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The experience of pain among patients who suffer from chronic pain: The role of suppression and mindfulness in the pain sensitivity and the autonomic nervous system activity

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Abstract
The present study aimed to examine the effects of mindfulness and suppression in the psychological and physiological experience of pain. Fifty-seven chronic pain patients responded to the Weinberger Adjustment Inventory and Mindful Attention and Awareness Scale. Then they were assigned to two groups to suppress or be mindful during the experience of invoked actual pain and participants in each of the two groups were assessed after their respective group intervention. They have reported their pain and distress by Numerical rate scores, and the biofeedback system has assessed their heart rate and the respiratory response. Each group had exposure to a massage device, with results recorded of both exposures to the device and participant psychological recovery (i.e. reporting of pain and distress scores) in the 48-h follow-up. The results showed that there were no differences between groups regarding reporting pain and distress scores immediately and after the 48-h follow-up. However, the mindfulness induction was accompanied by increased activity in the parasympathetic nervous system, and the suppression induction was accompanied by increased activity in the sympathetic nervous system in the cardiovascular and respiratory responses. Also, the suppression induction led to pain sensitivity in the muscular massage experience more than mindfulness induction. The present study provides new evidence for the rebound effects of suppression in revealing pain sensitivity and activation of the sympathetic nervous system. The suppression of pain and feelings increases pain tolerance, while more activation of the sympathetic nervous system leaves patients prone to greater pain sensitivity. Therefore, the induction of mindful attention, may positively alter both the process of developing and reducing chronic pain in patients.

Keywords Chronic pain · Mindfulness · Suppression · Repressive coping style · Rebound effect

The International Association for the Study of Pain defines "pain" as an unpleasant sensory and emotional experience that is associated with potential or actual tissue damage (International Association for the Study of Pain, 2012). Unfortunately, medicine, drugs, and surgery fail to eliminate pain alone or significantly improve emotional and physical functioning (Turk et al., 2011). This is due to the role of psycho-social factors in the formation of chronic pain and its related disabilities (Ramezanzade Tabriz et al., 2019). Chronic pain must be considered in the context of the biopsychosocial model, which views symptoms as the result of a complex and dynamic interaction between biological, psychological, and social factors (Uceyler et al., 2017). Chronic pain (CP) ranks among the most prevalent medical conditions affecting humans, being among the 10 most prevalent diseases worldwide. Similarly, when examining the number of years lived with disability (YLD) due to every single disease, low back pain is responsible for the most common cause of age-adjusted YLD in both men and women in most countries. Low back pain and migraine ranked among the top 10 causes of YLD in 195 countries, and neck pain was among the top 5 causes of YLD in high-income and high-middle-income countries (Treede et al., 2019).

Studies have shown that patients with chronic pain avoid their emotions and thoughts, and such avoidance is usually associated with poorer adaptation (Rimes et al., 2016); for example, Burns (2000) showed that chronic pain patients who participated in a 4-week pain management program had

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little improvement in post-test pain severity, depression, and increased capacity compared to the pre-test. The findings have shown that repressor patients with chronic pain show poor long-term adaptation even if they receive multifaceted pain therapy. However, this weakness of adjustment in the areas of physical pain and disability is greater than their emotional distress (Burns 2000).

On the other hand, Weinberger et al. (1979) have shown that people who repress their thoughts and feelings (repressors) show a significant difference between self-reported anxiety and high levels of anxiety as measured by non-verbal means (behavior, physiological responses). This finding has been repeated many times (Myers et al., 2008). Repressor individuals separate their physical reactions from their perception of distress, and, in stressful situations, report low levels of distress and high levels of physiological activity (Lambie and baker, 2003 as cited in Myers, 2010). People who are told to repress their emotions in experimental studies showed the same features with repressors and differ from those who are allowed to express their feelings as they like (Nyklíˇcek et al., 2002).

Repressors try to avoid negative emotions and often use distraction strategies to avoid becoming aware of negative emotions (Myers et al., 1998). Therefore, it is expected that repressors will report less pain and distress in the face of painful stimuli. According to Newman et al. (1997) assume that one of the strategies used by repressors to avoid threatening information is thought suppression. Repressors are "chronic suppressors of thought" (Wegner & Zanakos, 1994). As much as pain is unpleasant and associated with negative effects, people with a repressive coping style habitually suppress awareness of these feelings, which can have long term effects. Studies have shown that a repressive coping style is associated with impaired pain perception (Jamner & Schwartz, 1986) and repressor chronic pain patients have an avoidant bias to threatening stimuli (Franklin et al., 2016).

In considering the role of individual differences in the repressive coping style and the rapid recovery and delayed (rebound) effects of pain-related thought suppression, Elfant et al. (2008) showed that individual differences in coping style moderated the effect of experimental interventions. In this study, those repressors who were asked to suppress their thoughts during a Cold-Presser task showed greater sensitivity to pain in the recovery time and a more unpleasant sensation during the massage experience. Thus, these studies show that repressors suffer from long-term sensitivity to pain due to the contamination and rebound effects of the suppression of thoughts related to pain, and their coping style moderates the effectiveness of experimental interventions on pain.

In contrast, mindfulness is another psychological strategy that has been introduced as an effective strategy that can reduce both clinical pain and laboratory-induced pain (Zeidan et al., 2011). In contrast to other treatments, whose primary purpose is controlling and reducing the severity of pain, "mindfulness" suggests an alternative approach in which self-awareness can have a therapeutic effect without altering the severity of pain. Mindfulness is the awareness that arises through intentionally attending in an open, kind, and discerning way (Shapiro & Carlson, 2009). According to this approach, mindfulness-based interventions focus on the psychological consequences of pain to enhance function and generally improving pain-related distress (Hayes et al., 2006). Studies have shown that mindfulness-based training can increase the levels of mindfulness associated with a decrease in psychological symptoms in patients (Dobkin & Zhao, 2011).

A series of studies have shown that meditation training reduces pain symptoms and enhances psychological well-being (McCracken et al., 2007). Numerous studies have also shown that in laboratory-induced pain, short-term meditation interventions lead to greater tolerance of, and lower levels of pain and distress compared to control groups (Zeidan et al., 2010), but these are not only psychological effects. Rather, meditation exercises can also modulate the neural mechanisms associated with pain (Zeidan et al., 2011).

Experimental studies have shown that mindfulness exercises can promote health by reducing stress responsiveness and activating the parasympathetic system (Greeson, 2008) and by helping pay attention to painful stimuli, especially to their objective/sensory dimensions, leading to less pain perception (Gard, Ho`lzel, Sack, Hampel, Lazar, Vait & Ott, 2013).

The effectiveness of suppression as a practical way to reduce pain in the short term can be accompanied by less attention to its probable long term effects like increasing the incidence of chronic pain. Therefore, the present study has investigated this apparent discrepancy by examining the delayed effect of induction of suppression in creating subsequent pain sensitivity in the muscle massage experience. Also, considering what has been said, it seems that few studies in the evaluation of the effectiveness of pain management laboratory interventions have focused on these characteristic individual differences in participants, like repressive coping style and the extent of patients' mindfulness. Studies have either specifically examined individual differences in coping styles in pain experience or compared the effectiveness of psychological interventions such as mindfulness-induction or suppression-induction in terms of the pain scores. So, this study aimed to investigate the intervention's effectiveness on the physical and psychological experience of clinical pain in the clinic and in the short-term follow-up by controlling the “repressive coping style” and “mindfulness” in chronic pain patients. And the study also examined the rebound effect

of suppression on pain sensitivity during the experience of muscle massage.

In summary, this study aims to analyze the hypothesis that there are some physiological indices with the beneficial psychological effects of suppression and mindfulness in the short term, and through what mechanism can suppression facilitate the onset of chronic pain?

Method

Participants

Convenience sampling was use to select participants for this study, who were patients with chronic musculoskeletal pain who had suffered from pain for 3 months until one year in a part of their body and had been referred to a pain specialist. The Pain Specialist introduced to 60 musculoskeletal pain patients the opportunity to participate in a six-month study based on the inclusion and exclusion criteria. Three persons chose not to participate. Fifty-seven of these patients included 48 females and nine males with a mean age of 41.9 ($SD = 10.8$) were selected through convenience sampling. Concomitant physical and psychological problems, drug use, and concurrent attendance at meditation or yoga sessions were the exclusion criteria. All participation was voluntary and in full conformity with institutional ethical guidelines for conducting research. Participants were informed that they were taking part in a study and made fully aware that they could withdraw from the study at any time, if they wished.

Measures

The demographic scale included several questions about age, gender, duration of pain, history of other treatments for current pain, and history of simultaneous engaging in yoga or meditation practice.

Weinberger's Adjustment Inventory-Short Form (WAI-SF; Weinberger & Schwartz, 1990) is designed to measure long-term performance rather than short-term symptoms. It includes 37 items that provide response options ranging from 1 (incorrect) to 5 (correct). This inventory includes 3 main scales: 1) “Distress” which provides a general measure of individuals’ tendencies to feel dissatisfied with themselves and their ability to achieve desired outcomes with proneness to anxiety, depression, low self-esteem and low well-being operationally defined as subtypes of distress (e.g. I worry too much about things that aren’t important); 2) "Restraint" which encompasses domains related to socialization and self-control and refers to suppression of egoistic desires in the interest of long-term goals and relations with others and includes suppression of aggression, impulse control, consideration of others and responsibility (e. g. Before I do something, I think about how it will affect the people around me); and 3) "Defensiveness" which includes repressive defensiveness and denial of distress (e.g. I am never unkind to people I don’t like). This inventory has been validated for use in clinical and non-clinical populations from age 10 to 70, and It has high internal consistency in various samples and high test–retest reliability. (Weinberger, 1997; Weinberger & Schwartz, 1990). The appropriate factor structure of WAI has previously been confirmed in an Iranian sample (Saeedi, Ghorbani, Sarafraz & Karami Shoar, 2018; Saeedi et al., 2016). This measure also had high-internal consistency in the current sample (Cronbach’s α for distress = 0.82, for restraint = 0.78, and for repressiveness = 0.71).

The Mindful Attention and Awareness Scale (MAAS; Brown & Ryan, 2003) measures mindfulness as a naturally occurring personality trait. This scale has 15 items *(e.g.* I find it difficult to stay focused on what’s happening in the present) with response options ranging from 1 (almost always) to 6 (almost never). This scale is valid for clinical and non-clinical populations (Carlson & Brown, 2005) and it has been reported to have test–retest reliability and appropriate internal consistency (Tamagawa et al., 2013). This measure had acceptable internal consistency in the current sample (Cronbach’s $\alpha = 0.75$).

The Biofeedback system with a biograph Infinity program was used to measure physiological parameters. The system includes Procomp2, TT-USB and the sensors. These instruments have been developed by Thought Technology Ltd. With the aid of this instrument, the human physiological unit can be measured consisting of Electromyography (EMG(, Galvanic skin **response** (GSR), Hear Rate Variability (HRV) and Respiration (Resp). The data obtained from this method will be recorded in the Multimedia Biofeedback Biograph Infiniti Software, and then will be analyzed. Heart rate and respiratory status are measured through HR/BVP (PN: SA9308M) and respiration (P/N: SA9311M) data recording sensors. The heart rate sensor is placed against the fleshy part of the first joint of any finger and held in position using the elastic strap. The respiration sensor is sensitive to stretch and is strapped around a client`s chest or abdomen.

Massage Device that used was “Relax & Tone” (Epulse Global Inc, Model Number: 000190), that is a body-shaking tool with a calibrated volume control button. It has four spans: smooth, microfiber, wave, and roller, and used for different areas of the body. In a preliminary pilot study of ten people, the "rolling" span and the "extreme" state of the device produced a wide range of physical sensations. Therefore, in this study, the vibration intensity was adjusted for all participants in the "severe" state to the "roll" span.

The Numerical Pain Rating Scale (NPRS) was used to assess the severity of pain, with the response options ranging on an 11-point spectrum (0 = very low pain, 10 = very high pain).

The Numerical Distress Rating Scale was used to assess the severity of distress, with the response options ranging on an 11-point spectrum (0 = very low distress, 10 = very high distress).

The Numerical Massage Rating Scale that contains 4 questions was used to evaluate 1) overall experience of the massage, 2) pain score, and 3) thoughts and 4) feelings during the massage experience, the material of which included scoring on an 11-point scale (0 = very pleasant, 10 = very unpleasant).

Induction of suppression based on the guidelines in the studies of Wenzlaff and Wegner (2000) and Elfant et al. (2008), asked participants to deliberately ignore their pain and emotions and stop thinking about the pain, feelings, and emotions through distraction or controlling the mind.

Induction of mindfulness based on the body scan exercise in the MBSR protocol from Kabat-Zinn (1990) work focused on the experience of pain. Participants were asked to pay attention to their physical senses and thoughts and try to experience their pain and emotions objectively without any judging or controlling.

Procedure

Prior to the experiment, participants randomly (based on the odd or even national code) have divided into two groups: mindfulness induction (N = 32) or suppression induction (N = 25). They completed a demographic questionnaire, The mindfulness scale, and The Weinberger adjustment inventory. In addition, participants completed the ethical consent form, and the physiological sensors were installed at their fingertips and abdomen to record their cardiac and respiratory status during the test. Before performing the audio file intervention, their pain and distress have measured. Audio file intervention of mindfulness induction and suppression reduction were introduced, and the subjects were instructed to follow the instructions that they were given in the moment of physical pain and sensation. Their scores were recorded for pain severity and distress rate after the intervention, five minutes after the intervention, and one hour after the intervention (as the time of recovery). Then, the muscles leading to the chronic pain area of the participants received muscle stimulation for 2 min to evaluate the possible effects of the intervention on pain sensitivity. Participants were then asked to listen to the intervention audio file they had been given, in the first time they experienced pain within 48 h of leaving the clinic. Then before the intervention, after the intervention, and five minutes after the intervention (as the time for recovery) they were asked to enter their pain and distress scores in the form given to them.

After finishing the data collection phase, all of the participants in two groups were advised about the importance of using mindfulness exercises to manage chronic pain in their daily routine, and a mindfulness induction audio file was sent to them. They were asked to listen to this audio file when they experience pain.

Data analysis

Multivariate analysis of covariance with repeated measures was used to evaluate the differences in pain, distress and physiological indices in two groups of intervention (mindfulness induction & suppression induction). Then, an analysis of covariance was used to measure pain sensitivity in the muscle massage experience in the two groups.

Results

Pain and Distress

There were seven stages of reporting for pain and distress. Participants have scored the severity of their pain and distress in forms given to them; (a) regarding the intervention 1) before 2) after 3) five minutes after 4) one hour after; (b) pain outside of the clinic 5) before the intervention 6) after the intervention 7) 5 min after the intervention.

Multivariate covariance analysis with repeated measures (7*2) was used to evaluate the differences between the groups in terms of pain and distress at different stages of the experiment. The seven stages of reporting pain and distress were considering as the within-subject factor and the grouping based on the 2-level intervention (suppression induction and mindfulness induction) was considered as the between-subject factor. Due to the possible role of individual differences on the reporting of pain and distress (Elfant et al., 2008; Saeedi et al., 2018), the WAI and mindfulness scores were controlled as covariate variables. Table 1 shows the mean and standard deviation of pain and distress in the seven stages for the two intervention groups.

The results showed that the pattern of changes in the variables of pain and distress did not differ between the two intervention groups (Pillai`s trace = 0.02, $F_{(2, 42)} = 037$, $\alpha = 0.69$, Partial $\eta^2 = 0.02$), the seven stages of the experiment (Pillai`s trace = 0.29, $F_{(12, 32)} = 1.08$, $\alpha = 0.41$, Partial $\eta^2 = 0.29$), and the interaction of the intervention with the seven stages of the experiment (Pillai`s trace = 0.34, $F_{(12, 32)} = 1.37$, $\alpha = 0.23$, Partial $\eta^2 = 0.34$).

Physiological indices

Multivariate covariance analysis with repeated measures (4*2) was used to evaluate the differences between the groups in terms of physiological parameters (heart rate, respiratory rate, and abdominal respiration amplitude) at different stages of the experiment in the clinic. Physiological

Table 1 Mean and standard deviation of pain and distress

	N		variable	1	2	3	4	5	6	7
Suppression Induction	25	Mean	pain	5.38	4.71	4.48	4.29	6.24	5.10	4.43
			distress	4.86	3.81	3.38	2.76	4.71	3.43	3.52
		SD	pain	2.09	2.33	2.64	2.87	2.19	2.77	2.86
			distress	2.57	2.46	2.18	2.30	2.70	1.80	2.58
Mindfulness Induction	32	Mean	pain	5.79	4.29	3.64	3.04	6.50	5.39	4.93
			distress	6.04	4.00	2.75	1.89	6.19	4.82	4.43
		SD	pain	1.85	2.19	1.95	2.10	2.30	2.29	2.14
			distress	2.67	2.85	1.96	1.91	6.18	2.39	2.56

Regarding the intervention 1) before 2) after 3) five minutes after 4) one hour after; regarding pain outside of the clinic 5) before the intervention 6) after the intervention 7) 5 min after the intervention

indices (baseline, during the intervention, 5 min after the end of the intervention, and during the muscle massage) were considered as the within-subject factor, and the grouping based on the 2-level intervention (suppression induction and mindfulness induction) was considered as the between-subject factor. The WAI score and mindfulness trait score were also controlled as covariate variables. Table 2 shows the mean and standard deviation of heart rate, respiration rate, and amplitude of abdominal respiration in the four stages for the two intervention groups.

The results showed that the variations pattern of heart rate, respiration rate, and abdominal respiration amplitude did not differ across the four stages of the experiment (Pillai`s trace = 0.13, $F_{(9, 42)} = 069$, $\alpha = 0.71$, Partial $\eta^2 = 0.13$), but they did differ in the intervention groups (Pillai`s trace = 0.33, $F_{(3, 48)} = 7.88$, $\alpha = 0.001$, Partial $\eta^2 = 0.33$) and the interaction of the intervention with the four stages of the experiment (Pillai`s trace = 0.44, $F_{(9, 42)} = 3.68$, $\alpha = 0.001$, Partial $\eta^2 = 0.44$). To examine how this difference is presented, Table 3 shows the within-subject and between-subject variance analysis by the dependent variables in the four stages of the experiment.

As can be seen from the results, the pattern of heart rate variation only in the two intervention groups was different (F for Intervention = 7.47, $\alpha = 0.01$, Partial $\eta^2 = 0.13$; F for Intervention*experiment = 1.65, $\alpha = 0.19$, Partial $\eta^2 = 0.03$). But the pattern of changes in respiratory rate and amplitude of abdominal respiration was different between the intervention groups and in the interaction of the intervention with the quadruple stages of the experiment. Figures 1, 2 and 3 visually illustrates these findings.

As Fig. 1 shows, overall the mean heart rate of the suppression-induction group was higher than that of the mindfulness induction group.

According to Figs. 2 and 3, in the suppression induction group during the intervention (2) participants showed an increase of respiration rate and a decrease of the amplitude of abdominal respiration, and after the intervention (3), showed a decrease of respiration rate and an increase of the amplitude of abdominal respiration (return to the baseline), also in the muscle massage stage (4) participants showed an increase of respiration rate and a decrease of the amplitude of abdominal respiration. But versus in the mindfulness induction group, during the intervention (2), participants showed a decrease of respiration rate and increase of the amplitude of abdominal respiration, and after the intervention (3), showed an increase of the respiration rate and a decrease of the amplitude of abdominal respiration (return to the baseline), also in the muscle massage stage (4) participants showed an increase of respiration rate and a decrease of the amplitude of abdominal respiration.

Table 2 Mean and standard deviation of physiological indices

Suppression Induction	Variable	N	Baseline		During the Intervention		After the Intervention		During the massage	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
	HR	25	1.93	0.08	1.91	0.06	1.95	0.07	1.92	0.08
	Resp. R		1.14	0.05	1.18	0.04	1.15	0.04	1.16	0.06
	Abd. Resp.		0.31	0.23	0.21	0.27	0.32	0.22	0.22	0.25
Mindfulness Induction	HR	32	1.90	0.08	1.87	0.07	1.89	0.06	1.87	0.08
	Resp. R		1.13	0.05	1.06	0.08	1.12	0.04	1.17	0.06
	Abd. Resp.		0.41	0.21	0.47	0.27	0.43	0.16	0.36	0.20

** HR: Hear Rate, Resp. R: Respiratory Response, Abd. Resp.: Abdominal Respiration

Table 3 Within-subject and between-subject variance analysis by the physiological indices

variable		SS	df	F	p	Partial η^2
HR	Intervention	0.001	2.37	0.44	0.68	0.01
	Intervention*experiment stages	0.01	2.37	1.65	0.19	0.03
	Error	0.28	0.28	118.57		
	Intervention	0.12	1	7.47	0.01	0.13
	Error	0.83	0.83	50		
Resp. R	Intervention	0.001	2.36	0.18	0.87	0.001
	Intervention*experiment stages	0.12	2.36	19.23	0.001	0.28
	Error	0.31	117.92			
	Intervention	0.08	1	13.24	0.001	0.21
	Error	0.30	50			
Abd. Resp.	Intervention	0.08	2.62	1.42	0.24	0.03
	Intervention*experiment stages	0.25	2.62	4.12	0.01	0.08
	Error	2.88	130.77			
	Intervention	1.38	1	8.98	0.001	0.15
	Error	7.67	50			

** HR: Hear Rate, Resp. R: Respiratory Response, Abd. Resp.: Abdominal Respiration; Intervention: Mindfulness or Suppression induction; Experiment stages: 4stages of physiological indices assessment in the clinic

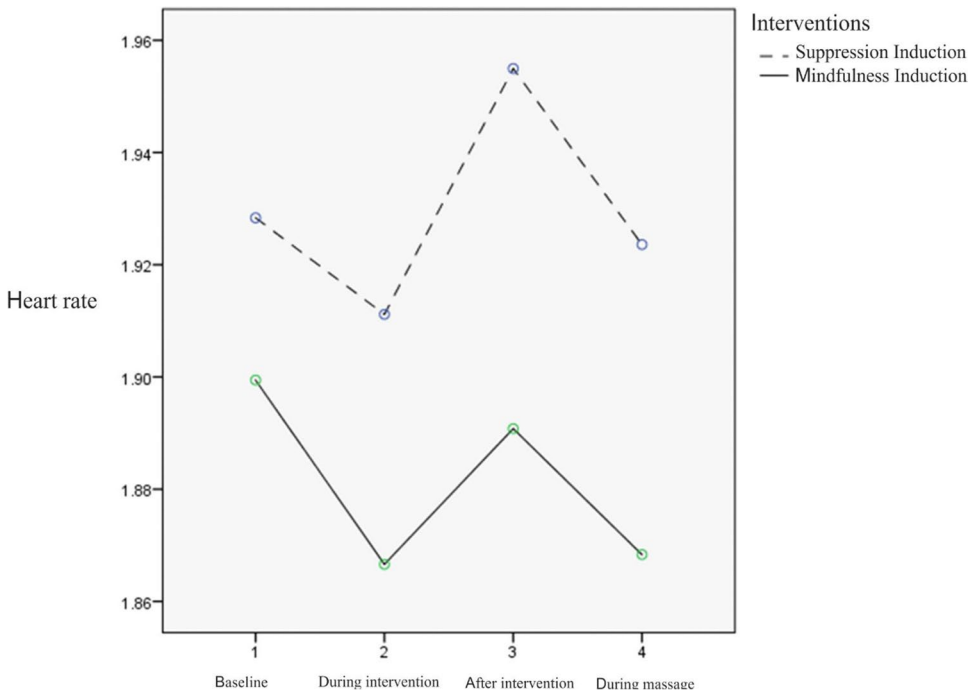

Fig. 1 Pattern of heart rate variations in the groups

Massage experience

Analysis of covariance was used to evaluate the psychological experiences of the muscle massage. The WAI score and mindfulness trait score were also controlled as covariate variables. Overall the mean massage score for the 25 participants in the suppression induction group was 1.42 (SD = 1.01) and for the 32 participants in the mindfulness induction group was 0.34 (SD = 0.42). ANCOVA`s results showed that the two groups differed from each other in their reported massage experience scores (SS = 13.48, $F_{(1, 49)} = 25.28$, $\alpha = 0.001$, Partial $\eta^2 = 0.34$). According to the massage scores, the suppression induction group appraised the massage experience as more painful and more unpleasant than the mindfulness induction group.

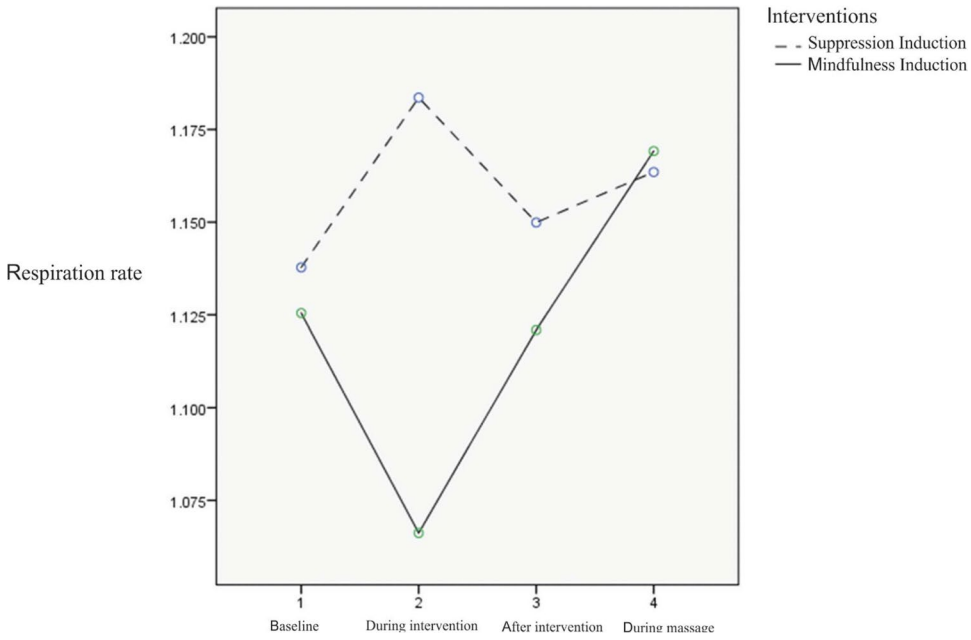

Fig. 2 Pattern of respiration rate variations in the groups

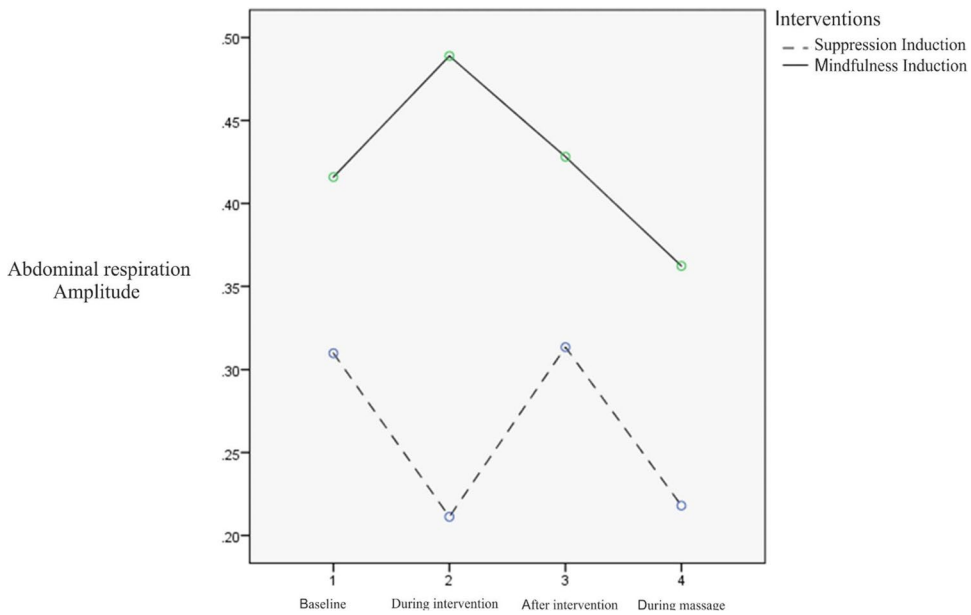

Fig. 3 Pattern of abdominal respiration amplitude variations in the groups

Declarations

Discussion The present study showed that there was no difference between the suppression induction and mindfulness induction groups in terms of reporting pain and distress in the seven stages of the experiment and follow-up. Even though there are differences in heart rate, respiration rate, and abdominal respiration amplitude between intervention groups in the clinic. Also, the suppression induction group appraised the massage experience as more painful and more unpleasant than the mindfulness induction group.

The same report of pain and distress between the two groups could be due to the short-term therapeutic effects of suppression (Cowan et al., 2017), which is as effective as mindfulness induction in reducing pain and distress in patients. Cioffi and Holloway (1993; Ryckeghem et al., 2018) revealed that suppressing pain-related thoughts is no different from other cognitive strategies that affect pain sensitivity in the short term but will lead to the formation of several long-term effects. The same result was found in the higher sensitivity suppression induction group during the experience of muscle massage in this study.

Considering the differences in physical indices despite no difference in reporting pain and distress in the chronic pain patients, it seems perhaps patients with chronic pain as a group usually avoiding or inhibiting conflicting emotions (Raphael et al., 2000) may have repressed or sup-

pressed their pain symptoms or feelings and did not report accurately their pain and distress in self-reports, while different scores on physical indices may have shown the actual difference in the experience of the two groups. In other words, although the differences in the self-report scales of the chronic pain patients were not significant, the physiological parameters measured differed between the two intervention groups. Thus, it seems that the interventions performed may have made a positive difference between the two groups, but patients with chronic pain did not report this difference in the self-report scales. This finding is consistent with the discrepancy that is often observed (Weinberger et al., 1979) between self-report anxiety and physiological and behavioral arousal in repressors (Myers et al., 2008). The simplest explanation of the discrepancies between the self-reports and the behavioral or physiological measures is that repressors experience high levels of anxiety but deny this in their self-reports. If this were the case, repressors' levels of experienced anxiety would be consistent with their levels of behavioral and physiological anxiety (Derakshan & Eysenck, 1999 as cited in Walsh et al., 2015).

From many evolutionary/functional perspectives, the mental experience of emotion is not the main characteristic of emotion, but the biosensor information that determines changes in temperature, pressure, body posture, muscle tension, and movement (Levenson,1999 as cited in Levenson, 2014) And the highest correlation between subjective experience and physiology is seen in subjects with a deep experience of Vipassana meditation (with a deep focus on inner states) (Sze, Gyurak, Yuan, & Levenson, 2010 as cited in Levenson, 2014). This consistency is very important in emotion theories and is associated with health and well-being (Levenson, 2014).

However, the respiratory status in this study showed that those who received the suppression induction intervention took more superficial breaths during the intervention and the patients who received the mindfulness induction intervention had deeper and slower breathing; both groups were close to the baseline respiratory status after the intervention. Both groups showed an increased respiratory rate and decreased amplitude at the time of the muscle massage. This pattern indicates that the suppression induction disrupted the autonomic system's balance (activation of the sympathetic system of patients) and the mindfulness induction led to a better balance of the autonomic system (activation of the patients' parasympathetic system) in the cardiac and respiratory states. Besides, a similar pattern of breathing during the muscle massage task indicated that this stimulus was somewhat anxious for both groups and activated the sympathetic system in both groups. These findings are consistent with studies showing that mindfulness training can inhibit the sympathetic nervous system response to acute stress (Nyklíˇcek et al., 2013) and lead to increased parasympathetic nervous system activity (Ditto et al., 2006).

Thayer and Lane (2000 as cited in Creswell & Lindsay, 2014) revealed that mindfulness can: 1) reduce sympathetic-nervous-system activation and its principle stress effectors (secretion of the catecholamines norepinephrine and epinephrine), or 2) lead to increased activity in the parasympathetic nervous system, which can slow-down the sympathetic-nervous-system fight-or-flight stress responses via the vagus nerve. The findings of this study also showed that the heart rate of the suppression induction group was higher than the heart rate of the mindfulness induction group. Indeed, suppression induction is one of the predictors of increased physiological response (Burns, 2006), and the suppression of emotion is associated with physiological indices such as increased heart rate and decreased skin conductance resistance (Myers et al., 2008) and increased risk of cardiovascular disease development through elevated cardiovascular reactions to both novel and recurrent stress (Howard et al. 2017).

It seems that a brief intervention through the suppression of emotion and thought can disrupt the autonomic nervous system balance and activate the sympathetic nervous system in patients. Perhaps repressors who are chronic thought suppressors (Wegner & Zanakos, 1994) and habitually suppress awareness of these feelings will be subject to many physical illnesses. Repressors may not be aware of their physical states and symptoms (Schwartz, 1990), But the long-term consequence of this increased autonomic nervous system activity may increase risk of many health problems (Myers et al., 2008). However, repressors, despite their lower reports of health problems, usually indicate more autonomic nervous system abnormalities (Giese-Davis et al., 2008).

Also, a brief intervention through mindful attention to emotion and thoughts can activate the parasympathetic nervous system of chronic pain patients, for whom avoidance and inhibition are characteristics (Raphael et al., 2000). Long term therapeutic mindfulness programs focusing on the characteristic of the repressive coping style (which can lead to more sympathetic nervous activity and more physical problems) can play an important role in improving the health of these individuals.

Also, in the experience of muscle massage, when the patients suppressed the experience of physical pain and attempted to deliberately suppress their internal stimuli, in the first step, apparently they calmed themselves down by ignoring their internal stimuli, but in the next step, without wanting to devote part of their mind to spamming unwanted content, the availability of unfavorable thoughts increased under the "ironic process model" (Wegner and Zanakos, 1994). And paradoxically, sensitivity to pain increases over time through the unconscious monitoring system. This study, consistent with the study by Elfant et al. (2008), has shown that participants in the suppression induction group were generally less responsive than the other group during the recovery and massage periods. Conversely, when a chronic pain patient tried to eagerly observe and accept their pain, emotions, feelings, and thoughts during the pain experience—without the tendency to change or control internal stimuli and allowing them to be processed—they could also try to experience this new physical stimulation and whatever was going on from moment to moment when they received the muscle massage, rather than relying on previous experiences of pain or fear of physical stimulation.

Studies have shown that meditation training, such as mindfulness-based stress reduction, can reduce pain symptoms and increase psychological well-being. (McCracken et al., 2007) and in the case of laboratory-induced pain, short-term meditation interventions lead to greater tolerance, less pain, and distress compared to control groups (Zeidan et al., 2010). Also, drawing attention to painful stimuli, in particular to their objective / sensory dimensions, can lead to less pain perception (Gard et al., 2013). Also, suppression and repression of experience are associated with activation of the sympathetic nervous system and increase the possibility of experiencing pain and physical sensitivity, while mindfulness is associated with the activation of the parasympathetic system and greater experience of pleasant emotions.

Studies have shown characteristic traits could moderate the effectiveness of experimental interventions on pain (Elfant et al., 2008). The importance of this study was showing the role of suppression and mindfulness induction on the experience of pain with controlling the trait of repressive coping style and mindfulness. In other words, this study has attended characteristic individual differences, while assessing the effectiveness of interventions on pain.

It seems overall relief from pain is an unrealistic goal. Therapists should focus on improving the pain-related distress and patients functioning. Pain-management protocols can avoid chronic pain through accepting and moment-to-moment attention to any pain. By activating the parasympathetic system in pain patients and breaking the vicious circle of pain suppression, they can take a fundamental step in reducing the distress and pain sensitivity caused by pain. Therefore, it can prevent and decrease the possible formation of chronic pain.

This study had some limitations; it was not possible to screen repressor patients from a large sample. Then to control the repressive coping style, we had to statistically control for this personality trait. And in the follow-up phase, it was not possible to measure physiological indices, and the follow-up data were limited to patients' self-reports. Similar further studies should be carried out with other samples to evaluate the effectiveness of mid-term and long-term mindfulness train-

ing, taking into account a repressive coping style, in the psychological and physical experience of pain. Also, a comparison of the efficacy of mindfulness-based interventions on repressor and non-repressor pain patients is another suggestion. Besides, it is suggested that to increase the generalizability of the results, similar studies should be conducted with other samples with different demographic characteristics.

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication. Approval was obtained from the University of Tehran ethics committee and the informed consent was written by participants. Also, datasets are available.

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