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Research article

THE IMPACT OF VISUALISATION ON EMOTIONAL STATES AND OXYTOCIN SECRETION IN PATIENTS AFTER MYOCARDICAL INFARCTION

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SUMMARY

Background: *Psychological interventions are increasingly used in the rehabilitation process after myocardial infarction. Previous studies have shown that guided visualization, which was also used in our research, is one of the most effective interventions.*

Subjects and methods: *The study involved 20 participants undergoing rehabilitation after myocardial infarction at the Internal Clinic of the University Medical Centre Ljubljana. They were divided into two groups, experimental and control. Participants in the experimental group performed guided visualization daily for 28 days. At the first and last sessions, two saliva samples were collected from all participants - before and after guided visualization. Participants measured their heart rate variability (HRV) parameters using a mobile application during visualization. Statistical methods used to determine the effects of visualization included t-test for two dependent samples and Wilcoxon test. Independent samples t-test and Mann-Whitney U test were used for comparisons between groups.*

Results: *The study results show a significant impact of visualization on reducing negative affective states, while other variables showed changes in the expected direction that were not statistically significant.*

Conclusion: *Study findings can contribute to the development of a more comprehensive psychophysiological approach to patients recovering from myocardial infarction, and they can also serve as a basis for the development of non-invasive post-infarction treatment with oxytocin.*

Key words: *visualization, oxytocin secretion, myocardial infarction, emotional states, heart rate variability*

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INTRODUCTION

According to WHO data (World Health Organization 2021) cardiovascular diseases are the leading cause of death worldwide, with approximately 17.9 million individuals dying each year from their consequences. Heart attacks and strokes account for 85% of these deaths. Myocardial infarction (MI) occurs as a result of arterial blockage, most commonly caused by atherosclerosis, which is characterized by the accumulation of atherosclerotic plaques in the arterial walls (Noč & Radšel 2008). The symptoms faced by individuals after an MI are both physiological and psychological. Most common physiological symptoms include difficulties with breathing, fatigue, and sleep problems (Kwekkeboom & Bratzke 2016). Research shows that psychological factors play an important role in the occurrence, development, and rehabilitation of coronary heart disease (Richards et al. 2017). More than 55% of coronary patients are reported to experience negative psychological symptoms, such as anxiety and depression (Eriksson et al. 2013), making it important to also offer patients psychological interventions.

Guided visualization is a cognitive intervention that involves mental imaging of content, which can be conveyed through listening to audio material (Kwekkeboom et al. 1998). It is said to help reduce pain following surgical procedures (Álvarez-García & Yaban 2020), as well as alleviate depression, fatigue, and regulate cortisol levels (McKinney et al. 1997). Psychological interventions have shown to reduce anxiety and depression in cardiac patients (Zhang et al. 2021).

Positive mental health is a combination of emotional, social, and psychological well-being (Keyes 2007). In

our study, we focused on the latter, which is indirectly associated with cardiological health through behaviors that promote a healthy lifestyle, including increased physical activity and balanced nutrition (Giltay et al. 2006), or directly through changes in the neuroendocrine, cardiovascular, and inflammatory systems (Steptoe et al. 2009). Guided visualization enables individuals to relax, impacting emotional well-being, reducing stress, and lowering negative emotionality (Ofentavšek 2023, Watanabe et al. 2005).

Depression is a common response to MI and according to the results of a meta-analysis by Van Der Kooy et al. (2007), depression increases the risk of developing cardiovascular diseases by 46 %. Lang et al. (2012) investigated the impact of visualization on the severity of depression symptoms in a sample of 26 depressed individuals. After two weeks of daily visualization practice, participants from the experimental group showed improvement in depressive symptoms compared to the control group.

Guided visualization as an intervention for reducing anxiety has proven to be effective by significantly lowering anxiety levels in patients with various health issues (Serra et al. 2012).

Chronic distress is associated with negative health outcomes. These include heart disease, depression, anxiety (Iglesias et al. 2012). Elevated stress indirectly affects the occurrence of atherosclerosis and ischemic heart diseases (Grewal et al. 2011). A study by Whitehead et al. (2005) showed that upon hospital admission for acute MI, 22% of patients reported high levels of stress, while 52% reported moderate levels of stress.

Non-pharmacological interventions, such as guided visualization, are increasingly used in medicine to alleviate many somatic symptoms (McDonald et al. 2015). Research has shown that visualization has positive effects on both psychological and physiological symptoms that occur in patients after MI. The psychological effects of visualization, such as reducing stress, depression and anxiety, are linked to physiological effects, as evidenced by changes in heart rate variability (HRV) parameters, regulation of heart rate, and breathing (Machida et al. 2018, Malik et al. 1996).

The key task of the autonomic nervous system (ANS) is to regulate the functioning of organic systems, including the cardiovascular system. Indicators of ANS function are HRV parameters, which reflect an individual's cardiovascular health (Malik et al. 1996). They demonstrate how the autonomic nervous system affects the sinoatrial node, responsible for initiating the heartbeat. The length of one cardiac cycle is represented by the RR interval. Since our heart beats irregularly, RR intervals vary. HRV represents the variation of these time intervals in milliseconds (Malik et al. 1996). HRV parameters are divided into time domain and frequency domain. In the time domain, the most commonly used measure is the standard deviation of NN intervals (SDNN), which are intervals occurring during the depolarization of the sinus node. In the frequency domain, time indicators are converted into frequency components, reflecting the power spectrum. This spectrum represents the total variability, divided into four components: very low frequency (VLF), low frequency (LF), high frequency (HF), and very high frequency component of the spectrum (VHF). HF, ranging between 0.15–0.4 Hz, is considered to reflect the activity of the parasympathetic nervous system, while LF reflects the activity of the sympathetic nervous system (Kšela 2020).

Malik et al. (1996) report that patients post-MI have statistically lower frequency component indicators of HRV, indicating an increased influence of sympathetic activity on heart rhythm regulation. Limmer et al. (2022) studied the effect of using a mobile device to increase HRV in patients post-MI. Participants performed breathing exercises for five minutes three times a day for 12 weeks, concurrently using a mobile device that measured real-time HRV. They found a significant increase in HRV values.

Oxytocin is an endogenous neuropeptide hormone synthesized in the paraventricular and supraoptic nuclei of the hypothalamus and released in the posterior part of the pituitary gland (Gimpl & Fahrenholz 2001). It plays a central role in promoting social behavior, attachment mechanisms, the formation of pair bonds and trust, and maternal behavior (Carter 2014). Through the central and peripheral nervous systems, it participates in the regulation of the cardiovascular system (Petersson & Uvnäs-Moberg 2007).

The study by Wsol et al. (2008) demonstrated that rats, in which endogenous secretion of oxytocin was stimulated, exhibited a significantly lower stress response and lower increase in heart rate compared to rats that did not receive oxytocin. Therefore, stimulation of oxytocin receptors in the brain plays a crucial role in inhibiting cardiovascular responses to stress. Kobayashi et al. (2009) in their research on post-infarction treatment in rabbits, found that oxytocin contributes to the reduction of MI size.

Vižintin (2021) studied psychophysiological responses to visualization with calming music and found a significant impact on increasing SDNN. Due to the small sample size, the results did not show significant effects on affective mood states, increased oxytocin, and parasympathetic activity, but the average values on the observed variables indicated expected effects. Machida et al. (2018) hypothesized that meditation focused on altruism, respect, and gratitude towards others could stimulate oxytocin secretion, using the Arigato-Zen method. The study involved 32 participants who had saliva samples taken before and after the meditation session. After the intervention, a sigificant increase in oxytocin levels was observed. A pilot study by Klaus et al. (2000) explored the effect of using guided visualization in patients with heart failure, and the results indicated a positive effect on reducing stress, anxiety, and depression.

AIMS AND OBJECTIVES

The objective of the study is to determine the impact of the guided visualization technique on oxytocin

secretion, HRV parameters, and affective mood states (depression, anxiety, stress, and psychological well-being) in patients recovering from MI.

We hypothesized that:

H1: After the first session of guided visualization, there will be a statistically significant increase in oxytocin levels in the experimental group (EG) compared to before the session.

H2: After the first session of guided visualization, the oxytocin levels in the EG will be statistically significantly higher compared to the control group (CG).

H3: After 4 weeks of guided visualization, there will be a statistically significant increase in oxytocin levels in the EG at the final measurement compared to before the intervention started.

H4: After 4 weeks of guided visualization, there will be a statistically significant increase in oxytocin levels in the EG at the final measurement compared to before the last visualization.

H5: After 4 weeks of guided visualization, there will be a statistically significant increase in oxytocin levels in the EG at the final measurement compared to the CG.

H6: After 4 weeks of guided visualization, there will be a statistically significant increase in positive emotionality and a decrease in negative emotionality in the EG compared to before the intervention started.

H7: After 4 weeks of guided visualization, there will be a statistically significant increase in positive mental health in the EG compared to before the intervention started.

H8: After 4 weeks of guided visualization, there will be a statistically significant reduction in depression, anxiety, and stress in the EG compared to before the intervention started.

H9: After 4 weeks of guided visualization, there will be a statistically significant increase in positive emotionality and a decrease in negative emotionality in the EG compared to the CG.

H10: After 4 weeks of guided visualization, there will be a statistically significant increase in positive mental health in the EG compared to the CG.

H11: After 4 weeks of guided visualization, there will be a statistically significant reduction in depression, anxiety, and stress in the EG compared to the CG.

H12: After 4 weeks of guided visualization, there will be a statistically significant increase in HF (parasympathetic activity) in the EG at the final measurement compared to before the intervention started.

SUBJECTS AND METHODS

Ethical considerations and informed consent

Prior to the commencement of the study, we received an ethical approval from the Republic of Slovenia National Medical Ethics Committee (number 0120-403/2022/7). The committee confirmed that the study was ethically acceptable and gave consent for its execution. Participants received both oral and written explanations of the research process and signed informed consent to participate in the study.

The study was designed to compare measurements before and after a 4-week intervention. Participants were randomly assigned to either EG or CG by drawing lots. Participants randomly drew a slip of paper numbered either 1 (EG) or 2 (CG) from an envelope. Each group consisted of 10 participants.

Participants

Participants were invited to take part both orally and in writing, during a psychophysiological examination at the Internal Clinic of the UMCL. The study included 20 male participants aged between 35 and 68 years (M = 55.85; SD = 7.68).

Inclusion Criteria

Male gender, participation in a rehabilitation program after a heart attack at the Clinical Department for Vascular Diseases at UMCL, same initial diagnosis (MI – STEMI, NSTEMI), and possession of an Android operating system phone.

Exclusion Criteria

Risk of complications during rehabilitation (e.g., individuals with diabetes), patients with 20 or more breaths per minute of average spontaneous breathing while seated, individuals with uncontrolled heart rhythm disorders, uncontrolled heart failure, age over 70 years, and individuals with severe psychiatric psychopathology.

Methods

Each participant who met the inclusion criteria was invited to the clinic for an initial meeting where they completed psychological questionnaires and provided two saliva samples for measuring the amount of oxytocin secreted. After the first saliva sample, participants in the EG downloaded the mobile application ecg4everybody on their smartphones and were taught how to use it. We then conducted the guided visualization technique titled Visualization of Positive Emotions (Enova in Jakša 2006), which lasts 18 minutes. After completing the visualization, we collected another saliva sample 10–15 minutes later. Research (Weisman et al. 2012) has shown that the peak level of oxytocin secretion occurs 10–15 minutes after intranasal administration of oxytocin. After the second saliva collection, we provided the participants with instructions for practicing the technique at home, along with written instructions and a link to the audio recording. During the first and second saliva collection, participants in the CG spent 10–15 minutes reading emotionally neutral text. We informed participants in the CG that their activities over the next four weeks would proceed as usual.

Participants in the EG practiced the guided visualization technique daily for 18 minutes over four

weeks, listening to it as an audio recording. While listening, they used the ecg4everybody app, which continuously measured their heart rate and HRV parameters. The measurement results were automatically stored in a cloud accessible only to the researchers.

After four weeks, each participant attended the final measurements where they completed psychological questionnaires, and another saliva sample was collected. We repeated the guided visualization technique with participants from the EG, followed by the last collection of a saliva sample 10–15 minutes after performing the visualization. CG read emotionally neutral text between the first and second saliva collections.

Instruments

We measured positive and negative emotionality with the Positive and Negative Affect Scale (PANAS) (Watson et al. 1988). It consists of 2 scales, each containing 10 items. An individual rates how often each emotional state is expressed in them on a Likert scale ranging from 1 (very rarely) to 5 (very often). The authors report high internal reliability coefficients for positive emotionality scale (α = .90–.96), and for the negative emotionality scale (α = .84–.87).

To assess the emotional and social aspects of well-being, we used the 9-item Positive Mental Health Scale (PMH) (Lukat et al. 2016). Participants rate how much they agree with each statement on a 4-point Likert scale ranging from 0 (disagree) to 3 (agree). The authors report high internal reliability (α = .93).

The Depression Anxiety Stress Scales (DASS-21) (Lovibond & Lovibond 1995) measure negative emotional states with 21 items. Individuals rate how much each statement applies to them on a 4-point Likert scale ranging from 0 (Does not apply to me at all/never) to 3 (Applies to me very much or most of the time). Authors report high internal consistency for depression dimension (α = .91) anxiety dimension (α = .84) and for stress dimension α = .90).

Anxiety as a state was measured using the 20-item State Trait Anxiety Inventory (STAI X-1) (Spielberger et al. 1983), which assesses the presence and intensity of current anxiety symptoms. Individuals rate how they feel at the moment on a 4-point Likert scale from 1 (not at all) to 4 (very much). The authors report high internal consistency (α = .86–.95).

Trait anxiety was measured using the Trait Anxiety Inventory (STAI X-2) (Spielberger et al. 1983). This 20-item scale assesses an individual's tendency to perceive situations as threatening and respond accordingly. Individuals rate how they generally feel on a 4-point Likert scale from 1 (almost never) to 4 (almost always). High reliability is reported by the authors (α = .90).

We measured positive and negative emotionality using the Scale of Positive and Negative Experience (SPANE) (Diener et al. 2009), which consists of 12 items. Six items assess positive emotionality, while six items assess negative emotionality. Individuals rate how often they experience certain moods on a 5-point Likert scale, ranging from 1 (never or very rarely) to 5 (very often or always). The authors report high internal reliability for the positive experience (α = .87) and for the negative experience subscale (α = .81).

In the study, participants used the mobile application ecg4everybody, which they installed on their Android smartphones. It was created by Dr. Stevan Jokić from the University of Novi Sad, Serbia, who provided us with free access to the collected data. The application enables the measurement of HRV parameters and heart rate using photoplethysmography through the smartphone camera, where participants placed their finger.

The enzyme immunoassay Elabscience Oxytocin ELISA Kit (Oxytocin ELISA Kit Catalog No. E-EL-0029, Elabscience) was used to determine the amount of oxytocin in saliva. The study used a competitive ELISA analysis. The measurement range of the analysis is from 15.63 to 1000 pg/mL. To perform the analysis, 50 μL of the saliva sample was added to the reagent. The analysis of the saliva samples takes 120 minutes and was performed according to the reagent manufacturer's instructions.

Statistical Analyses

The data was processed using statistical software RStudio and IBM SPSS Statistics 29. To analyze significant effects between the EG and CG, we calculated the differences between the first and last measurements, as well as the average differences, and used tests for equality of means to compare the obtained averages. We used the paired t-test, Wilcoxon test, independent t-test, and Mann-Whitney U test. The normality of the distribution of individual variables was checked with the Shapiro-Wilk test.

RESULTS

Oxytocin

Table 1 shows that the measured amount of oxytocin in the saliva of participants in CG is not normally distributed in any of the time conditions. The measured amount of oxytocin in the EG participants is normally distributed in all time conditions. The average amount of oxytocin in saliva increased in all time conditions and for both groups, except before and after the first visualization in the EG, where the average amount of oxytocin decreased. The large standard deviations indicate substantial variation in the measured amount of oxytocin in the saliva of both groups.

The results of the tests for equality of means of oxytocin levels, indicate that there was no significant increase in secreted oxytocin among participants in EG before and after the first visualization ($t(9) = 0.78$, $p = .46$), before and after the last visualization ($t(9) = 1.42$, $p = .19$), and there was also no significant increase in oxytocin secretion before the first

visualization and after the last visualization ($t(9) = 1.46$, $p = .18$).

Table 1. Descriptive Statistics and Normality Tests for Oxytocin Before the Start of the Intervention, After the First Visualization, and After the 4-week Intervention Before the Visualization for EG and CG, and After it

		N	*M (ng/L)*	*SD*	*Min*	*Max*	*Sk*	*Ku*	*S-W*
1. measurement									
EG	before	10	599.73	599.22	40.20	1790.50	0.79	-0.98	0.85
	after	10	477.90	396.67	85.90	1228.80	0.58	-1.24	0.89
CG	before	10	524.61	566.05	18.80	1843.20	1.13	0.17	0.84*
	after	10	546.80	525.26	40.90	1649.10	0.88	-0.74	0.83*
2. measurement									
EG	before	10	750.93	523.24	22.60	1403.00	-0.06	-1.70	0.92
	after	10	876.97	663.46	68.10	1724.80	0.02	-1.84	0.89
CG	before	10	435.71	456.16	16.40	1167.70	0.64	-1.53	0.80*
	after	10	509.08	542.08	50.30	1541.00	0.90	-0.92	0.80*

Note. *Sk* = skewness coefficient; *Ku* = kurtosis coefficient; *S-W* = Shapiro-Wilk normality test.
* $p < .05$.

Table 2. Descriptive Statistics and Normality Test for Average Differences in Oxytocin levels Before and After the First Visualization, Before and After the Last Visualization, and Before the First and After the Last Visualization for EG and CG

	N	*M (ng/L)*	*SD*	*Min*	*Max*	*Sk*	*Ku*	*S-W*
EG								
Before and after the first visualization	10	-121.83	497.11	-1023.50	637.00	-0.55	-0.78	0.90
Before and after the last visualization	10	126.04	279.99	-204.00	701.80	0.72	-0.78	0.91
Before the first visualization and after the last visualization	10	277.24	600.09	-400.70	1404.40	0.77	-1.05	0.84*
CG								
Before and after the visualization	10	22.19	207.46	-225.50	464.10	0.71	-0.49	0.93
Before and after the last visualization	10	73.37	172.24	-156.40	373.30	0.48	-1.32	0.91

Note. *Sk* = skewness coefficient; *Ku* = kurtosis coefficient; *S-W* = Shapiro-Wilk normality test.
* $p < .05$.

The results from Table 2 indicate that the average difference in the amount of oxytocin in the saliva of participants in the EG before the start of the first visualization and after the end of the last visualization is not normally distributed. The average difference in the amount of oxytocin in participants in the EG decreased by M = -121.83 ng/L after the first visualization compared to the state before the first visualization. After the last visualization, it increased by M = 126.04 ng/L compared to the state before the last visualization, and it increased by M = 277.24 ng/L compared to the state before the first visualization. The standard deviations of the average amount of secreted oxytocin indicate data dispersion and variation in oxytocin levels in the saliva of participants within each group.

Comparison of oxytocin levels between the EG and CG shows that there were no significant differences in the amount of oxytocin secretion between the groups after the first ($t(12.04) = -0.85$, $p = .41$), and after the last performance of the visualization exercise ($t(14.96) = 0.51$, $p = .62$),.

Mood Affective States

Table 3. Descriptive Statistics and Tests of Normality for Psychological Questionnaires Before and After the Intervention for the EG

		N	*M*	*SD*	*Min*	*Max*	*Sk*	*Ku*	*S-W*
PANAS									
Positive emotionality	before	10	35.70	3.65	30	43	0.52	-0.58	0.94
	after	10	35.20	3.62	31	42	0.67	-1.13	0.89
Negative emotionality	before	10	21.10	5.34	14	30	0.10	-1.40	0.94
	after	10	17.70	5.91	10	29	0.25	-0.93	0.92
SPANE									
Positive emotionality	before	10	25.20	2.10	22	28	-0.17	-1.72	0.92
	after	10	25.70	2.50	22	30	0.23	-1.40	0.93
Negative emotionality	before	10	10.10	3.03	7	17	0.99	-0.10	0.84*
	after	10	9.10	2.73	7	15	0.97	-0.51	0.81*
Emotional balance	before	10	15.10	3.73	10	20	-0.02	-1.85	0.90
	after	10	16.60	4.93	7	23	-0.50	-1.05	0.95
PMH	before	10	30.00	4.52	20	36	-0.69	-0.12	0.91
	after	10	31.30	3.50	25	36	-0.34	-1.29	0.96
DASS-21									
Depression	before	10	9.00	1.56	7	12	0.63	-1.03	0.90
	after	10	8.30	1.83	7	13	1.56	1.47	0.72*
Anxiety	before	10	8.90	1.79	7	13	0.97	0.04	0.87
	after	10	8.10	1.29	7	11	0.96	-0.16	0.82*
Stress	before	10	11.00	3.33	7	17	0.45	-1.25	0.92
	after	10	9.70	3.09	7	17	1.15	0.32	0.84*
STAI X-1	before	10	27.60	5.68	21	36	0.21	-1.86	0.88
	after	10	25.30	4.30	20	32	0.39	-1.58	0.90
STAI X-2	before	10	30.90	6.92	21	46	0.77	-0.14	0.91
	after	10	29.30	6.06	20	36	-0.24	-1.61	0.90

Note. Sk = skewness coefficient; *Ku* = kurtosis coefficient; *S-W* = Shapiro-Wilk normality test.
* $p < .05$.

From Table 3, it is evident that the average score of Positive Affect and Emotional Balance on the SPANE questionnaire, as well as the total score on the PMH questionnaire, after a 4-week intervention, is higher compared to the average score before the intervention. It is also evident that after the intervention, the average score of Negative Affect on the PANAS and SPANE questionnaires is lower compared to the average score before the intervention. Furthermore, it is evident that there is a decrease in average scores on all depression, anxiety, and stress questionnaires after the intervention, indicating an improvement in scores. The distribution of scores is normal on all questionnaires, except for the dimension of Negative Affect (SPANE), both before and after the intervention, and dimensions of depression, anxiety, and stress after the intervention.

The positive average differences in scores on the dimensions of Positive Affect, Emotional Balance (SPANE), and the PMH questionnaire in Table 5 suggest an improvement in positive affectivity and positive mental health after the intervention. The negative average differences in scores on the dimensions of Negative Affect (PANAS) and Negative Affect (SPANE) indicate a decrease in negative affectivity after the intervention. Furthermore, it is evident that participants in the EG achieved lower average scores on all dimensions and questionnaires after the intervention compared to before the intervention, indicating a reduction in symptoms of depression, anxiety, and stress.

Table 4. Tests of Equality of Means for Paired Samples for Psychological Questionnaires for the EG

	N	*t*	*df*	*p*	*d*
PANAS					
Positive emotionality	10	0.43	9	.68	0.14
Negative emotionality	10	2.80	9	.02*	0.89
SPANE					
Positive emotionality	10	-0.54	9	.60	0.17
Emotional balance	10	-0.82	9	.44	0.26
PMH	10	-1.54	9	.16	0.49
STAI X-1	10	1.51	9	.17	0.48
STAI X-2	10	0.91	9	.38	0.29
	N	*T*	*z*	*p*	*r*
SPANE					
Negative emotionality	10	17.50	-0.60	.55	.17
DASS-21					
Depression	10	10.50	-1.07	.29	.23
Anxiety	10	13.50	-1.08	.28	.23
Stress	10	5.50	-1.77	.08	.30

* $p < .05$.

From Table 4, it is evident that significant differences in average scores before and after the intervention only occur in the dimension of Negative Affect (PANAS).

Table 5. Descriptive Statistics and Tests of Normality for the Average Differences in Scores on Psychological Questionnaires Before and After the 4-week Intervention for the EG

	N	*M*	*SD*	*Min*	*Max*	*Sk*	*Ku*	*S-W*
PANAS								
Positive emotionality	10	-0.50	3.66	-5	5	0.34	-1.63	0.89
Negative emotionality	10	-3.40	3.84	-12	3	-0.66	0.34	0.90
SPANE								
Positive emotionality	10	0.50	2.92	-4	6	0.33	-0.98	0.96
Negative emotionality	10	-1.00	3.86	-9	4	-0.66	-0.62	0.94
Emotional balance	10	1.50	5.82	-6	10	0.13	-1.76	0.91
PMH	10	1.30	2.67	-4	5	-0.45	-0.87	0.96
DASS-21								
Depression	10	-0.70	1.89	-4	2	-0.30	-1.27	0.97
Anxiety	10	-0.80	2.04	-3	4	-0.46	-0.81	0.92
Stress	10	-1.30	2.11	-6	2	-0.73	0.13	0.90
STAI X-1	10	-2.30	4.81	-10	6	-0.28	-0.78	0.89
STAI X-2	10	-1.60	5.52	-10	7	0.10	-1.51	0.95

Note. *Sk* = skewness coefficient; *Ku* = kurtosis coefficient; *S-W* = Shapiro-Wilk normality test.
* $p < .05$.

Table 6. Tests of Equality of Means of Average Differences Before and After the 4-Week Intervention for Psychological Questionnaires Considering the EG and CG

	N	*U*	*z*	*p*	*r*
PANAS					
Positive emotionality	20	41	-0.68	.53	.18
Negative emotionality	20	44.5	-0.42	.68	.15
SPANE					
Emotional balance	20	36	-1.07	.29	.23
PMH	20	30	-1.51	.13	.28
STAI X-1	20	50	0.00	1.00	.00
	N	*t*	*df*	*p*	*d*
SPANE					
Positive emotionality	20	1.34	17.94	.20	0.60
Negative emotionality	20	-0.90	15.25	.38	0.40
DASS-21					
Depression	20	1.23	17.81	.23	0.55
Anxiety	20	0.88	14.80	.39	0.39
Stress	20	0.23	14.54	.82	0.10
STAI X-2	20	-0.47	12.65	.65	0.21

The results presented in Table 6 indicate that there were no significant differences in scores on the psychological questionnaires PANAS, SPANE, PMH, DASS-21, STAI X-1, and STAI X-2 between the EG and CG before and after the intervention. This means that participants in the EG did not achieve significantly better results compared to the CG on the questionnaires.

Heart Rate Variability

To assess the average change in HF before and after 4 weeks of guided visualization practice, we used the Wilcoxon signed-rank test. The change in HF before starting the intervention (M_{before} = 221.20, *SD* = 117.25) is not significantly higher than the change in HF after completing the intervention (M_{after} = 413.80, *SD* = 492.17), *T* = 36, *p* = .39, *r* = .29.

Results for the normality test of the average differences in HF change show that, on average, we measured higher values of HF in participants after the 4-week intervention compared to before the intervention (*M* = 192.60, *SD* = 529.01), indicating that the visualization intervention has influenced an increase in HF values.

DISCUSSION

The study investigated the physiological and psychological effects of guided visualization on post-MI patients, focusing on examining oxytocin hormone secretion, HRV parameters, and mood affective states (anxiety, depression, stress, psychological well-being). The EG practiced guided visualization technique daily for 4 weeks while monitoring HRV parameters through the mobile application ecg4everybody. The CG did not engage in any activities. We hypothesized that guided visualization would lead to a significant increase in oxytocin levels in saliva already after the first visualization session, and that the changes in oxytocin levels would be significantly higher compared to the CG. However, our findings did not align with the hypotheses we set.

Previous studies (Klaus et al. 2000, Machida et al. 2018, Vižintin 2021) have indeed demonstrated the influence of relaxation techniques on oxytocin secretion. The discrepancy with past findings could be attributed to the participants' inability to relax during the initial session in the EG, as they received a lot of new information and were still learning how to perform the technique and use the mobile application. There was no significant increase in oxytocin levels even at the final session, and the oxytocin levels in the saliva of participants in the EG were not significantly higher compared to the CG. The reasons for the discrepancy with the hypotheses can again be attributed to the conditions under which the participants performed the visualization. They had to be mindful of keeping their hand still to avoid tremors and inaccurate measurements in the mobile application, while there was also a lot of noise in the area around the clinic where the measurements were taken, which may have hindered participants' relaxation and focus on performing the visualization. At the final measurements, the results of the study showed that after the 4-week visualization intervention, the oxytocin levels in patients did not significantly increase compared to the pre-intervention state, although the results indicate an increase in oxytocin in the expected direction. One reason for rejecting the hypothesis could have been the choice of visualization technique, which in our case focused on promoting positive emotions. Machida et al. (2018) study found that visualization focused on gratitude stimulates oxytocin secretion in participants. It would be advisable to verify the influence of visualization on a larger, more representative sample.

With the exception of the subscale of negative affectivity on the PANAS questionnaire, where there was a significant decrease in negative affectivity in the EG after the 4-week intervention, there was no statistically significant increase or decrease in any of the other mood affective states. The study by Kaplan et al. (2014) has shown a significant influence of

guided visualization on increasing positive affectivity and decreasing negative affectivity. Therefore, we can partially confirm the hypothesis that after the 4-week intervention, positive affectivity will increase and negative affectivity will decrease, as there were statistically significant differences in the latter at the final measurement compared to the pre-intervention state.

We also rejected the hypothesis that guided visualization would significantly impact reducing depression, anxiety, and stress, as some previous studies have shown (Broadbent et.al. 2012, Lang et.al. 2012, Zhang et.al. 2021).

Additionally, we assumed that the results would significantly differ from the CG, which did not undergo the 4-week intervention. There could be several reasons for the discrepancy with previous research. Our participants did not have diagnosed depression, unlike some other studies (Lang et al. 2012). Furthermore, the choice of guided visualization technique may have influenced the results, as it did not focus on visualizing a safe place compared to previous research (Serra et al. 2012). Moreover, participants in the visualization did not perform it immediately after the occurrence of MI but rather as part of rehabilitation, so their perceived stress might have been lower than in the period immediately after MI.

Based on past research (Limmer et al. 2022) we assumed there would be a statistically significant increase in HF values reflecting parasympathetic activity in the EG after the 4-week intervention compared to before the intervention. Although the results suggest changes in the expected direction, these differences are not significantly large, so we can reject our hypothesis. Therefore, the results do not align with the findings of previous research, which could be attributed to different methods used in the studies. Limmer et al. (2022) used a breathing exercise technique in their study, and the intervention lasted for 12 weeks. In contrast, our intervention only lasted for four weeks, thus we suggest future research to explore the timeframe in which significant differences in HF value increases may appear.

The study suggests a complex interplay of psychophysiological variables, which would be worthwhile to expand in future research. The results of the study indicate changes in all average values in the expected direction. It would be essential to increase the sample size, and potentially, participants in future studies could listen to a variety of guided visualization recordings. It would also be necessary to provide more suitable conditions for conducting the first and last sessions in calm environments to give participants the opportunity for relaxation and focus on listening to the guided visualization.

CONCLUSIONS

The study did not show significant effects of guided visualization technique on increasing oxytocin or parasympathetic nervous system activity, nor did it significantly affect the majority of affective mood states. However, the results demonstrated a significant decrease in negative affectivity on the PANAS questionnaire, indicating the method's effectiveness in reducing negative emotional states. Despite the average values on all observed variables suggesting expected effects, it would be necessary to verify the effects on a larger sample of patients. The method is simple, cost-effective, and time-efficient, making it a potential for the development of non-invasive oxytocin therapy post-MI. It also allows for a comprehensive assessment of effectiveness both at the psychological and physiological levels and transfer of findings to other clinical areas. The use of an application for measuring HRV parameters enables safe and accessible monitoring of individuals' psychophysiological state post-MI and has no adverse side effects.

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REFERENCES

1. *Álvarez-García C & Yaban ZŞ: The effects of preoperative guided imagery interventions on preoperative anxiety and postoperative pain: A meta-analysis. Complement Ther Clin Pract 2020; 38:101077. https://doi.org/10.1016/j.ctcp.2019.101077*
2. *Broadbent E, Kahokehr A, Booth RJ, Thomas J, Windsor JA, Buchanan CM et al.: A brief relaxation intervention reduces stress and improves surgical wound healing response: A randomised trial. Brain Behav Immun 2020; 26(2):212–217. https://doi.org/10.1016/j.bbi.2011.06.014*
3. *Carter CS: Oxytocin pathways and the evolution of human behavior. Annu Rev Psychol 2014; 65(1):17–39. https://doi.org/10.1146/annurev-psych-010213-115110*
4. *Diener E, Wirtz D, Tov W, Kim-Prieto C, Choi DW, Oishi S et al.: Scale of positive and negative experience. Soc Indic Res 2009; 247–266. https://doi.org/10.1007/BF01207052*
5. *Eriksson M, Asplund K, Hochwälder J, Svedlund M: Changes in hope and health-related quality of life in couples following acute myocardial infarction: A quantitative longitudinal study. Scand J Caring Sci 2013;27(2):295–302. https://doi.org/10.1111/j.1471-6712.2012.01032.x*
6. *Giltay EJ, Kamphuis MH, Kalmijn S, Zitman FG, Kromhout D: Dispositional optimism and the risk of cardiovascular death: The Zutphen Elderly Study. Arch Intern Med 2006; 166(4):431. https://doi.org/10.1001/archinte.166.4.431*

7. *Gimpl G & Fahrenholz F: The oxytocin receptor system: Structure, function, and regulation. Physiol Rev 2001; 81(2):629–683. https://doi.org/10.1152/physrev.2001.81.2.629*
8. *Grewal K, Gravely-Witte S, Stewart DE, Grace SL: A simultaneous test of the relationship between identified psychosocial risk factors and recurrent events in coronary artery disease patients. Anxiety Stress Coping 2011; 24(4):463–475. https://doi.org/10.1080/10615806.2010.546838*
9. *Iglesias SL, Azzara S, Argibay JC, Arnaiz ML, De Valle Carpineta M, Granchetti H et al.: Psychological and physiological response of students to different types of stress management programs. Am J Health Promot 2012; 26(6):e149–e158. https://doi.org/10.4278/ajhp.110516-QUAL-199*
10. *Kaplan U, Epstein GN, Smith AS: Microdevelopment of daily well-being through mental imagery practice. Imagin Cogn Pers 2014; 34(1):73–96. https://doi.org/10.2190/IC.34.1.f*
11. *Keyes CLM: Promoting and protecting mental health as flourishing: A complementary strategy for improving national mental health. Am Psychol 2007; 62(2):95–108. https://doi.org/10.1037/0003-066X.62.2.95*
12. *Klaus L, Beniaminovitz A, Choi L, Greenfield F, Whitworth GC, Oz MC et al.: Pilot study of guided imagery use in patients with severe heart failure. Am J Cardiol 2000; 86(1):101–104. https://doi.org/10.1016/S0002-9149(00)00838-9*
13. *Kobayashi H, Yasuda S, Bao N et al.: Postinfarct treatment with oxytocin improves cardiac function and remodeling via activating cell-survival signals and angiogenesis. J Cardiovasc Pharmacol 2009; 54(6):510–519. https://doi.org/10.1097/FJC.0b013e3181bfac02*
14. *Kšela J: Variabilnost srčne frekvence – iz kardioloških laboratorijev v svet rekreativnega in profesionalnega športa. Slov Med J 2020; 89(5–6):287–300. https://doi.org/10.6016/ZdravVestn.2957*
15. *Kwekkeboom K, Huseby-Moore K, Ward S: Imaging ability and effective use of guided imagery. Res Nurs Health 1998; 21(3):189–198. https://doi.org/10.1002/(SICI)1098-240X(199806)21:3<189::AID-NUR2>3.0.CO;2-D*
16. *Kwekkeboom KL, Bratzke LC: A systematic review of relaxation, meditation, and guided imagery strategies for symptom management in heart failure. J Cardiovasc Nurs 2016; 31(5):457–468. https://doi.org/10.1097/JCN.0000000000000274*
17. *Lang TJ, Blackwell SE, Harmer CJ, Davison P, Holmes EA: Cognitive bias modification using mental imagery for depression: Developing a novel computerized intervention to change negative thinking styles. Eur J Pers 2012; 26(2):145–157. https://doi.org/10.1002/per.855*
18. *Limmer A, Laser M, Schütz A: Mobile heart rate variability biofeedback as a complementary intervention after myocardial infarction: A randomized controlled study. Int J Behav Med 2022; 29(2):230–239. https://doi.org/10.1007/s12529-021-10000-6*
19. *Lovibond SH, Lovibond PF: Manual for the depression anxiety stress scales. Psychology Foundation of Australia 1995.*
20. *Lukat J, Margraf J, Lutz R, Van Der Veld WM, Becker ES: Psychometric properties of the Positive Mental Health Scale (PMH-scale). BMC Psychol 2016; 4(1):8. https://doi.org/10.1186/s40359-016-0111-x*
21. *Machida S, Sunagawa M, Takahashi T: Oxytocin release during the meditation of altruism and appreciation (Arigato-Zen): Machida S et al. Oxytocin release stimulated by meditation. Int J Neurol Res 2018; 4(1):364–370. https://doi.org/10.17554/j.issn.2313-5611.2018.04.75*
22. *Malik M, Bigger JT, Camm AJ et al.: Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. Eur Heart J 1996; 17(3):354–381. https://doi.org/10.1093/oxfordjournals.eurheartj.a014868*
23. *McDonald DD, Soutar C, Chan MA, Afriyie A: A closer look: Alternative pain management practices by heart failure patients with chronic pain. Heart Lung 2015; 44(5):395–399. https://doi.org/10.1016/j.hrtlng.2015.06.001*
24. *McKinney CH, Antoni MH, Kumar M et al.: Effects of guided imagery and music therapy on mood and cortisol in healthy adults. Health Psychol 1997; 16(4):390–400. https://doi.org/10.1037/0278-6133.16.4.390*
25. *Noč M, Radšel P: Bolnik po srčnem infarktu. Krka 2008.*
26. *Ofentavšek P: Vpliv vizualizacije na izločanje oksitocina pri pacientih po miokardnem infarktu (master's dissertation). Univerza v Ljubljani 2023. https://repozitorij.uni-lj.si/IzpisGradiva.php?lang=slv&id=152062*
27. *Petersson M, Uvnäs-Moberg K: Effects of an acute stressor on blood pressure and heart rate in rats pretreated with intracerebroventricular oxytocin injections. Psychoneuroendocrinology 2007; 32(8–10):959–965. https://doi.org/10.1016/j.psyneuen.2007.06.015*
28. *Richards SH, Anderson L, Jenkinson CE et al.: Psychological interventions for coronary heart disease. Cochrane Database Syst Rev 2017; 2021(2). https://doi.org/10.1002/14651858.CD002902.pub4*
29. *Serra D, Parris CR, Carper E et al.: Outcomes of guided imagery in patients receiving radiation therapy for breast cancer. Clin J Oncol Nurs 2012; 16(6):617–623. https://doi.org/10.1188/12.CJON.617-623*
30. *Spielberger CD, Gorsuch RL, Lushene R et al.: Manual for the State-Trait Anxiety Inventory. Consulting Psychologists Press 1983.*
31. *Steptoe A, Dockray S, Wardle J: Positive affect and psychobiological processes relevant to health. J Pers 2009; 77(6):1747–1776. https://doi.org/10.1111/j.1467-6494.2009.00599.x*
32. *Van Der Kooy K, Van Hout H, Marwijk H et al.: Depression and the risk for cardiovascular diseases: Systematic review and meta-analysis. Int J Geriatr Psychiatry 2007; 22(7):613–626. https://doi.org/10.1002/gps.1723*
33. *Vižintin A: Psihofiziološki odzivi na vizualizacijo z umirjeno glasbo (master's dissertation). Univerza v Ljubljani 2021. https://repozitorij.uni-lj.si/IzpisGradiva.php?id=127530&lang=slv*

34. *Watanabe E, Fukuda S, Shirakawa T: Effects among healthy subjects of the duration of regularly practicing a guided imagery program. BMC Complement Altern Med 2005; 5(1):21. https://doi.org/10.1186/1472-6882-5-21*
35. *Watson D, Clark LA, Tellegen A: Development and validation of brief measures of positive and negative affect: The PANAS scales. J Pers Soc Psychol 1988; 54(6):1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063*
36. *Weisman O, Zagoory-Sharon O, Feldman R: Intranasal oxytocin administration is reflected in human saliva. Psychoneuroendocrinology 2012; 37(9):1582–1586. https://doi.org/10.1016/j.psyneuen.2012.02.014*
37. *Whitehead DL, Strike P, Perkins-Porras L, Steptoe A: Frequency of distress and fear of dying during acute coronary syndromes and consequences for adaptation. Am J Cardiol 2005; 96(11):1512–1516. https://doi.org/10.1016/j.amjcard.2005.07.070*
38. *WHO: Cardiovascular diseases (CVDs). World Health Organization 2021. Available from: https://www.who.int/en/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)*
39. *Wsol A, Cudnoch-Jedrzejewska A, Szczepanska-Sadowska E et al.: Oxytocin in the cardiovascular responses to stress. J Physiol Pharmacol 2008; 59:123–127.*
40. *Zhang Y, Liang Y, Huang H, Xu Y: Systematic review and meta-analysis of psychological intervention on patients with coronary heart disease. Ann Palliat Med 2021; 10(8):8848–8857. https://doi.org/10.21037/apm-21-1623*

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