ORIGINAL RESEARCH

The Combined Effects of Cardiac Rehabilitation Exercise Training and Mindfulness Care on Post-PCI Rehabilitation in Coronary Heart Disease Patients

Xiaoling Zheng, BD; Jing Zhao, BD

ABSTRACT

Objective • This study aimed to explore the effects of combining cardiac rehabilitation exercise training with mindfulness care on cardiac function, exercise capacity, and mood in patients with coronary heart disease (CHD) after percutaneous coronary intervention (PCI).

Methods • A total of 108 patients admitted to our hospital from January 2020 to January 2022, following PCI for CHD, were selected for this study. The participants were randomly assigned to either the control group or the observation group, with 54 patients in each group. The control group underwent standard rehabilitation exercise training, while the observation group received a combination of rehabilitation exercise training and mindfulness care. Cardiac function, exercise capacity, and psychological status were assessed and compared between the two groups before and after the intervention.

Results • Post-intervention, both groups showed significant improvements in left ventricular ejection fraction (LVEF), left ventricular end-systolic volume (LVESV), and left ventricular end-diastolic volume (LVEDV) compared to pre-intervention levels, with the observation group demonstrating significantly greater improvements than the control group ($P < .05$). Additionally, the left ventricular end-systolic dimension (LVESD) and left ventricular end-diastolic dimension (LVEDD) decreased in both groups, with more significant reductions observed in the observation group ($P < .05$). Exercise capacity, as measured by the 6-minute walk distance, exercise time, and maximum exercise load, improved in both groups post-intervention, with the observation group showing greater improvements ($P < .05$). Psychological assessments indicated reductions in Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) scores in both groups after the intervention, with the observation group experiencing more substantial reductions ($P < .05$).

Conclusion • Integrating mindfulness care with cardiac rehabilitation exercise training significantly improves cardiac function, enhances exercise capacity, and reduces anxiety and depression in CHD patients post-PCI. This combined approach offers a more effective rehabilitation strategy compared to exercise training alone. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Coronary heart disease (CHD) remains a leading cause of morbidity and mortality worldwide. Percutaneous coronary intervention (PCI) is a standard and effective treatment for many CHD patients, offering immediate relief by improving blood flow to the heart.[1-3] However, to ensure optimal long-term outcomes, it is essential to focus on comprehensive recovery and rehabilitation post-PCI.[4] Cardiac rehabilitation exercise training is widely recognized for its beneficial impact on the overall health and well-being of CHD patients post-PCI, offering structured exercise regimens and medical guidance that significantly aid in recovery.[5,6]

Additionally, mindfulness-based interventions have emerged as a valuable complementary approach to traditional medical care, further supporting patient recovery and well-being.[7] Mindfulness care plays a crucial role in promoting emotional well-being and psychological resilience, especially for CHD patients who struggle with the emotional stress and anxiety linked to their condition and treatment.[8] Previous studies have underscored the positive impact of mindfulness interventions on a range of chronic health conditions, including cardiovascular diseases.[9]

However, the potential synergistic benefits of integrating mindfulness care with cardiac rehabilitation exercise training for CHD patients post-PCI have not been extensively explored. This study aims to investigate the combined effects of cardiac rehabilitation exercise training and mindfulness care on the rehabilitation progress and overall well-being of CHD patients who have undergone PCI. Our findings highlight a potentially innovative approach to CHD patient rehabilitation post-PCI. Understanding its synergistic benefits could significantly enhance treatment strategies and improve the long-term outcomes and quality of life for CHD patients.

MATERIALS AND METHODS

Study Design

A total of 108 patients admitted to our hospital between January 2020 and January 2022 following PCI for coronary artery disease were selected as study subjects. They were randomly assigned to either the control group or the observation group, with 54 cases in each group, utilizing the random number table method. The control group received rehabilitation exercise training alone, while the observation group received rehabilitation exercise training combined with mindfulness care.

Demographic Characteristics

In the control group, comprising 30 males and 24 females, ages ranged from 48 to 78 years, with a mean of (63.24±7.17) years. The duration of the disease ranged from 2 to 9 years, with a mean of (5.33±1.57) years. Similarly, in the observation group, there were 32 males and 22 females, with ages ranging from 46 to 77 years and a mean age of (62.86±6.92) years. Disease duration in this group varied from 2 to 8 years, with a mean of (5.17±1.48) years. Statistical analysis revealed no significant differences in baseline age, gender distribution, or disease duration between the two groups ($P > .05$).

Criteria for Inclusion and Exclusion

Inclusion criteria were as follows: (1) Patients meeting the diagnostic criteria for coronary heart disease;[10] (2) Patients who underwent emergency PCI; (3) Patients undergoing PCI for the first time. Exclusion criteria were as follows: (1) Patients presenting with cardiogenic shock or severe arrhythmia; (2) Patients with significant cerebrovascular disease, hepatic or renal insufficiency, or respiratory disease; (3) Patients diagnosed with psychiatric disorders or cognitive impairments; (4) Patients with hemorrhagic disease or malignant tumors.

Intervention in the Control Group

Rehabilitation Exercise Training. Patients in the control group received rehabilitation exercise training interventions. In-hospital rehabilitation involves assisting patients in bed to perform passive exercises, gradually transitioning to the patient's own movements, such as turning over, sitting up, sitting on the bedside chair, and standing. This regimen aimed to increase the heart rate by approximately 8 times per minute. Subsequently, patients engaged in bedside walking, with the heart rate increasing by approximately 12 times per minute. Additionally, patients walked outside the ward for 10 minutes twice daily, with the heart rate increasing by about 15 times per minute. Climbing a flight of stairs was also incorporated into the regimen, with the heart rate increasing by approximately 20 times per minute.

Post-Discharge Rehabilitation Regimen. After discharge, patients underwent a structured rehabilitation program, which included the following components: (1) Stretching Exercises: Patients engaged in stretching exercises for the neck, shoulders, back, abdomen, and lower limbs. Initially, each stretch lasted approximately 10 seconds, gradually increasing in duration over time. (2) Walking and Jogging: Patients began with 5-minute sessions of walking or jogging, gradually increasing the duration to 60 minutes per session. The intensity of exercise also increased gradually, with sessions conducted four times per week.

(3) Strength Training: Strength training exercises targeted various muscle groups, including chest, shoulder, and upper limb muscles, which were exercised through push-ups. Abdominal muscles were trained using supine leg raises, abdominal curls, and plank exercises. Squats were incorporated to work the muscles of the lower limbs and buttocks. Each muscle group was trained at least once per week, with 10 repetitions per set initially, gradually increasing to four sets per session.

Intervention in the Observation Group: Mindfulness Care

Patients in the observation group received mindfulness care in addition to the interventions received by the control group. The mindfulness care regimen consisted of the following components:

Education and Body Scanning Exercises. Patients were educated about coronary heart disease (CHD) and its implications. Body scanning exercises were conducted to help patients become aware of their bodily sensations and perceive physical symptoms associated with CHD.

Mindfulness Thinking. Patients were guided to adopt mindfulness thinking when responding to unpleasant events from the past. Upon detecting stress or pressure, patients were instructed to eliminate distractions in their minds and experience the process of emotional fading. Patients were then guided to make reasonable responses to the identified stressors.

Mindfulness Respiratory Training. Patients engaged in mindfulness respiratory training, focusing on the sensation of air entering the nasal cavity during the breathing process. This exercise encouraged patients to synchronize their breathing with the natural rhythm of respiratory ups and downs, resembling waves on the sea. Each session lasted for 10 minutes.

Mindfulness Stretching Training. Patients were instructed in mindfulness stretching techniques aimed at

Table 1. Comparison of Cardiac Function Indicators Between the Two Groups ($\bar{x} \pm s$)

Group	Cases	LVEF (%)		LVESD (mm)		LVEDD (mm)		LVESV (ml)		LVEDV (ml)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control Group	54	39.52±5.33	46.19±6.12[a]	31.58±4.52	29.54±3.75[a]	61.11±5.12	57.95±3.21[a]	36.68±4.51	51.35±5.09[a]	70.29±5.24	75.32±6.08[a]
Observation Group	54	39.89±5.71	59.38±6.41[a]	31.37±4.78	27.75±3.71[a]	60.89±4.92	55.12±3.15[a]	37.01±4.02	74.18±5.42[a]	70.47±5.61	85.17±6.53[a]
t		0.348	10.937	0.235	2.494	0.228	4.624	0.401	22.563	0.172	8.113
P value		.729	<.001	.815	.014	.820	<.001	.689	<.001	.864	<.001

[a]Compared with the same group before the intervention, $P < .05$.

Note: Values are expressed as mean ± standard deviation ($\bar{x} \pm s$).

Abbreviations: LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; LVEDD, left ventricular end-diastolic dimension; LVESV, left ventricular end-systolic volume; LVEDV, left ventricular end-diastolic volume.

Table 2. Comparison of Exercise Function Between the Two Groups ($\bar{x} \pm s$)

Group	Cases	6 Min Walking Distance (6MWD) (m)		Exercise Time (min/d)		Maximum Exercise Load (W)	
		Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control Group	54	92.11±8.73	312.45±22.57[a]	7.98±1.35	9.88±1.47[a]	125.23±9.87	141.55±11.25[a]
Observation Group	54	91.68±9.01	433.19±31.39[a]	8.12±1.21	11.47±1.64[a]	123.76±10.21	164.56±13.36[a]
t		0.252	22.949	0.568	5.305	0.761	9.681
P value		.802	<.001	.572	<.001	.449	<.001

[a]Statistically significant difference ($P < .05$) compared with the same group before intervention.

Note: Values are expressed as mean ± standard deviation.

maintaining a calm state of mind. This training included activities such as mindfulness walking, mindfulness meditation, and mindfulness yoga. During these exercises, patients selected an object of focus, such as music, and seated themselves with closed eyes. They then directed their attention solely towards the chosen object for a duration of 15 minutes per session.

Observation Indicators

Cardiac Function Indicators. Cardiac function indicators, including left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic volume (LVESV), left ventricular end-systolic dimension (LVESD), left ventricular end-diastolic volume (LVEDV), and left ventricular ejection fraction (LVEF), were assessed in patients both before and three months after the intervention.

Exercise Function Assessment. Exercise function was evaluated using the following methods: (1) 6-minute walk test (6MWT): The 6MWT was conducted before and three months after the intervention. During this test, patients walked back and forth in a 30-meter-long straight corridor within a period of 6 minutes. The distance covered, known as the 6-minute walking distance (6MWD), was recorded. Larger values of 6MWD indicate greater exercise function. (2) Power-vehicle load test: Additionally, the power-vehicle load test was utilized to assess exercise function. This test measured parameters such as the maximum exercise load and exercise time.

Psychological Status Assessment. The psychological status of patients was evaluated using the following scales: (1) Self-rating anxiety scale (SAS): The SAS was administered before and three months after the intervention. This scale comprises 20 items, with each item scored on a scale of 1 to 4 points. An SAS score of ≥50 indicates the presence of anxiety. (2) Self-rating depression scale (SDS): Similarly, the SDS was utilized before and three months after the intervention. It also consists of 20 items, each scored on a scale of 1 to 4 points. An SDS score of ≥53 suggests the presence of depression.

Statistical Analysis

The statistical analysis was conducted using SPSS version 19.0 software. Measurement data were presented as mean ± standard deviation ($\bar{x} \pm s$), and between-group comparisons were performed using the *t* test. Counting data were expressed as the number of cases and percentages [n (%)], and comparisons were made using the χ^2 test. $P < .05$ was considered statistically significant.

RESULTS

Comparison of Cardiac Function Indicators

The differences in LVEDD, LVESV, LVESD, LVEDV, and LVEF between the two groups before the intervention were not statistically significant ($P > .05$). However, post-intervention, LVEF, LVESV, and LVEDV increased in both groups, with significantly higher values observed in the observation group compared to the control group ($P < .05$). Conversely, LVESD and LVEDD decreased in both groups post-intervention, with significantly lower values noted in the observation group compared to the control group ($P < .05$). Refer to Table 1 for details.

Comparison of Exercise Function

The differences in 6-minute walking distance, exercise time, and maximum exercise load between the two groups before intervention were not statistically significant ($P > .05$). However, post-intervention, both groups exhibited improvements in these parameters ($P < .05$), with the observation group demonstrating significantly greater improvements compared to the control group ($P < .05$). Please refer to Table 2 for detailed data.

Table 3. Comparison of Anxiety and Depression Scores Between the Two Groups ($\bar{x} \pm s$)

Group	Cases	SAS (Points)		SDS (Points)	
		Pre-Intervention	Post-Intervention	Pre-Intervention	Post-Intervention
Control Group	54	54.58±4.65	37.26±4.16[a]	55.62±5.17	39.58±3.82[a]
Observation Group	54	54.91±5.03	29.49±3.84[a]	55.37±4.93	31.27±3.45[a]
t		0.354	10.086	0.257	11.864
P value		.724	<.001	.798	<.001

[a]statistically significant difference ($P < .05$) compared with the same group before intervention.

Note: Values are expressed as mean ± standard deviation ($\bar{x} \pm s$).

Abbreviations: SAS, Self-Rating Anxiety Scale Points; SDS, Self-Rating Depression Scale Points.

Comparison of Psychological Status

The difference in SAS and SDS scores between the two groups before intervention was not statistically significant ($P > .05$). However, post-intervention, both groups demonstrated a decrease in SAS and SDS scores compared to baseline, with the observation group exhibiting significantly lower scores than the control group ($P < .05$). Refer to Table 3 for detailed results.

DISCUSSION

In the realm of cardiac care, where managing the complexities of CHD is paramount, PCI effectively alleviates acute cardiovascular risk and diminishes complications and mortality among CHD patients. However, it confronts numerous challenges, including variations of clinical symptoms and the potential for recurrent cardiac events.[11,12] The synergistic impact of integrating cardiac rehabilitation exercise training with mindfulness care in post-PCI rehabilitation for CHD patients holds promise for enhancing the overall well-being of individuals recovering from this debilitating condition.

Rehabilitation exercise training aims to enhance both central and peripheral vascular function in patients through structured physical activity, ultimately improving central cardiovascular function.[13,14] This regimen facilitates the increase of myocardial contractility, accelerates coronary blood flow, and promotes the development of collateral circulation after PCI. Furthermore, it fosters improvements in endothelial function and mitigates platelet aggregation, thereby delaying the progression of atherosclerosis.[15,16]

A meta-analysis conducted by Campos et al.[17] revealed that exercise-based cardiac rehabilitation leads to enhanced physical performance after PCI. Our study supports these findings, demonstrating significant improvements in cardiac function indicators and exercise capacity following rehabilitation exercise training in both study groups compared to pre-intervention levels. Furthermore, our results indicate that the observation group exhibited superior cardiac function indicators and exercise capacity compared to the control group.

This finding indicates that rehabilitation exercise training plays a crucial role in enhancing exercise capacity and optimizing cardiac function among post-PCI patients. Aerobic exercises, such as walking and jogging, contribute to improving cardiopulmonary exercise tolerance and mitigating cardiovascular disease risk factors. Conversely, resistance exercises aid in augmenting muscle strength, endurance, and self-care capabilities in patients. Moreover, the integration of mindfulness care alongside rehabilitation exercise training results in superior outcomes.

The prognosis of patients with CHD after PCI is intricately linked to psychological factors. Cognitive deficits and uncertainty regarding prognosis can increase psychological stress among patients, precipitating emotional reactions such as panic, anxiety, and depression. These emotional responses have the potential to adversely impact patients' adherence to medical recommendations, consequently influencing their prognosis and elevating the risk of disease recurrence and cardiac mortality.[18,19]

In a clinical study conducted by Chi et al.,[20] which encompassed 98 patients diagnosed with coronary artery disease post-PCI, it was observed that the intervention involving motivational psychological nursing combined with procedural nursing led to enhanced rehabilitation compliance, alleviation of negative mood states, and improvement in patients' prognosis.

In our study, we observed lower SAS and SDS scores in the group receiving combined rehabilitation exercise training and mindfulness care compared to the group receiving rehabilitation exercise training alone. This finding indicates that the integration of positive thinking care with rehabilitation exercise training may effectively improve negative emotions among patients with coronary artery disease after PCI.

Study Limitations

Despite the valuable insights provided by this study, a few limitations warrant consideration. Firstly, the sample size was relatively small, potentially limiting the generalizability of the findings to broader populations. Additionally, the study duration was relatively short, which may have restricted the ability to observe the long-term effects of the interventions. Furthermore, the study design was observational, precluding the establishment of causal relationships between the interventions and outcomes. Moreover, the use of self-reported measures for assessing psychological status may introduce bias. Future research endeavors should aim to address these limitations by employing larger sample sizes, longer follow-up periods, randomized controlled trial designs, and objective measures for assessing psychological status, thereby enhancing the robustness and applicability of the findings.

CONCLUSION

In conclusion, the integration of cardiac rehabilitation exercise training with mindfulness care intervention in patients with CHD after emergency PCI demonstrates promising outcomes. This combined approach not only improves patients' cardiac function and exercise capacity but

also alleviates negative emotions. The findings underscore the potential clinical significance of implementing such integrated interventions in CHD management. Moving forward, promoting this combined approach in clinical practice holds considerable value for enhancing the overall well-being and prognosis of CHD patients post-PCI.

CONFLICTS OF INTEREST

The authors report no conflict of interest.

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AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

1. Voutilainen A, Brester C, Kolehmainen M, Tuomainen TP. Epidemiological analysis of coronary heart disease and its main risk factors: are their associations multiplicative, additive, or interactive? [J]. *Ann Med*. 2022;54(1):1500-1510. doi:10.1080/07853890.2022.2078875
2. Duggan JP, Peters AS, Trachiotis GD, Antevil JL. Epidemiology of Coronary Artery Disease. [J]. *Surg Clin North Am*. 2022;102(3):499-516. doi:10.1016/j.suc.2022.01.007
3. Doenst T, Thiele H, Haasenritter J, Wahlers T, Massberg S, Haverich A. The Treatment of Coronary Artery Disease. [J]. *Dtsch Arztebl Int*. 2022;119(42):716-723.
4. Dibben G, Faulkner J, Oldridge N, et al. Exercise-based cardiac rehabilitation for coronary heart disease. [J]. *Cochrane Database Syst Rev*. 2021;11(11):CD001800.
5. Dibben GO, Faulkner J, Oldridge N, et al. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. [J]. *Eur Heart J*. 2023;44(6):452-469. doi:10.1093/eurheartj/ehac747
6. Anderson L, Oldridge N, Thompson DR, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. [J]. *J Am Coll Cardiol*. 2016;67(1):1-12. doi:10.1016/j.jacc.2015.10.044
7. Wielgosz J, Goldberg SB, Kral TRA, Dunne JD, Davidson RJ. Mindfulness Meditation and Psychopathology. [J]. *Annu Rev Clin Psychol*. 2019;15(1):285-316. doi:10.1146/annurev-clinpsy-021815-093423
8. Lundgren O, Garvin P, Nilsson L, et al. Mindfulness-Based Stress Reduction for Coronary Artery Disease Patients: Potential Improvements in Mastery and Depressive Symptoms. [J]. *J Clin Psychol Med Settings*. 2022;29(3):489-497. doi:10.1007/s10880-021-09822-z
9. Nasiri Z, Alavi M, Ghazavi Z, Rabiei K. The effectiveness of mindfulness-based intervention on perceived stress and perception of disease in patients with acute coronary syndrome. [J]. *J Educ Health Promot*. 2020;9(1):130. doi:10.4103/jehp.jehp_660_19
10. Lawton JS, Tamis-Holland JE, Bangalore S, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. [J]. *Circulation*. 2022;145(3):e4-e17. doi:10.1161/CIR.0000000000001039
11. Doll JA, O'Donnell CI, Plomondon ME, Waldo SW. Contemporary Clinical and Coronary Anatomic Risk Model for 30-Day Mortality After Percutaneous Coronary Intervention. [J]. *Circ Cardiovasc Interv*. 2021;14(12):e010863. doi:10.1161/CIRCINTERVENTIONS.121.010863
12. Hoole SP, Bambrough P. Recent advances in percutaneous coronary intervention. [J]. *Heart*. 2020;106(18):1380-1386. doi:10.1136/heartjnl-2019-315707
13. Patti A, Merlo L, Ambrosetti M, Sarto P. Exercise-Based Cardiac Rehabilitation Programs in Heart Failure Patients. [J]. *Heart Fail Clin*. 2021;17(2):263-271. doi:10.1016/j.hfc.2021.01.007
14. Squires RW, Bonikowske AR. Cardiac rehabilitation for heart transplant patients: considerations for exercise training. [J]. *Prog Cardiovasc Dis*. 2022;70:40-48. doi:10.1016/j.pcad.2021.12.003
15. Sabbahi A, Canada JM, Babu AS, Severin R, Arena R, Ozemek C. Exercise training in cardiac rehabilitation: setting the right intensity for optimal benefit. [J]. *Prog Cardiovasc Dis*. 2022;70:58-65. doi:10.1016/j.pcad.2022.02.001
16. Taylor RS, Dalal HM, Zwisler AD. Cardiac rehabilitation for heart failure: 'Cinderella' or evidence-based pillar of care? [J]. *Eur Heart J*. 2023;44(17):1511-1518. doi:10.1093/eurheartj/ehad118
17. Campos HO, Rodrigues QT, Drummond LR, et al. Exercise-based cardiac rehabilitation after myocardial revascularization: a systematic review and meta-analysis. [J]. *Rev Cardiovasc Med*. 2022;23(2):74. doi:10.31083/j.rcm2302074
18. Richards SH, Anderson L, Jenkinson CE, et al. Psychological interventions for coronary heart disease. [J]. *Cochrane Database Syst Rev*. 2017;4(4):CD002902.
19. Hu YY, Jiang X, Mao FY, et al. Effect of positive event recording based on positive psychology on healthy behaviors and readmission rate of patients after PCI: a study protocol for a prospective, randomized controlled trial. [J]. *Trials*. 2022;23(1):1013. doi:10.1186/s13063-022-06964-9
20. Chi RB, Cai YY, Mao HP. Intervention effect of encouraging mental and programmed nursing of patients in interventional operating room on their compliance and bad moods. [J]. *World J Clin Cases*. 2022;10(21):7285-7292. doi:10.12998/wjcc.v10.i21.7285