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The Effectiveness of Progressive Muscle Relaxation on Troponin Levels and Anxiety in Women with Chest Pain

Abstract

Background: Chest pain in women is a significant health concern often associated with elevated troponin levels and anxiety. Progressive Muscle Relaxation (PMR) has been proposed as a non-pharmacological intervention to address these issues.

Methods: This study was a pre-test-post-test semi-experiment with a control group, involving 40 women with chest pain from Karaj city. Participants were divided into a PMR treatment group and a control group. The PMR intervention comprised 8 sessions of 2 hours each. Anxiety was assessed using Beck's Anxiety Inventory, the Anxiety Sensitivity Index-Revised (ASI-R), and the Perception of Anxiety Control Questionnaire (ACQ). Troponin levels were measured using specific kits. Covariance analysis was employed for data analysis.

Results: PMR significantly reduced anxiety levels (p=0.007), with a notable decrease in anxiety sensitivity (p=0.024) and an increase in the perception of anxiety control (p=0.036). Furthermore, there was a significant improvement in troponin levels (p=0.033), indicating a positive impact on cardiac biomarkers.

Conclusion: PMR appears to be an effective intervention for reducing anxiety and improving troponin levels in women experiencing chest pain. This suggests a beneficial role for PMR in managing psychological and physiological aspects of chest pain.

Keywords

Chest Pain • Progressive Muscle Relaxation • Troponin • Anxiety • Women's Health • Perception • Health Interventions • Pain

Research Article

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Introduction

Chest pain is a leading reason for emergency department visits [1]. Approximately 0.6 to 0.7 of heart disease patients experience chest pain [2], with the highest emergency visitation rates among individuals aged 45-64 years [3]. Notably, there are significant gender-based differences in the perception and incidence of chest pain. Women, who constitute the majority of chest pain patients, display greater sensitivity to pain than men [4].

Research highlights the influence of psychological factors like anxiety, pain perception, and mood disorders on

chest pain [5]. Anxiety, in particular, is prevalent among chest pain patients [6]. Pardo et al. [7] identified anxiety as a causal factor for chest pain. Anxiety, characterized by negative emotions such as tension, restlessness, apprehension, and worry, is typically future-oriented and general [8]. It manifests both physically and psychologically in individuals experiencing anxiety [9] and often precedes new experiences, potentially impacting actions and self-confidence [10].

Anxiety comprises various components, including emotional, cognitive, physical, and motivational symptoms [9]. Anxiety sensitivity refers to the fear of anxiety symptoms due to perceived harmful social, cognitive, and physical consequences [11]. Individuals' perception of anxiety control varies, with anxiety classified into high and low spectrums [12]. Addressing psychological issues like anxiety and depression can effectively treat and resolve chest pain in heart patients [13]. Kheirandish et al. [14] also emphasized anxiety's significant role in chest pain.

Chest pain is a common symptom of heart diseases, ranging from stable heartache to unstable angina and myocardial infarction [15]. Diagnosis relies on clinical findings, electrocardiogram (ECG), and initial biomarker levels, particularly cardiac enzymes [16]. Troponin is a key biomarker for chest pain [17] and a predictive factor for acute coronary syndromes [18]. Studies, such as those by Aghayousefi et al. [19], have examined the impact of psychological factors on cardiac enzymes.

Health psychology acknowledges the role of psychological factors in disease exacerbation and treatment response, including chest pain [20]. Fakhrmoradi et al. [21] further supported the significant influence of psychological factors in cardiac chest pain. Various interventions, including psychological ones, can benefit patients with chest pain [22]. Progressive muscle relaxation (PMR), introduced by Edmond Jacobsen in 1938, is an effective treatment for chronic diseases like cardiac chest pain [23]. It induces mental relaxation by alleviating muscle tension, preventing negative thoughts and emotions such as anxiety [25]. Research by Kazak and Ozkarman [26] demonstrated PMR's effectiveness in reducing pain intensity.

Given the background, PMR has proven effective for various psychological issues [23, 26] and brings mental peace through complete body relaxation [25]. In Iran, PMR has been implemented for diverse groups like MS patients [25], breast cancer patients [24], and hypertension patients [27]. However, no research has explored PMR's effectiveness on troponin levels and anxiety in women with chest pain in Iran. Hence, this study aims to investigate the effectiveness of PMR on troponin levels and anxiety in women with chest pain.

Materials and Methods

The study employed a semi-experimental, pre-test-post-test design with a control group and a three-month follow-up period. The target population included all women with chest pain in Karaj city in 2021, with the sample drawn from patients at Shahid Rajaei Karaj Hospital. A targeted sampling approach was utilized [28], selecting participants aligned with the study's objectives. The sample comprised 40 women, evenly divided into a control group and a PMR test group through random assignment.

Inclusion criteria were a diagnosis of chest pain by a specialist, age of 18 years or above, absence of severe mental disorders like psychosis, no chronic physical diseases as diagnosed by a specialist, and not currently using psychoactive substances, sedatives, or painkillers. Exclusion criteria included development of physical problems disrupting psychotherapy (as diagnosed by a specialist), symptom severity increase during treatment, absence from more than two treatment sessions, concurrent participation in other psychological training or clinical trials, and withdrawal from the study for any reason.

This clinical trial (ID: IR.PNU.REC.1401.056) was registered at Payam Noor University, Dubai branch. Ethical considerations were thoroughly addressed, including obtaining informed consent from all participants and ensuring adherence to ethical guidelines throughout the research process.

The research utilized the following tools for assessing variables:

1. Beck Anxiety Inventory: Developed by Beck in 1988, this questionnaire features 21 four-choice questions, each scored from 0 to 3, reflecting increasing intensity of anxiety symptoms. The total score ranges from

0 to 63 [29]. Beck and Clark [30] reported its internal consistency as 0.93 and retest reliability as 0.75. In Iran, its reliability was reported as 0.78 using Cronbach's alpha method, with differential validity between anxious and normal groups shown with a T-value of 12.3 at a significance level of 0.001 [31]. Its validity and reliability in the Iranian population are 0.72 and 0.83, respectively, with an internal consistency of 0.92 [32].

2. Anxiety Sensitivity Index Revised (ASI-R): Prepared by Taylor and Cox in 1998, this scale includes 16 questions on a five-point Likert scale, ranging from 0 (very little) to 4 (very much), with a total score range of 0 to 64 [33]. It assesses three subscales: physical, cognitive, and social concerns. Its internal stability, measured by Cronbach's alpha, ranges from 0.80 to 0.90, with retest reliabilities of 0.75 (two weeks) and 0.71 (three years) [34]. Beyrami et al. [35] conducted a psychometric analysis in Iran, reporting reliability coefficients of 0.93, 0.95, and 0.97 and a correlation coefficient of 0.56 with the SCL-90 questionnaire.

3. Anxiety Control Questionnaire (ACQ): Developed by Rapi et al. [36], this 30-question scale is based on DSM standards and uses a 6-point Likert scale. It measures individuals' perceptions of controlling emotional reactions and external threats, with scores ranging from 0 to 180. The scale has been validated in both clinical and non-clinical populations. Rapi et al. reported a Cronbach's alpha of 87% to 89% [36], while Najimi et al. [38] in Iran found an initial alpha of 0.62.

4. Troponin Measurement: Venous blood (5-7cc) was collected from participants and processed using centrifugation (3000 rpm for 10 minutes) to separate serum. Serum troponin concentration was measured using the Biomerieux kit and enzyme immunoassay method with final fluorescent detection on the VIDAS device [39].

5. PMR Protocol: Based on Bernstein and Boruk's protocol [40], this intervention consisted of 8 weekly sessions, each lasting two hours. The sessions encompassed activities for achieving complete muscle relaxation, subsequently leading to mental relaxation (Table 1).

Analysis of covariance methods were employed for hypothesis testing, with post hoc tests for pairwise group comparisons. SPSS version 21 was used for data analysis.

Results

In this study, data from 40 participants were analyzed. The demographic analysis revealed that 66.33% of participants were married and 36.67% were single. Educationally, 20% held a diploma, 31.6% a bachelor's degree, and 18.3% a master's degree or higher. Duration of illness varied: 33.3% under 6 months, 28.3% between 6 months and a year, and 38.3% over a year.

Table 2 illustrates changes in anxiety measures. For the PMR group, mean anxiety components decreased from 43.68 (SD=3.65) pre-test to 32.59 (SD=4.01) post-test. Anxiety sensitivity reduced from a pre-test mean of 36.98 (SD=3.58) to 27.58 (SD=2.51) post-test. Perception of anxiety control improved from a pre-test mean of 91.49 (SD=4.68) to 76.67 (SD=5.23) post-test. Troponin levels improved from a pre-test mean of 0.079 (SD=0.047) to 0.047 (SD=0.040) post-test (Table 2).

The Kolmogorov–Smirnov test confirmed normal distribution of research variables ($p > 0.05$). Levin's test indicated equal error variance across groups ($p > 0.05$). Multivariate covariance analysis (Table 3) revealed significant differences between groups in anxiety component reduction post-test ($F=11.77$, $p=0.007$) and at three-month follow-up ($F=35.8$, $p<0.001$).

PMR significantly reduced anxiety sensitivity in women with chest pain. This reduction was evidenced in the post-test stage ($F=18.76$, $P=0.024$) and at the three-month follow-up ($F=14.16$, $P=0.011$), indicating a sustained effect of PMR over time (Table 4).

PMR significantly enhanced the perception of anxiety control among the participants. This improvement was notable both in the post-test stage ($F=23.99$, $P=0.036$) and at the three-month follow-up ($F=23.68$, $P=0.018$), suggesting a consistent positive impact of PMR (Table 5).

PMR effectively improved troponin levels in the study participants. This improvement was significant in the post-test stage ($F=27.05$, $P=0.033$) and maintained at the three-

Sessions	Content
1st	Explanation of the logic of treatment and relaxation of breathing. The members of the group were introduced to each other and the philosophy, conditions and rules of group therapy were explained.
2nd	Relaxation of 16 groups of muscles. Contraction and release was taught for 16 groups of muscles, including two muscles of the left hand, three muscles of the face, neck muscle, shoulder and scapula muscles, abdominal muscle, three muscles of the right leg and three muscles of the left leg.
3rd	Relaxation of 7 groups of muscles. Contraction and release for 7 groups of muscles including all the muscles of the right hand and all the muscles of the left hand, all the muscles of the face, neck, shoulder an scapula, right leg and left leg.
4th	Relaxation of 4 groups of muscles. Contraction and release for 4 groups of muscles including all muscles of both right and left hands at the same time, all muscles of the face and neck at the same time, all muscles of the shoulder and scapula and abdomen together, all muscles of both the right and left legs at the same time.
5th	Relaxation through remembrance. Eliminating muscle contraction and focusing on the enhanced ability of the group members to feel tension and relaxation, how to pay attention to any muscle contraction and remember the recalling the feeling of releasing the muscle contraction was taught.
6th	Relaxation through recall by counting. How to pay attention to any contraction in the muscles and recall the feeling of releasing the contraction and tension, counting from 1 to 10 and paying attention to each muscle in harmony with tenophus was taught.
7th	Relaxation through counting. Counting from 1 to 10 and paying attention to each muscle in harmony with breathing was taught without any help from a specific muscle and without remembering the moment of releasing the contraction.
8th	After the test and final feedback of the therapeutic intervention process, 3 months of differential relaxation homework training was done. This stage includes a series of relaxation exercises that begin with relatively mild physical activities and continue with more active behaviors. In mild activities, the relaxation of the unnecessary muscles involved was emphasized so that more complex activities can be identified and stress reduction is easier.

Table 1. Summary of progressive muscle relaxation intervention.

Components	Test stages	Progressive muscle relaxation		Control group	
		mean	SD	mean	SD
Anxiety components	Pre-test	43.68	3.65	40.95	2.26
	Post-test	32.59	4.01	41.88	3.36
	3 months follow-up	33.12	2.26	40.63	2.68
Anxiety sensitivity	Pre-test	36.98	3.58	37.49	3.36
	Post-test	27.58	2.51	36.65	3.54
	3 months follow-up	28.91	3.22	37.49	2.68
Anxiety control perception	Pre-test	91.49	4.68	90.13	4.26
	Post-test	76.67	5.23	89.64	4.68
	3 months follow-up	77.55	4.18	90.20	5.23
Troponin	Pre-test	0.079	0.047	0.054	0.037
	Post-test	0.047	0.040	0.056	0.041
	3 months follow-up	0.048	0.040	0.055	0.029

Table 2. Mean and standard deviation of research variables.

Variable	Stage	Source	Mean Squares	Freedom rate	Mean Squares	F	P	Eta
Anxiety components	Post-test	Pre-test	23.24	1	23.24	2.053	0.284	0.054
		Group	133.41	1	133.1	11.77	0.007	0.905
		Error	16.30	37	11.32			
		Total	172.95	40				
	3 months follow-up	Pre-test	51.65	1	51.65	5.130	0.510	0.041
		Group	84.10	1	84.10	8.354	0.0001	0.957
		Error	13.80	37	10.067			
		Total	149.55	40				

Table 3. The results of multivariate covariance analysis in anxiety components.

Variable	Stage	Source	Mean Squares	Freedom rate	Mean Squares	F	P	Eta
Anxiety sensitivity	Post-test	Pre-test	32.11	1	32.11	2.371	0.311	0.064
		Group	254.03	1	254.03	18.76	0.024	0.811
		Error	15.11	37	13.54			
		Total	301.25	40				
	3 months follow-up	Pre-test	47.14	1	47.14	5.16	0.351	0.017
		Group	147.22	1	147.22	16.14	0.011	0.457
		Error	8.68	37	9.12			
		Total	203.04	40				

Table 4. Results of multivariate analysis of covariance in anxiety sensitivity.

Variable	Stage	Source	Mean Squares	Freedom rate	Mean Squares	F	P	Eta
Perception of anxiety control	Post-test	Pre-test	40.04	1	40.04	2.935	0.428	0.091
		Group	327.28	1	327.28	23.99	0.036	0.674
		Error	15.93	37	13.64			
		Total	283.25	40				
	3 months follow-up	Pre-test	35.81	1	35.81	2.96	0.422	0.027
		Group	286.13	1	286.13	23.686	0.018	0.431
		Error	14.33	37	12.08			
		Total	149.55	40				

Table 5. The result of multivariate covariance analysis in the perception of anxiety control.

Variable	Stage	Source	Mean Squares	Freedom rate	Mean Squares	F	P	Eta
Troponin levels	Post-test	Pre-test	27.01	1	27.01	1.65	0.357	0.082
		Group	440.51	1	440.51	27.05	0.033	0.731
		Error	18.90	37	16.28			
		Total	486.42	40				
	3 months follow-up	Pre-test	25.48	1	25.48	1.58	0.389	0.0691
		Group	365.62	1	365.62	22.69	0.020	0.523
		Error	16.91	37	16.11			
		Total	408.01	40				

Table 6. The results of multivariate covariance analysis of direction in troponin levels.

month follow-up (F=22.69, P=0.020), demonstrating the long-term benefits of PMR on cardiac biomarkers (Table 6).

Discussion

This study aimed to evaluate the effectiveness of PMR on troponin levels and anxiety in women with chest pain. The findings indicate that PMR positively influences troponin levels, corroborating the results of Abutalebi et al. [16]. The relationship between cardiac enzymes and psychological factors suggests that psychological states can modulate cardiovascular biomarkers [16]. PMR, by promoting mental relaxation and reducing negative emotions such as anxiety and tension, potentially impacts these biomarkers. It operates by countering the effects of muscle tension and stress on the body. As a non-pharmacological and behavioral intervention, PMR is effective in managing the tension associated with chronic diseases and alleviating anxiety and pain [25]. Therefore, the observed improvement in troponin levels can be attributed to the influence of PMR on psychological factors.

The study also demonstrated that PMR effectively reduced anxiety in women with chest pain, aligning with the findings of Najimi et al. [38], Heydari and Saedi [40], Tabarsi et al. [25], and Liu et al. [41]. PMR enhances mental and psychological capabilities, boosting self-confidence, efficiency, creativity, and inner talents. It balances the posterior and anterior hypothalamus, mitigating the adverse effects of tension and anxiety [25].

Concerning anxiety sensitivity in chest pain patients, PMR addresses the underlying muscle tension associated with anxiety. By teaching patients to discern and control muscle tension and relaxation, PMR provides a physiological counter to anxiety. This relaxation technique effectively reduces anxiety sensitivity by promoting an awareness of muscular states and facilitating deep relaxation [39].

Regarding anxiety components, PMR's ability to induce deep muscle relaxation directly counters anxiety. This relaxation has profound benefits for patients with chest pain, including improved mental and physical health, better sleep, reduced stress hormones, lower heart rate and blood pressure, decreased heart attack frequency, reduced mortality, and enhanced concentration [42]. PMR's impact on both physical and psychological states significantly diminishes anxiety components.

A holistic view of PMR's effectiveness includes its influence on blood flow, oxygen supply, and nervous system activities. This approach enhances pain management and resilience. The improvement in pain management can also be linked to the HPA axis's role in regulating stress hormones like cortisol, which contributes to pain reduction and immune system strengthening.

The bidirectional communication between mind and body is another vital aspect. Stress relief techniques like PMR impact the central nervous system, facilitating the release of analgesic substances and inhibiting pain neurotransmitters. This leads to reduced sympathetic

stimulation and enhanced parasympathetic activation, culminating in muscle relaxation and pain reduction.

Moreover, the relaxation exercises in PMR promote deeper breathing, ensuring adequate oxygen supply to the brain and body. This shift in tension and pain perception fosters a relaxed state, further enhancing the therapeutic impact of PMR.Future research should compare PMR with other therapeutic interventions to further explore its relative effectiveness. It is also recommended to replicate this study in different cultural settings to assess the universality of its findings.

Data Availability

Data generated in this study are available from the corresponding author upon request.

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Conflict of Interest

The authors have no conflicts of interest.

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Author Declaration

The corresponding author hereby declares, on behalf of all co-authors, that this manuscript is not under simultaneous

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