baeken C. The effect of transcranial direct current stimulation of the prefrontal cortex on implicit self-esteem is mediated by rumination after criticism. Behav Res Ther. 2017; 99: 138-46.
24. Narimani M, Pouresmali A, Alizadeh G, Mowlaie M. The effect of trancecranial Direct Current Stimulation (tDCS) on reduction of craving, depression and anxiety in students with tramadol abuse: Preliminary study. Research on Addiction. 2017; 10(40): 87-102.
25. Brunoni AR, Nitsche MA, Bolognini N, Bikson M, Wagner T, Merabet L, et al. Clinical research with transcranial direct current stimulation (tDCS): Challenges and future directions. Brain Stimul. 2012; 5(3): 175-95.