

Clinical Article

Effects of Mindfulness Based Stress Reduction Program on Depression, Anxiety and Stress in Patients with Aneurysmal Subarachnoid Hemorrhage

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Objective : In this study, the Mindfulness Based Stress Reduction (MBSR) program was applied to patients presenting with depression and anxiety after surgery from spontaneous subarachnoid hemorrhage (SAH) and the effects were assessed.

Methods : The subjects were patients admitted for cerebral aneurysm rupture and treated by means of surgery from March to December, 2007. More than 6 months had passed after surgery, without any special lesions showing up on computed tomography (CT), and the Glasgow outcome scale (GOS) was 5 points. Among patients with anxiety and depression symptoms, 11 patients completed the program. The MBSR program was conducted once a week, 2.5 hours each, for 8 weeks. The evaluation criteria were : 1) the Beck Depression Inventory (BDI): it measures the type and level of depression, 2) the State-Trait Anxiety Inventory : the anxiety state of normal adults without mental disorder, and 3) Heart Rate Variability (HRV) : the influence of the autonomous nervous system on the sinoarterial node varies continuously in response to the change of the internal/external environment.

Results : The BDI value was decreased from 18.5 ± 10.9 to 9.5 ± 7.1 ($p = 0.013$) : it was statistically significant, and the depression level of patients was lowered. The state anxiety was decreased from 51.3 ± 13.9 to 42.3 ± 15.2 ; the trait anxiety was reduced from 50.9 ± 12.3 to 41.3 ± 12.8 , and a borderline significant difference was shown ($p = 0.091$, $p = 0.056$). In other words, after the treatment, although it was not statistically significant, a decreased tendency in anxiety was shown. In the HRV measurement, standard deviation normal to normal (SDNN), square root of the square root of the mean sum of squared differences between adjacent normal to normal intervals (RMSSD), and total power (TP) showed significant increase, Physical Stress Index (PSI) showed a significant reduction, and thus an improvement in the homeostatic control mechanism of the autonomic nervous system was seen.

Conclusion : The MBSR program was applied to the patients showing anxiety and depression reaction after SAH treatment, and a reduction in depression symptoms and physiological reactions were observed. The application of the MBSR program may be considered as a new tool in improving the quality of life for patients after surgery.

KEY WORDS : Subarachnoid hemorrhage · Depression anxiety · Mindfulness based stress reduction program.

INTRODUCTION

Recently, subarachnoid hemorrhage (SAH) caused by cerebral aneurysm rupture shows a high survival rate due to an improvement in diagnostic methods and treatment techniques. In addition, in most patients, due to the diverse

methods of aggressive rehabilitation treatments after surgery, the neurological functions of patients have shown to improve drastically.

When SAH occurs, the Hunt-Hess (H-H) grade, that is, the grade assessing neurological symptoms and the Fisher grade classification by the hemorrhage volume on the brain computed tomography (CT) are applied, the grade of neurological recovery is then evaluated by the Glasgow outcome scale (GOS). However, the assessment of the prognosis of SAH by such grades is only limited to the evaluation of the recovery of the neurological function of patients. Generally, the survival rate of SAH patients has been increased and the physical symptoms of patient have also been lessened,

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nevertheless, numerous studies have shown that the patients still experience depression and anxiety^{1,2,7,11,24,26,27}.

Therefore, although most patients recover physiologically after their treatments, they may experience deterioration in the quality of life (QOL) due to psychological problems such as anxiety, depression as well as the difficulty to return to their everyday social activities. Furthermore, such emotional status may not resolve spontaneously without treatment but sometimes remain persistently^{23,24}. Powell et al.²⁶ pointed out the necessity of the intervention controlling and reducing such anxiety and depression to improve the day to day function of patients. Nonetheless, in Korea as well as other countries, studies on such programs are insufficient. In this study, by applying the Mindfulness Based Stress Reduction (MBSR) program in the treatment of patients, the effects on psychological problems after SAH, such as anxiety and depression as well as physiological changes, were studied.

MATERIALS AND METHODS

Patient population

Among the patients admitted to our hospital from March to December 2007 for SAH caused by cerebral aneurysm rupture, having undergone surgical treatments, the study was conducted on the patient group experiencing psychological problems such as anxiety, depression, etc. even 6 months after discharge. The MBSR program was explained, and the study was conducted on patients who wished to participate in the study. The subjects were from 30 to 70 years of age, and the patients who recovered after surgery due to subarachnoid hemorrhage, showed normal func-

tions in their neurological tests. Their Glasgow outcome scale (GOS) was 5 points; exhibiting signs of good recovery, and at 6 months after surgery, without abnormal lesions such as brain infarction or hydrocephalus on their cerebral CT scans, they nonetheless presented anxiety, depression, memory impairment. Those patients requiring continuous rehabilitation treatment for serious sequela; those under other psychological treatments and the ones showing schizophrenia or delusion, as well as patients having undergone other partial surgeries after cerebral aneurysm surgery, and those currently under psychiatric drugs were excluded from the experiment. Initially, 28 patients who wished to participate in the study were recruited, however, 17 patients dropped out during the course of the study, and only 11 patients completed the study.

Contents of program

The location of the aneurysm of patients, treatment methods, H-H Gr, and Fisher Gr at admission, the postsurgical follow up period, general disease history were recorded (Table 1).

The Beck depression score and the state-specific anxiety score of the subjects were prepared, and Heart Rate Variability (HRV) and blood pressures were measured before the experiment. The subjects attended the MBSR program that was offered once a week, 2.5 times each, and continued for 8 weeks. The essence of the program was to train the 'mindfulness' of patients. Kabat-Zinn et al.¹⁵ defined mindfulness as paying attention in a particular way; that is with purpose, in the present moment and nonjudgmentally. In the MBSR program, the methods to train mindfulness are : body scan, sitting meditation, and Hatha yoga. The body

Table 1. Detail data for patients

Patient number	Age/Sex	Location	treatment	Hunt-Hess Gr	Fisher Gr	Follow-up Period (mon)	Smoking	Alcohol intake	Past history	Drug Hx
1	44/M	AcomA BA	Clip Coil	II	III	12	+	+	HT	+
2	44/M	AcomA	Clip	II	II	8	+	-	HT	+
3	54/M	AcomA	Clip	II	II	10	-	+	Hepatitis	-
4	63/M	Rt. MCA	Clip	III	II	16	+	+	HT	+
5	65/M	Lt. MCA	Clip	III	II	10	-	+	DM	+
6	38/F	AcomA	Clip	I	II	12	-	+	-	-
7	42/F	Rt. MCA	Clip	II	II	6	-	+	-	-
8	47/F	Both P-com	Clip	III	III	11	-	-	-	-
9	52/F	Lt. Acho	Clip	II	I	12	-	+	HT	-
10	65/F	Lt. MCA	Clip	I	I	13	+	-	-	-
11	65/F	Lt. P-com Rt. ICA	Clip Coil	II	III	8	-	+	-	-

Drug History. Three people took hypertensive medication and one person took drug for diabetes. No psychiatric drug was taken. AchoA : anterior choroidal artery, AcomA : anterior communicating artery, BA : basilar artery, DM : diabetes mellitus, HT : hypertension, ICA : internal cerebral artery, Lt : left, MCA : middle cerebral artery, P-com : posterior communicating artery, Rt : right

scan is to concentrate on each area of the body from head to toe and to observe the sensations felt in each area. Sitting meditation is to be aware and to observe the thought processes generated while paying attention to continuous breathing, feeling, body sensation. In addition, through Hatha yoga, by performing various yoga movements to strengthen the muscular skeletal system, in order to achieve balance, and simultaneously, to be well aware of each movement and to culture the ability of mindfulness. In addition, 'loving-kindness meditation' is practiced, and through group discussions, the patients have time to share their experiences. In addition to attending the program, the subjects performed the task of body scan, sitting meditation, yoga, and the mindfulness of routine life using the provided compact disk (CD). After the completion of the 8 week program, again, the Beck's Depression Inventory, and the State-Trait Anxiety Inventory (STAI) were checked, and HRV and blood pressure were measured.

Measurement tools

The Beck Depression Inventory, Korean version

The Beck Depression Inventory, Korean version, was prepared based on clinical depression symptoms, and it measured the type and level of depression. This was prepared by the translation of the original questions developed by Beck et al. (1967) into Korean by Yi, Young Ho (1993), and subsequently, it was examined by psychologists and English scholars. It includes 21 areas such as emotional, cognitive, motivational, physiological syndromes, etc., the range of score may be from 0 points to 63 points. From 0 point to 9 points was referred to as the state of not depressed, from 10 points to 15 points was the mild depression state, from 16 points to 23 points was the moderate level depression state, and higher than 24 points was the severe depression state²⁹. The confidentiality and biserial correlation coefficient to the Beck et al. (1961) Depression Inventory were from 0.65 to 0.67, respectively⁸.

The State-Trait Anxiety Inventory

The STAI is a tool to measure the anxiety state of normal adults without any psychological disorder. It is a useful test to distinguish the clinically anxiety group as well as the anxiety of psychiatric patients. The STAI of Spielberger³¹ was revised by Kim, Jung Taek (1978), it consists of a total of 40 questions, and it is a Likert type measurement comprising of 4 levels. Each question is scored on the scale : 1 point for 'hardly', 2 points for 'occasionally', 3 points for 'frequently' and 4 points for 'almost always', and the questions scoring reversely are present in the state/trait score. The

range of the state anxiety and the trait anxiety scores obtained by an individual is 20-80 points each, and higher scores imply higher anxiety levels⁸. 52-56 was defined as the state in which the anxiety level was slightly high, 57-61 was the state wherein the anxiety level was very high, and higher than 62 constituted a state in which the anxiety level was extremely high. Concerning the trait anxiety, 54-58 was slightly high, 59-63 was very high, and higher than 64 was extremely high³¹.

Heart Rate Variability

When peaks in a wave pattern are detected on an electrocardiogram (ECG), the interval between the peaks is measured. The heart beat interval thus measured is around 800 msec, and it varies continuously. When the real-time heart beat interval is measured, it could be converted to number of heart beats and presented in such a way, and the continuously varying heart rate is referred to as heart rate variability. In other words, the intervals between heartbeats vary continuously even at rest, and this is referred to as heart rate variability. In healthy individuals, HRV appears to be big and complex, and it is reduced in a diseased or a stressed state^{12,21}. HRV was measured by the use of BFM-5000P (Medicore, Korea), and it was used to determine whether the homeostasis control mechanisms of the autonomic nervous system from prior to and after the program varied. HRV was measured prior to and after the program by experienced practitioners. For the measurement, the patient was prohibited to take any food from 2 hours prior to the test, and from 12 hours prior to the test, smoking and coffee consumption were prohibited. For the patient to adjust to the experimental environment sufficiently, a preparation period prior to the test was allowed, and while sitting on a chair, the heart rate variability was measured for 3 minutes. The value used for HRV was the time domain analysis; they are mean heart rate (MHR), standard deviation normal to normal (SDNN), square root of the mean sum of squared differences between adjacent NN intervals (RMSSD), and Physical Stress Index (PSI), and Frequency Domain Analysis are total power (TP), lower frequency (LF), high frequency (HF), and LF/HF (LF/HF two component ratio) value. The MHR is an average heart rate, the SDNN is the standard deviation of the entire RR interval, the cases with a large SDNN implies that the heart rate variability signal is irregular at that level, and small cases imply that the heart rate variability signal is simple. The RMSSD is the square root of the average adjacent RR interval, and it is a variable used to evaluate the activity of the parasympathetic nerves, and a reduction of RMSSD suggests a risk of cardiac disease development. Pounds per square inch (PSI) expresses the level of

pressure by the application of the domain parameters such as HRV and the distribution of RR interval, etc. TP implies all powers in 5 minutes including VLF, LF, and HF, and in cases with stress or certain diseases, because of the decrease of the regulation capacity of the autonomic nervous system, TP is decreased. LF is the domain parameter of the value of the area higher than 0.15-0.4 Hz, and it includes the sympathetic and the parasympathetic nervous systems, nonetheless, at rest, it is known to be a value within this range representing primarily the sympathetic nervous system, and the HF in high frequency areas is an area value higher than 0.4 Hz, and it is known to be a value range representing primarily the parasympathetic nervous system. LF/HF ratio signifies the ratio of LF and HF, which reflects the overall balance level of the sympathetic and the parasympathetic nerves, in other words, the autonomic nerves. This is proportional to the activity level of the sympathetic nerve and inversely proportional to the activity level of the parasympathetic nerve¹²⁾.

Data analysis

For the analysis of all data, the SPSS program was used, and the pre- and post-measured values analyzed by the Wilcoxon signed rank test; the variables exerted a significant effect on the MBSR that was analyzed. A significant level was $p < 0.05$.

Table 2. Average and standard variation of blood pressure and psychological scales

Variables	Pre MBSR	Post MBSR	p-value
Systolic BP (mmHg)	127.9 (16.9)	114.2 (13.7)	0.062
Diastolic BP (mmHg)	76.8 (9.5)	72.5 (9.3)	0.059
BDI	18.5 (10.9)	9.5 (7.1)	0.013
SAI	51.3 (13.9)	42.3 (15.2)	0.091
TAI	50.9 (12.3)	41.3 (12.8)	0.056

BDI : Beck Depression Inventory Korean version, BP : blood pressure, SAI : State Anxiety Inventory, TAI : Trait Anxiety Inventory

Table 3. Average and standard variation of HRV (Heart Rate Variability)

Variables	Pre	Post	p-value
MHR (bpm)	74.55 (10.838)	66.2 (7.0)	0.007
SDNN (ms)	25.5 (12.2)	37.2 (20.6)	0.013
RMSSD (ms)	21.2 (12.4)	30.2 (16.3)	0.021
PSI	131.4 (107.7)	71.3 (84.8)	0.037
TP (ms ²)	580.3 (630.7)	1307.7 (1674.2)	0.026
VLF (ms ²)	230.3 (290.3)	278.0 (268.1)	0.534
LF (ms ²)	157.2 (196.8)	758.8 (1316.2)	0.008
HF (ms ²)	192.8 (239.0)	270.9 (292.6)	0.248
LFN (n.u)	48.6 (18.2)	59.5 (25.1)	0.248
HFN (n.u)	51.4 (18.2)	40.5 (25.1)	0.248
LF/HF	1.3 (1.2)	4.3 (7.0)	0.182

HF : high frequency, HRV : heart rate variability, LF : lower frequency, LF/HF ratio : LF/HF component ratio, MHR : mean heart rate, PSI : Physical Stress Index, RMSSD : square root of the mean of sum of the square of differences between adjacent NN intervals, SDNN : standard deviation normal to normal, TP : total power, VLF : very lower frequency

RESULTS

Depression and anxiety prior to and after treatments and physiological reactions

The result of the test conducted prior to and after the program is shown in Table 2.

With regard to blood pressure, the maximal blood pressure was decreased from 127.9 ± 16.9 mmHg to 114.2 ± 13.7 mmHg, and the minimal blood pressure was decreased from 76.8 ± 9.5 mmHg to 72.5 ± 9.3 mmHg, and borderline significant differences were shown ($p = 0.062$, $p = 0.059$). In the depression inventory, after the experiment, the BDI measurement value was reduced from 18.5 ± 10.9 to 9.5 ± 7.1, and a statistically significant difference was shown ($p = 0.013$). In other words, after the treatment, the depression level of patients became low. In the anxiety inventory cases, the state anxiety was decreased from 51.3 ± 13.9 to 42.3 ± 15.2, the trait anxiety was decreased from 50.9 ± 12.3 to 41.3 ± 12.8, and borderline significant differences were shown ($p = 0.091$, $p = 0.056$).

The effect on the change of the autonomic nervous system

The result of the individual index of HRV was shown in Table 3. After the experiment, in the time domain analysis, the SDNN was increased from 25.5 ± 12.2 to 37.2 ± 20.6,

and it was statistically significant ($p = 0.013$), the RMSSD was increased from 21.2 ± 12.4 to 30.2 ± 16.3, and it was statistically significant ($p = 0.021$). The PSI was decreased from 131.4 ± 107.7 to 71.3 ± 84.8, and a statistically significant difference was shown ($p = 0.037$). The TP was increased from 580.3 ± 630.7 to 1307.7 ± 1674.2, and it was statistically and significantly different ($p = 0.026$). This implies that the homeostasis control mechanism of the autonomic nervous system was improved.

DISCUSSION

MBSR

Mindfulness is the translated word of the Pali Vipassa¹⁹⁾. It is the combined word of vi and passana in Pali language, 'vi' means 'various' and passana means 'see through'. Mindfulness meditation provides a means to practice

mindfulness, and the characteristic of the method is to pay attention on the experience of each moment, to open the mind to all stimulations, regardless of being external or internal, and being purely aware or observing without being involved in the experience. Therefore, through mindfulness meditation, by seeing the self and the world as is, ideal living or discernment of the self and the world could be achieved^{16,18}.

Since the MBSR program that is known to be an oriental psychological practice method was introduced to the medical field by Kabat-Zinn at the University of Massachusetts in 1980 for the first time, it has been discussed as a new treatment for diverse chronic diseases and anxiety, depression, and other psychological disorders. Meditation mediates physiological changes by inducing the relaxation of the parasympathetic nerves that have a potent reaction to stress caused by the excitation of the sympathetic nervous system. In addition, during the practice of meditation, the brain wave referring to the most awakened cognitive state; the theta wave is shown abundantly, and it has been reported to increase not only cognitive function but also physical performance capacity noticeably¹⁰.

At the Massachusetts University Medical Center, after adopting the MBSR program, more than 10,000 patients completed the 8 week program in a timespan of 30 years. It has been reported that overall, the patients participated in the stress reduction program liked this meditation training, and they were able to prepare a changing point of view to a new life¹⁰. This program is designed to allow meditation to become routine by the end of 8 weeks of gradual training, and thus to decrease physical and psychological disorders such as depression, anxiety, sleep disorder, etc. by resolving stress experienced during daily life and reducing tension. It has been reported that generally, after the completion of the 8 week program, various medical physical syndromes, and psychological syndromes, for example anxiety, depression, and hostility that were shown at the beginning of the program were markedly decreased¹⁰. After the application in the medical field, the MBSR program has been shown to improve psychological disorders such as anxiety and depression^{3,4,6,14,17}, alleviate chronic pains¹³, and when applied to psoriasis, fibromyalgia, eating disorder, and other diverse diseases, it was shown to ameliorate the symptoms or alleviate psychological pain caused by and associated with their symptoms^{3,4,6,14,15,22,28,30}.

The psychological difficulties of SAH patients

According to the study reported by Beristain et al.¹, conducted on patients that underwent aneurysm surgery, who did not die or end up in a vegetative state; among 20 sub-

jects, 13 patients showed good recovery, nonetheless, 18 patients were found to experience physiological and psychological damage such as depression, anxiety, and behavioral changes. This suggests that the criteria such as Karnofsky Scale (KS) or GOS do not measure any daily discomfort by properly reflecting the sequelae associated with psychological symptoms. In addition, Jeannette¹¹ has reported that even without functional or cognitive damage, the subjective psychological and social health level felt by patients may be low.

According to Berry², 50% of SAH patients showed anxiety disorder and 32% corresponded to the post-traumatic stress disorder (PTSD) diagnostic criteria. Morris et al.²⁴ have reported that 39% of patients had from severe to moderate anxiety even 16 months after hemorrhage and 17% of patients had depression problems. In the study reported by Carter et al.⁵, performed on the patients with the H-H Grade from I to III, 35% of them were shown to experience depression. Furthermore, it was considered that such emotional confusion did not disappear spontaneously without treatment, but rather remained persistent. According to Powell et al.²⁶, 3 months as well as 9 months after SAH surgery, the clinically significant levels of anxiety and depression were shown in all cases, and in comparison with the control group, the ratio of emotional disorders after 3 months was shown to be higher by approximately 2 times, and decreased gradually. In addition, after 3 months, 60% of patients, and after 9 months, 30% of patients showed a high ratio of PTSD. Reviewing the study conducted 18 months after surgery by the identical investigators on the identical patients, PTSD symptoms were decreased slightly, but on the other hand, in the anxiety scale of the Hospital Anxiety and Depression Scale (HADS), the clinical range was increased from 17 to 18.4%, the HADS depression scale was increased from 8.5 to 10.2%, and anxiety or depression became slightly higher than after 9 months from the time of their operation²⁷. According to this study, despite the absence of cognitive defect or physiological disability, 50% of patients were dependent on others to carry out routine life, and they did not participate in productive activities including any volunteer activity, paid working activity, babysitting, education, etc.

Anxiety and depression are major causes to limit their function by acting as a disability during social functions or while returning to the job⁷. Carter et al.⁵ pointed out that the two major causes hindering patients in returning to normal life are depression coupled with physiological limitations. In the above mentioned studies, it could be observed that despite of physiological recovery, SAH surgery patients' experienced anxiety and depression due to the change of

life functions. In case of the patients who participated in our study, similarly, the average BDI score by the test conducted prior to treatments was 18.5 points, the average score of their state and trait anxiety levels were 51.3 points and 50.9 points respectively, and regarding depression, severe levels of depression were shown, and concerning their state and trait anxiety levels, they were shown to be higher than average. In this study, the effect of the mindfulness-based stress reduction program on depression as well as the physiological reactions of patients after SAH treatments was examined. However, the fact that during the application of the program, the drop out rate of the patient group being high proved to be a problem. This implies that the program should be improved to kind of program that more patients could participate in.

The clinical application of HRV

In our study, to examine the effects of the MBSR program on SAH patients, not only subjective psychological scales, but also as a tool to evaluate the activity of the autonomic nervous system objectively and reliably HRV was applied. The reduction of HRV implies a reduction in the complexity of heart beat spasmic changes, which in turn implies a decrease in the capacity of the body to adjust to environmental changes continuously. The autonomic nervous system plays a role of maintaining the balance of the internal environment against external environmental changes, and thus it is directly involved in managing healthy life by maintaining the life sustaining activities and homeostasis within the body²⁰. The function of the autonomic nervous system is closely associated with various physical activities. When the balance within the body is disrupted by external environmental changes or various factors, the autonomic nervous system functions to try and restore them. During the process, a change in the heart beat develops, and the HVR of the individuals well able to adapt to diverse changes becomes large¹². This is also associated with the psychological state of patients, and in the depression predisposed group, and their heart rate variability is decreased significantly¹². In the HRV scale, SDNN, RMSSD, and TP showed significant increase, PSI showed significant reduction, and thus an improvement of the homeostasis control mechanism of the autonomic nervous system was shown. The heartrate is determined by the proprietary and voluntary properties of the heartbeat control cells in the sinoarterial node. The sinoarterial node is regulated by both the sympathetic nerves and the parasympathetic nerves, and their opposite influences become balanced and determine the heartbeat rate.

The SDNN is an index assessing heartbeat changes, and

together with the stability of the cardiovascular system, it is used as a potent index providing information on the capacity of the autonomic nervous system to control the body⁹. The average SDNN value of healthy adults has been reported to be 35.9²⁵. The SDNN value of the patients measured prior to the program was 25.5, which is far below the average range, and thus fine changes in heartbeat were shown to be very monotonous. Nevertheless, after the experiment, it was 37.2, and it was found to surpass the normal range. This implies that the homeostasis control mechanism of the body was improved, and thus sensitively responded to the concentration of oxygen in the blood, body temperature, blood pressure, etc., and reached the physiological homeostasis state in a short period of time. The increase of VLF, LF, and total power also implies an elevation of the overall activity level of the autonomic nervous system. In the chronic stress state, the total power is decreased, and a significant increase implies the same for SDNN and an improvement of the regulation ability of the autonomic nervous system, which could be detected by a significant reduction of the TP of the patient group in comparison to the control group¹². LF reflects the activity of the sympathetic nervous system at the low level tilt, and at the high level tilt, it reflects the activities of both the sympathetic and parasympathetic nervous systems²⁰. The reduction of LF shows an energy loss of living organisms¹³. HF is an index of the activity of the parasympathetic nervous system, and it is closely associated with the electric stability of the heart. In patients with deteriorated cardiopulmonary function, HF is noticeably decreased. In addition, it is shown to be low in patients suffering from stress, fear, anxiety, and worry or in the case of heart disease. Additionally, in most patients presenting stress and fatigue, the reduction of LF and HF has been reported²⁰. In our study, both the LF and HF index of patients were elevated after the experiment. Particularly, LF was elevated significantly, which implies an activation of physiological functions.

CONCLUSION

Results of this study demonstrate the improvement of depression as well as physiological changes after the application of the MBSR program to SAH patients. In addition, the study is meaningful since new attempts were made to improve the states of QOL of SAH patients suffering from psychological problems despite of improvements of their physiological indexes after surgery. The application of the MBSR program may be considered as a new strategy to improve the QOL of patients after surgery, nevertheless, additional studies are required.

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