

Original Article

Effect of early home-based exercise for cardiac rehabilitation on the prognosis of patients with acute myocardial infarction after percutaneous coronary intervention

Huaqin Yu¹, Honger Yang²

¹Department of Cardiovascular Medicine, The First People's Hospital of Fuyang Hangzhou, Hangzhou 311400, Zhejiang Province, China; ²Nursing Department, The First People's Hospital of Fuyang Hangzhou, Hangzhou 311400, Zhejiang Province, China

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Abstract: Objective: To investigate the effect of early home-based cardiac rehabilitation (CR) exercise on the prognosis of patients with acute myocardial infarction (AMI) after percutaneous coronary intervention (PCI). Methods: The clinical data of 115 patients with AMI in our hospital were collected retrospectively. All patients underwent PCI and were divided into group A (n=57) and group B (n=58) according to postoperative intervention. Patients in group A only received routine rehabilitation guidance, while those in group B received early home-based CR exercise. The incidence of postoperative complications, cardiac function index, 6-minute walking distance (6MWD), cardiac antioxidant index, exercise endurance index and quality of life score were compared between the two groups before and after intervention. Results: Compared with those in group B, patients in group A showed a lower incidence of postoperative complications (17.54% vs. 3.45%, $P<0.05$). After intervention, group A had lower left ventricular ejection fraction (LVEF), left ventricular end systolic diameter (LVESD) and left ventricular end diastolic diameter (LVEDD), longer 6MWD, higher total antioxidant capacity (T-AOC) and superoxide dismutase (SOD), lower malonaldehyde (MAD), higher exercise duration (ED), anaerobic threshold (AT) and VO_2 and higher scores of quality of life than group B ($P<0.05$). Conclusion: Early home-based CR exercise in patients with AMI after PCI can improve cardiac function, reduce the incidence of postoperative complications as well as enhance cardiac antioxidant capacity, exercise ability and quality of life.

Keywords: Acute myocardial infarction, interventional therapy, early stage, home-based exercise cardiac rehabilitation, prognosis, effect

Introduction

Acute myocardial infarction (AMI) is a severe type of coronary heart disease (CAD) and is a major cause of disability and death [1]. Due to alcoholism, overwork and other types of occurrences, most patients with AMI often develop coronary atherosclerotic plaque rupture, thrombosis, myocardial ischemic necrosis, arrhythmia, heart failure and even shock, all of which pose a great threat to patients' life and safety [2, 3].

Percutaneous coronary intervention (PCI) is a common treatment for AMI due to its accurate and direct revascularization [4]. At present,

many clinical studies have shown that PCI can produce ideal clinical therapeutic effects for patients with AMI, so as to improve their prognosis [5]. Despite its obvious advantages, PCI fails to retard or reverse the biological process of coronary atherosclerosis. Besides, the risk factors associated with CAD cannot be eliminated [6]. Therefore, in addition to the therapeutic effect of PCI, the secondary prevention of CAD should also be actively implemented to improve the prognosis of patients with AMI [7].

Cardiac rehabilitation (CR) exercise is an important part of the secondary prevention of CAD. Scientific and reasonable CR exercise can improve vascular endothelial function, maintain

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the stability of coronary artery plaque, and promote the establishment of the collateral circulation, thus reducing mortality and improving cardiac function and the quality of life of patients [8, 9]. In view of this, this study investigated the effect of early home-based CR exercise on improving the prognosis of AMI patients after PCI, which is feasible and scientific.

Materials and methods

General materials

The clinical data of 115 patients with AMI in our hospital were collected retrospectively. According to the postoperative intervention, all patients were divided into two groups: group A (n=57) and group B (n=58). Group A received routine exercise rehabilitation education, while group B received early home-based CR exercise. (1) Inclusion criteria: patients and their families had signed the informed consent form; AMI was confirmed by emergency coronary angiography; patients with no contraindication for PCI; patients who had clear consciousness without communication barriers; this study was approved by the medical ethics committee of our hospital. (2) Exclusion criteria: long-term bedridden patients; patients with a history of drug dependence; patients with severe hepatic and renal dysfunction; patients with congenital heart disease; patients who had NYHA grade 3 to 4 and hemodynamic instability after PCI; patients with malformed cerebrovascular accidents; patients with neuromuscular disease; patients who had diabetes mellitus and hypertension without effective control.

Methods

Group A: During hospitalization and discharge, patients in group A received strengthened health education and were informed of risk factors related to CAD and matters needing attention after PCI. They were also instructed to take their medicine strictly according to doctor's advice and have a scientific and a rational diet. Meanwhile, patients were followed up after discharge for a total of 3 months.

Group B: According to the patients' actual conditions, CR specialists made individual CR exercise plans, which included two phases: Hospitalization (for 1 week) and early outpatient service after discharge (for 3 months). Patients' energy consumption during exercise

was controlled by 2-4 metabolic equivalents. The purpose of CR training during hospitalization was to prepare for early outpatient CR training after discharge. The specific training content is shown in **Table 1**.

Observation indices

(1) Incidence of postoperative complications was compared between the two groups, including angina pectoris, coronary artery restenosis and arrhythmia. (2) Cardiac function index [10]: Left ventricular ejection fraction (LVEF), left ventricular end systolic diameter (LVESD) and left ventricular end diastolic diameter (LVEDD) were measured by color Doppler echocardiography before and after intervention. (3) Six-minute walking distance (6MWD) [11]: Before and after intervention, patients in both groups were tested with 6MWD in a closed corridor. They were instructed to stand on the starting line. Once they started walking, the timer was started immediately to calculate the walking distance in 6 minutes. (4) Cardiac antioxidant index [12]: Before and after intervention, 3 ml of fasting venous blood from the elbow was collected in both groups. Total antioxidant capacity (T-AOC) was tested by phenanthroline colorimetry. Malondialdehyde was tested by thiobarbituric acid reactive substances colorimetry. Superoxide dismutase was tested by xanthine oxidase. (5) Exercise endurance [13]: Exercise duration (ED), anaerobic threshold (AT), and VO_2 (peak oxygen uptake) were compared between the two groups before and after intervention. (6) Quality of life [14]: Before and after intervention, the quality of life was evaluated in both groups by the Seattle angina questionnaire (SAQ), which includes disease perception, physical limitation, treatment satisfaction and angina frequency. Each item is transformed to a score of 0 to 100, and higher scores indicate better quality of life.

Statistical analysis

SPSS 22.0 software was used for statistical analysis. GraphPad Prism 8 was used as the graphic software for analysis. Measurement data were represented by mean \pm standard deviation. Data with a normal distribution were tested by *t*-test, otherwise by Mann-Whitney U test. Counting data were represented by [n (%)]. Counting data between groups were com-

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Table 1. Content of early home-based CR exercise training in group B

Time	Contents
Phase I (Hospitalization)	
12 hours after surgery	Patients are instructed to stay in bed. They are allowed to turn over on the bed, move limbs slowly and try to sit up and eat, defecate and brush their teeth.
1-2 days after surgery	Patients are encouraged to get out of bed and sit in a chair 3 times a day, each time <30 minutes.
3-4 days after surgery	Patients are instructed to walk slowly indoors with the assistance of medical staffs or family members 3 times a day, and each walking time is controlled to 10 minutes.
5 days after surgery	Patients are instructed to walk slowly in the ward corridor for 10-20 minutes, 3-4 times a day, and take a shower and defecate.
6 days after surgery	Patients are instructed to walk slowly in the hospital, accompanied by medical staffs or family members twice a day for 10-20 minutes.
7 days after surgery to discharge	Patients basically have the ability to take care of themselves. They can walk slowly for 15 minutes each time, 3 times a day.
Phase II (Early outpatient service after discharge)	
First week after discharge	Patients can walk outdoors at a near normal pace 3 times a day, and each time of walking is controlled at 15-20 minutes.
Second week after discharge	Patients can walk outdoors at a normal pace 3 times a day, and each time of walking is controlled to 20 minutes.
Third week after discharge	Patients can take a quick walk outdoors 3 times a day, and each walk time is controlled to 20-30 minutes.
Fourth week after discharge	Patients can jog outdoors 3 times a day, and each walking time is controlled to 20-30 minutes.
Fifth week after discharge to 3 months after discharge	Patients slowly return to normal work and life.

Table 2. Comparison of general data between the two groups [n (%)]/($\bar{x} \pm s$)

Data		Group A (n=57)	Group B (n=58)	t/ χ^2	P
Gender (cases)	Male	39 (68.42)	41 (70.69)	0.069	0.792
	Female	18 (31.58)	17 (29.31)		
Age (years)		60.18±2.56	60.22±2.48	0.085	0.932
Course of diseases (years)		3.68±0.17	3.72±0.16	1.299	0.196
BMI (kg/m ²)		25.52±0.28	25.53±0.23	0.209	0.835
Angina pectoris type (cases)					
	Stable angina pectoris	32 (56.14)	33 (56.90)	0.007	0.935
	Unstable angina pectoris	25 (43.86)	25 (43.10)		

Table 3. Comparison of postoperative complications between the two groups [n (%)]

Group	Cases	Stable angina	Coronary artery restenosis	Arrhythmia	Total incidence
Group A	57	3 (5.26)	2 (3.51)	5 (8.77)	10 (17.54)
Group B	58	1 (1.72)	0 (0.00)	1 (1.72)	2 (3.45)*
χ^2					6.112
P					0.013

Note: *indicates P<0.05 compared with group A.

pared by χ^2 test. P<0.05 was considered as statistically significant.

Results

Comparison of general data between the two groups

There was no significant difference in gender, age, course of disease, BMI, type of angina pectoris or other general data between the two groups (P>0.05, **Table 2**).

Comparison of postoperative complications between the two groups

There were 3 cases of angina pectoris, 2 cases of coronary artery restenosis and 5 cases of arrhythmia in group A, while the corresponding cases in group B were 1, 0 and 1, respectively. The incidence of postoperative complications was 3.45% in group B, which was significantly lower than 17.54% in group A (P<0.05, **Table 3**).

Comparison of cardiac function indices and 6MWD between the two groups

Before intervention, cardiac function indices between the two groups showed no significant difference (P>0.05). After intervention, both groups showed higher LVEF and lower LVESD and LVEDD (P<0.05). Group B had higher LVEF

and lower LVESD and LVEDD than group A after intervention (P<0.05, **Figure 1**).

6MWD testing exhibited no significant difference in both groups before intervention (P>0.05). After intervention, both groups showed longer 6MWD (P<0.05); and group B had longer 6MWD than group A after intervention (P<0.05, **Table 4**).

Comparison of cardiac antioxidant indices and exercise endurance between the two groups

After intervention, T-AOC and SOD increased and MAD decreased significantly in both groups (P<0.05). Group B showed higher T-AOC and SOD and lower MAD than group A after intervention (P<0.05, **Figure 2**).

After intervention, ED, AT and VO₂ all increased in both groups (P<0.05); and group B was higher than group A in terms of ED, AT and VO₂ after intervention (P<0.05, **Figure 3**).

Comparison of quality of life between the two groups

After intervention, the score of quality of life in each dimension increased significantly (P<0.05), and the scores in group B were higher than those in group A (P<0.05, **Figure 4**).

Discussion

AMI refers to myocardial necrosis or severe ischemia due to the termination or continuous decrease of blood supply as a result of acute occlusion or stenosis of coronary artery [15]. The pathophysiological basis of AMI is as follows: On the basis of coronary atherosclerosis, various mechanical factors (such as coronary artery spasm, hypertension, etc.) can induce

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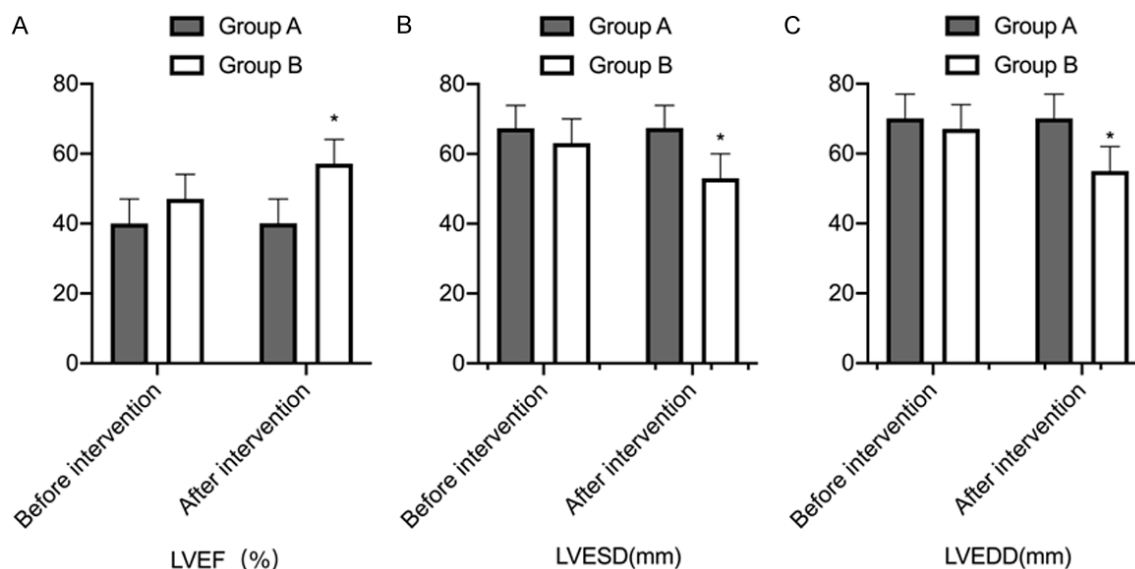


Figure 1. Comparison of cardiac function indices between the two groups. (A) shows comparison of LVEF between the two groups ($P>0.05$) before intervention, after intervention, group B had higher LVEF than group A ($P<0.05$); (B) shows comparison of LVESD between the two groups ($P>0.05$) before intervention, after intervention, group B had lower LVESD than group A ($P<0.05$); (C) shows comparison of LVEDD between the two groups ($P>0.05$) before intervention, after intervention, group B had lower LVEDD than group A ($P<0.05$).

Table 4. Comparison of 6MWD between the two groups ($\bar{x} \pm s, m$)

Group	Before intervention	After intervention
Group A (n=57)	298.63±2.56	352.12±6.28 [#]
Group B (n=58)	298.59±2.62	458.96±3.63 ^{#,*}
t	0.083	111.933
P	0.934	0.000

Note: [#]indicates $P<0.05$ compared with before intervention; ^{*}indicates $P<0.05$ compared with group A.

thrombus formation and vulnerable plaque rupture, which eventually triggers acute coronary artery occlusion or severe stenosis [16]. At present, PCI is the main method to treat AMI. PCI can effectively alleviate patients' conditions. CR after PCI is one of the key issues of clinical concern [17].

CR refers to the comprehensive guidance of psychology, lifestyle and exercise for patients on the basis of professional treatment, so as to prevent cardiac complications, reduce the risk of heart disease deterioration and improve the quality of life of the patients [18]. At present, CR after PCI is getting more and more attention [19]. CR exercise is able to increase the adaptability of cardiac function, improve the blood supply capacity and elasticity of the

coronary artery, reduce various risk factors of heart disease and improve the ability of human vascular regulation. CR exercise has a certain effect on reducing the risk factors of AMI and improving prognosis, but the participation rate of CR after PCI differs greatly in different countries [20, 21]. In China, the participation rate of CR in patients with AMI after PCI is relatively low, which may be due to the fact that some families are unable to afford high expenses [22]. Secondly, some patients may consider CR unnecessary, so they give up their participation [23]. In view of this, this study combined the actual situation of Chinese people and designed an early home-based CR exercise model in line with China's population's conditions, which has been widely used in CR after PCI in China. In this study, the incidence of postoperative complications in group B was lower than that in group A, and the indices of cardiac function, cardiac antioxidation, exercise endurance and quality of life in group B were better than those in group A, suggesting that early home-based CR exercise after PCI in patients with AMI can improve cardiac function, reduce the incidence of postoperative complications and improve cardiac antioxidant capacity, exercise ability and quality of life. To explore the mechanism, we consider

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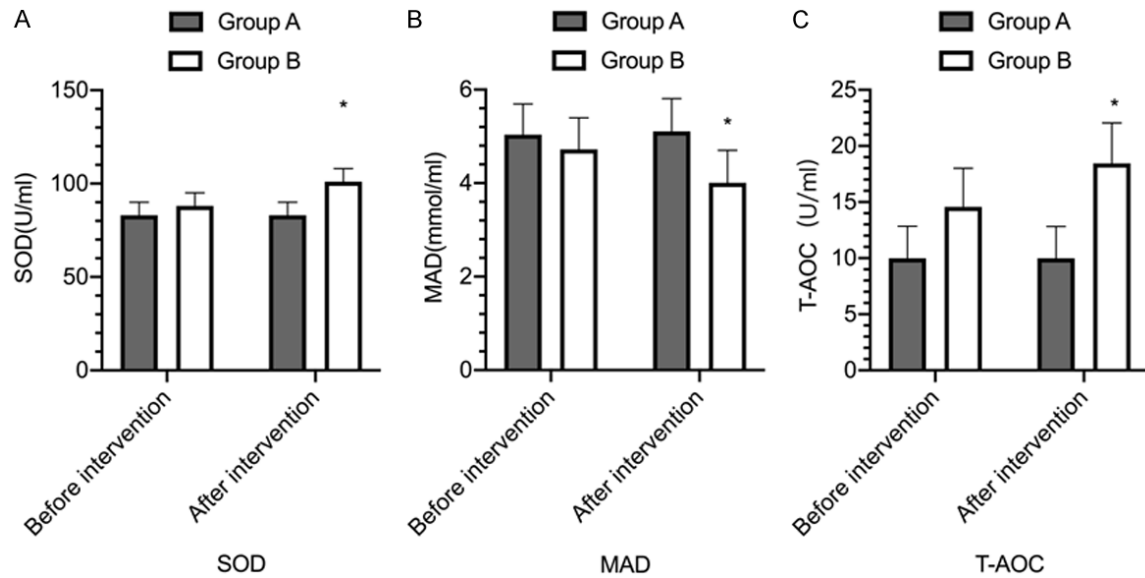


Figure 2. Comparison of cardiac antioxidant indices between the two groups. (A) shows that SOD between two groups had no significant difference ($P > 0.05$) before intervention, after intervention, SOD in group B was higher than that in group A ($P < 0.05$); (B) shows that MAD between two groups had no significant difference ($P > 0.05$) before intervention, after intervention, MAD in group B was lower than that in group A ($P < 0.05$); (C) shows that T-AOC between two groups had no significant difference ($P > 0.05$) before intervention, after intervention, T-AOC in group B was higher than that in group A ($P < 0.05$). * indicates $P < 0.05$ compared with group A.

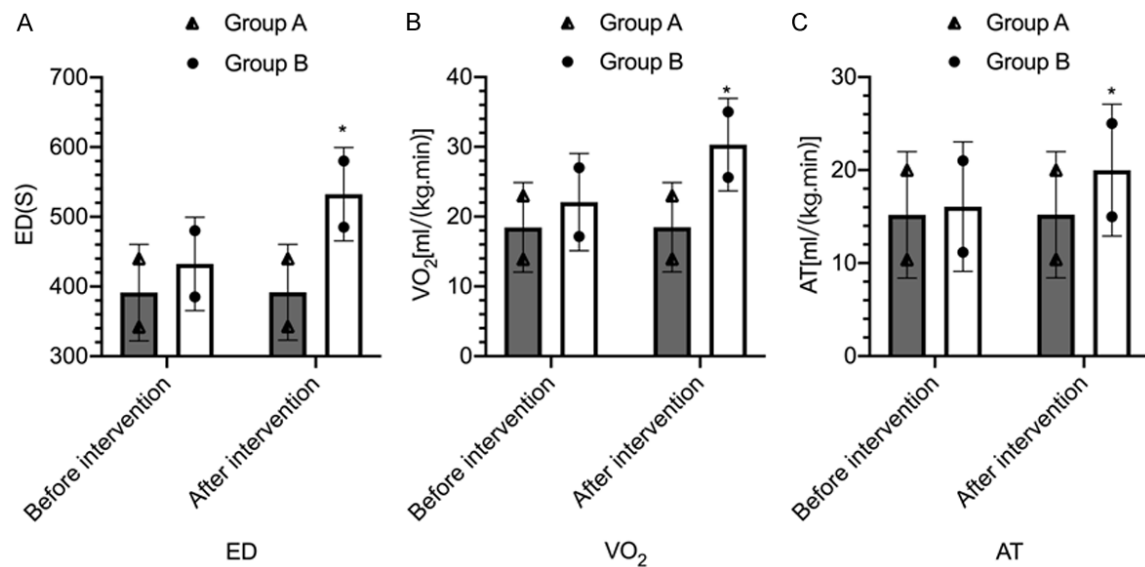


Figure 3. Comparison of exercise endurance between the two groups. (A) indicates that the two groups showed no significant difference in ED before intervention ($P > 0.05$), after intervention, group B had higher ED than group A ($P < 0.05$); (B) indicates that two groups showed no significant difference in VO₂ before intervention ($P > 0.05$), after intervention, group B had higher VO₂ than group A ($P < 0.05$); (C) indicates that the two groups showed no significant difference in AT before intervention ($P > 0.05$), after intervention, group B had higher AT than group A ($P < 0.05$). * indicates $P < 0.05$ compared with group A.

that early home-based CR exercise after PCI can provide patients with multi-faceted care with low expenses that most families can af-

ford, and patients can still receive continuous guidance and care after discharge. In addition, CR exercise has relatively little impact on pa-

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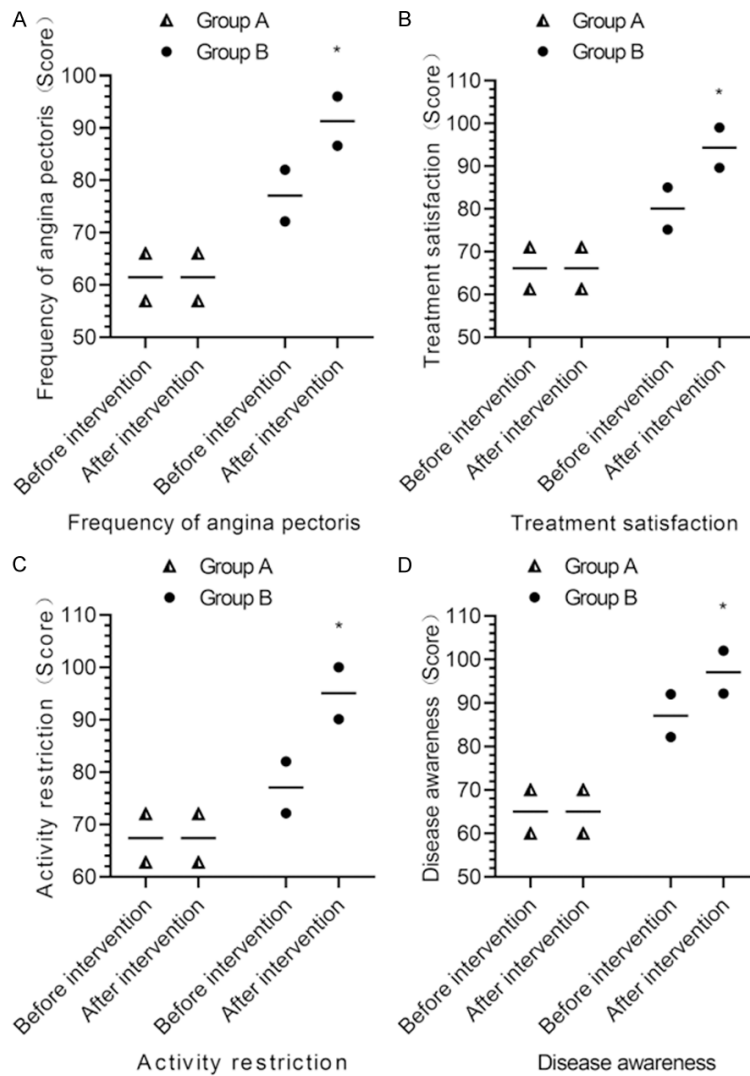


Figure 4. Comparison of quality of life between the two groups. (A) indicates that before intervention, the angina frequency score showed no significant difference between the two groups ($P>0.05$), and group B had higher score of angina frequency than group A after intervention ($P<0.05$); (B) indicates that before intervention, the score of treatment satisfaction showed no significant difference between the two groups ($P>0.05$), and group B had higher score of treatment satisfaction than group A after intervention ($P<0.05$); (C) indicates that before intervention, the score of physical limitation showed no significant difference between the two groups ($P>0.05$), and group B had higher score of physical limitation than group A after intervention ($P<0.05$); (D) indicates that before intervention, the score of disease perception showed no significant difference between the two groups ($P>0.05$), and group B had higher score of disease perception than group A after intervention ($P<0.05$). * indicates $P<0.05$ compared with group A.

patient's daily life. After PCI, cardiac exercise in patients with AMI can significantly reduce various cardiovascular risk factors and protect cardiac function, thus improving cardiac function and increasing cardiac antioxidant capacity and exercise endurance [24]. Postoperative CR

exercise is beneficial to improve myocardial blood supply and myocardial function, enhance left atrial contractility, alleviate left ventricular remodeling, open coronary collateral circulation, strengthen cardiomyocyte vitality, improve glucose absorption as well as utilization of cardiomyocytes and thus helps avoid cardiomyocyte injury [25]. Moreover, multiple cooperative ways of cardiac rehabilitation can induce epinephrine secretion, increase lipase activity, accelerate fat decomposition, reduce the content of free fatty acids and avoid massive blood lipid decomposition in blood vessel walls. Aerobic exercise is the main exercise mode of CR. It helps promote coronary artery recovery, inhibit platelet smooth muscle spasms, and eliminate oxygen free radical production, thus increasing SOD activity, preventing cell hypoxia and eventually improving the CR effect [26].

To conclude, early home-based CR exercise patients with AMI after PCI is beneficial to improve cardiac function, reduce the incidence of post-operative complications and increase cardiac antioxidant capacity, exercise ability and quality of life.

Despite some achievements, this study also has the limitation of a small sample size, which needs to be further expanded for more in-depth research and analysis in the future.

Disclosure of conflict of interest

None.

Address correspondence to: Huaqin Yu, Department of Cardiovascular Medicine, The First Peo-

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ple's Hospital of Fuyang Hangzhou, Hangzhou 311400, Zhejiang Province, China. Tel: +86-186-58157683; E-mail: 591686283@qq.com

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