



Observation of the effect of a 7-day gradual early functional exercise program in middle-aged and young patients with acute myocardial infarction after percutaneous coronary intervention

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Background: Acute myocardial infarction (AMI) is characterized by a critical condition, rapid progression, and a high fatality rate. Percutaneous coronary intervention (PCI) is the treatment of choice for AMI. The purpose of this study was to investigate the efficacy of a 7-day gradual early functional exercise program after PCI in young and middle-aged patients with AMI.

Methods: A total of 106 young and middle-aged patients with AMI at the Affiliated Hospital of Jiangnan University from May 2018 to May 2019 were selected and divided into 2 groups according to the random number table method (n=53 per group). Both groups were treated with PCI, and the control group then received routine functional exercises after surgery, whilst the observation group received a 7-day gradual early functional exercise program after surgery. Functional exercise compliance, daily life ability before and after intervention, changes in quality of life, and postoperative complications after 1 year were compared between the 2 groups.

Results: The functional exercise compliance of the observation group was significantly higher than that of the control group (P<0.05). The daily living ability of the observation group was also significantly better than that of the control group after the intervention (P<0.05). The physical activity, emotional response, diet, adverse drug reactions, and anxiety medication scores of the observation group after the intervention were lower than those of the control group (P<0.05). Furthermore, the postoperative complications and total complication rate after 1 year in the observation group was lower than the control group (P<0.05).

Conclusions: The application of a 7-day gradual early functional exercise program in young and middle-aged patients with AMI after PCI can improve functional exercise compliance, daily life ability, quality of life, and reduce the incidence of complications.

Keywords: 7-day gradual early functional exercise; young and middle-aged; acute myocardial infarction (AMI); percutaneous coronary intervention (PCI); compliance; quality of life; complications

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Introduction

Acute myocardial infarction (AMI) is a serious consequence of coronary heart disease, and is characterized by critical illness, rapid progression, and high mortality (1). In recent

years, the incidence of AMI among younger people is increasing. Studies have shown that the proportion of young and middle-aged patients with AMI is 3–6% (2). Percutaneous coronary intervention (PCI) is a treatment

method in which transcatheter catheter technology is inserted into narrowed or occluded coronary artery lumen to improve myocardial blood perfusion. PCI is currently the first choice for the clinical treatment of AMI (3,4). The young and middle-aged are the economic pillars of the family unit, and are the backbone of society. Therefore, the treatment of such patients cannot aim at just prolonging life, but to restore heart function as much as possible to reduce loss to the family and society (5). Early progressive exercises, initiated by supervised inpatient training and followed by an unsupervised outpatient program, improved HRQL and functional capacity in patients at low cardiovascular risk who recently experienced an acute myocardial infarction (6). Exercise can improve several cardiovascular and non-cardiovascular parameters, such as glucose metabolism, skeletal muscle function, oxidative stress, vascular function, pulmonary circulation, ischemia-reperfusion lesion, and ventricular remodelling. Rehabilitation exercise is effective in improving functional capacity and quality of life in patients with AMI (7). Young and middle-aged patients after PCI are prone to irritability during rehabilitation exercises due to their eagerness for success, and their compliance is generally poor. Hence, effective intervention measures are needed to improve the effect of their postoperative rehabilitation exercises (8). Therefore, this study analyzed the influence of a 7-day gradual early functional exercise program on daily life ability, quality of life, and postoperative complications at 1 year follow-up in young and middle-aged patients with AMI after PCI, aiming to provide a reference for the clinical development of intervention measures after PCI. We present the following article in accordance with the CONSORT reporting checklist (available at <http://dx.doi.org/10.21037/apm-20-2243>).

Methods

Patient selection

A total of 106 young and middle-aged patients with AMI who underwent surgical treatment at the Affiliated Hospital of Jiangnan University from May 2018 to May 2019 were enrolled in this study. Subjects were divided into an observation group (53 cases) and a control group (53 cases) using the random number table method. Patients who met the following criteria were included in the study: (I) patients met the diagnostic criteria for AMI; (II) patients underwent PCI; (III) aged 18 to 59 years old; (IV) had clear

consciousness; (V) had certain language communication ability. Patients were excluded if they met any of the following criteria: (I) cardiac function Killip class III–IV; (II) comorbidities including serious liver, kidney, lung and other visceral functional diseases, serious cerebrovascular disease, blood system diseases, malignant tumor, or mental disorders; (III) dysfunction in audiovisual integration; (IV) failure to cooperate with postoperative follow-up or midway withdrawal. The study was approved by the Ethics Committee of the Affiliated Hospital of Jiangnan University {Ethics approval number: [(2018) KY043]} and conducted in accordance with the Declaration of Helsinki (as revised in 2013). All subjects provided informed consent.

Interventions

The control group received regular rehabilitation exercises, while the observation group received a 7-day gradual early functional exercise program. The training was performed at the bedside, and the patients were guided by the trained Specialist nurse. The specific plans and processes are shown in *Table 1*. The program of functional exercise in the observation group was devised by the director of the department, attending physician, provincial and municipal nurses, and nursing supervisors through consultation. The safety of the rehabilitation exercises for middle-aged and young patients with AMI was analyzed by consulting the literature. The time, method, and content of early functional exercises were also clarified, and a specific plan for functional exercises was finally devised.

Evaluation indexes

Functional exercise compliance

Complete compliance was defined as exercising on time and according to the doctor's instructions, partial compliance was defined as basically following the doctor's instructions to exercise, but occasionally forgetting to exercise or reduce the intensity of exercise, and non-compliance was defined as not following the doctor's instructions to exercise. In the process of exercise, the instructor scored on the spot. Compliance = complete compliance + partial compliance (9).

Daily life ability

The functional independence Rating Scale was used to evaluate daily life ability in the 2 groups before and after the intervention. The scale included 6 dimensions of self-

Table 1 Comparison of the intervention programs in the observation group and the control group

Time (after surgery)	Control group	Observation group	Special attention
1d	Maintain absolute bed rest and perform passive exercise of surgical limbs	Active flexion and extension of limbs on the bed and ankle pump movements of lower limbs on the side of femoral artery; performed 3 times each, 3 min/time	Keep the patient's lower limbs immobilized on the surgical side for 12 hours; assist in the daily activities of the radial artery puncture; prohibit extension and flexion of the surgical upper limb
2d	Keep bed rest and implement active limb exercises	Implement training of leg droop, limb joint flexion and rotation bedside, and bedside toilet seat training, 2 times for each item, 15–30 min/time	Assist patients to complete some activities of daily living; instruct them to eat
3d	Perform daily activities in bed, including defecation, eating, washing, etc.	Use a wheelchair for 15–20 minutes; walking exercises accompanied by family members or intervention personnel, 50 m/time, 1 time	Assist patients to complete some activities of daily living; for those who still need ECG monitoring, they need to be evaluated by the nurse in charge before performing functional exercises, and complete the exercises after confirming safety
4d	Implement bedside meditation exercises	Implement walking exercise, 50 m/time, 2 times	Assist patients to complete some activities of daily living; teach patients self-detection methods for pulse
5d	Implement active exercise of limbs and joints at the bedside	Implement medium-speed walking exercises, 100 m/time, 2 times; walk down 3–5 stairs with the accompaniment of family members and intervention personnel; then walk in the corridor with the accompaniment of family members or intervention personnel	Intervention staff must accompany the whole process and provide assistance when necessary
6d	Switch from the bedside to the chairside with the assistance of family members	Implement medium-speed walking exercise, 150 m, a total of 2 times; complete the next staircase, and then take the elevator to return; let the patient bathe under the care of the family member, with the time controlled within 5–10 min	Pay attention to promoting the patient's self-care; for femoral artery puncture, ask them to cling to the handrails of the stairs when walking down the stairs. When walking, the limb on the side that is not punctured will go down first, and the other side will go down and stay at the same level of the limb on the puncture side
7d	Perform bedside standing, bedside walking, and indoor walking exercises with the assistance of family members	Implement medium-speed walking exercise, 150 m, 2 times; try to go up a flight of stairs; let the patient bathe by themselves, with the time controlled within 5–10 min	For femoral artery puncture, the limb on the side that is not punctured when going up the stairs goes up first, and the other side goes up and stays at the same level as the limb on the puncture side; inform the patient about the precautions related to bathing and make them aware of the way to call for help

care activity, social cognition ability, sphincter control, communication ability, transfer ability, and walking status. There were 18 items in total, with each item scoring 1–7 points, and the total score was 18–126 points. Complete independence was defined as 126 points, basic independence was defined as 108–125 points, conditional independence or extremely light dependence was defined as 90–107 points, mildly dependent was defined as 72–89 points,

moderately dependent was defined as 54–71 points, severely dependent was defined as 36–53 points, extremely dependent was defined as 19–35 points, and completely dependent was defined as 18 points (10).

Quality of life

The Myocardial Infarction Dimensional Assessment Scale (MIDAS) was used to evaluate the quality of life of the 2

groups before and after the intervention. The scale included 7 dimensions of physical activity, emotional response, security, dependence, diet, adverse drug reactions, and anxiety medication. There were 35 items in total, with each item scoring 1–5 points. The lower the score, the better the quality of life (11).

Complications

The 2 groups were followed up for 1 year after surgery, and the incidence of complications such as angina, arrhythmia, and coronary artery restenosis were statistically analyzed, and the total incidence of complications was finally calculated.

Statistical analyses

The statistical analysis in this study was performed using SPSS22.0 (SPSS Inc., Chicago, IL, USA). Measurement data were expressed as mean \pm standard deviation and compared using two-tailed *t*-tests. Count data were reported as rates and percentages, and compared using the χ^2 test or rank-sum test. $P < 0.05$ was considered statistically significant in this study.

Results

Baseline characteristics of patients

The control group included 33 males and 20 females. Their ages ranged from 20 to 58 years old, and the average age was 45.62 ± 6.39 years. The observation group included 34 males and 19 females. Their ages ranged from 21 to 59 years old, and the average age was 45.36 ± 6.51 years. There were no significant differences in baseline data between the 2 groups ($P > 0.05$).

Comparison of functional exercise compliance

The functional exercise compliance of the observation group was significantly higher than that of the control group ($\chi^2 = 10.600$, $P = 0.001$), as shown in *Table 2*.

Daily life ability

Before intervention, there was no statistically significant difference in daily life ability between the observation group and the control group ($Z = 0.299$, $P = 0.861$). After 1 week of intervention, the daily life ability of patients in the observation

group was significantly better than that of the control group ($Z = 6.879$, $P = 0.032$), as shown in *Table 3*.

Quality of life

Before intervention, there were no statistically significant differences between the observation group and the control group in the scores for physical activity, emotional response, security, dependence, diet, adverse drug reactions, and anxiety medication ($t = 0.363$, 0.075 , 0.253 , 0.200 , 0.830 , 0.335 , 0.158 , respectively; $P = 0.717$, 0.940 , 0.801 , 0.842 , 0.408 , 0.739 , 0.875 , respectively). After 1 week of intervention, the scores for physical activity, emotional response, diet, adverse drug reactions, and anxiety medication in the observation group were all significantly lower than those of the control group ($t = 16.359$, 11.858 , 10.517 , 23.162 , 23.050 , respectively; $P = 0.000$, 0.000 , 0.000 , 0.000 , 0.000 , respectively), as shown in *Table 4*.

Complications

In the control group, 10 cases of angina, 7 cases of arrhythmia, and 7 cases of coronary artery restenosis occurred 1 year after surgery, with a total complication rate of 45.28%. Contrastingly, in the observation group, 4 cases of angina, 1 case of arrhythmia, and no coronary artery restenosis occurred, with a total complication rate of 9.43%. These postoperative complications 1 year after surgery and the total complication rate of the observation group were lower than the control group ($\chi^2 = 2.963$, 3.380 , 5.506 , 17.137 , respectively; $P = 0.085$, 0.066 , 0.019 , 0.000 , respectively), as shown in *Table 5*.

Discussion

In recent years, partly due to the increases in poor lifestyle choices such as lack of exercise, smoking, drinking, poor eating habits, and excessive social interaction, there has been a significant increase in the level of catecholamines in the young and middle-aged population, which in turn stimulates the coronary arteries and induces narrowed coronary arteries spasms. As a result, the incidence of AMI is increasing year by year (12,13). Although PCI can significantly improve the survival rate of young and middle-aged patients with AMI, postoperative functional recovery is not optimal. Hence, effective postoperative rehabilitation exercise guidance should be given to such patients (14). A 7-day gradual early functional exercise program is an early

Table 2 Comparison of functional exercise compliance between the 2 groups (n, %)

Group	Complete compliance	Partial compliance	Non-compliance	Compliance
Control group (n=53)	25 (47.17)	14 (26.42)	14 (26.42)	39 (73.58)
Observation group (n=53)	38 (71.70)	13 (24.53)	2 (3.77)	51 (96.23)
χ^2 value			10.600	
P value			0.001	

Table 3 Comparison of activities of daily living between the 2 groups before and after intervention (n, %)

Time	Group	Complete independence	Basic independence	Conditional independence or extremely light dependence
Before intervention	Control group (n=53)	7 (13.21)	30 (56.60)	16 (30.19)
	Observation group (n=53)	9 (16.98)	29 (54.72)	15 (28.30)
	Z value			0.299
	P value			0.861
After intervention	Control group (n=53)	13 (24.53)	27 (50.94)	13 (24.53)
	Observation group (n=53)	25 (47.17)	22 (41.51)	6 (11.32)
	Z value			6.879
	P value			0.032

Table 4 Comparison of quality of life between the 2 groups before and after intervention ($\bar{x}\pm$ SD, points)

Time	Group	Physical activity	Emotional response	Security	Dependence	Diet	Adverse drug reactions	Anxiety medication
Before intervention	Control group (n=53)	35.28 \pm 4.15	18.01 \pm 1.25	20.18 \pm 3.82	12.02 \pm 1.05	13.11 \pm 0.95	9.01 \pm 0.64	9.11 \pm 0.68
	Observation group (n=53)	34.97 \pm 4.62	17.99 \pm 1.47	20.37 \pm 3.91	12.06 \pm 1.01	13.26 \pm 0.91	9.05 \pm 0.59	9.09 \pm 0.62
	t value	0.363	0.075	0.253	0.200	0.830	0.335	0.158
	P value	0.717	0.940	0.801	0.842	0.408	0.739	0.875
After intervention	Control group (n=53)	24.71 \pm 2.01	15.02 \pm 1.33	13.41 \pm 1.05	9.96 \pm 0.84	12.51 \pm 1.60	8.51 \pm 0.52	8.26 \pm 0.45
	Observation group (n=53)	19.18 \pm 1.42	12.27 \pm 1.04	13.22 \pm 0.98	9.88 \pm 0.75	9.41 \pm 1.43	6.28 \pm 0.47	6.01 \pm 0.55
	t value	16.359	11.858	0.963	0.517	10.517	23.162	23.050
	P value	0.000	0.000	0.338	0.606	0.000	0.000	0.000

SD, standard deviation.

Table 5 Comparison of the incidence of complications between the 2 groups (n, %)

Group	Angina	Arrhythmia	Coronary artery restenosis	Total complications
Control group (n=53)	10 (18.87)	7 (13.21)	7 (13.21)	24 (45.28)
Observation group (n=53)	4 (7.55)	1 (1.89)	0 (0.00)	5 (9.43)
χ^2 value	2.963	3.380	5.506	17.137
P value	0.085	0.066	0.019	0.000

cardiac exercise measure for young and middle-aged patients with AMI. It follows the principle of gradual and orderly progress to help patients quickly restore cardiac function, so that they can return to society as soon as possible, and take care of their family and societal responsibilities (15,16).

The present findings demonstrated that young and middle-aged patients with AMI in the observation group had significantly higher functional exercise compliance than the control group. This result suggests that the 7-day gradual early functional exercise program can significantly improve patient exercise compliance. There are many factors affecting functional exercise compliance, mainly including complicated rehabilitation exercise content, long rehabilitation exercise cycle, low awareness of rehabilitation exercises, and lack of effective supervision and encouragement (17). The 7-day gradual early functional exercise program is targeted towards the characteristics of the young and middle-aged population. Functional exercise after PCI is divided into days, and the corresponding exercise tasks are completed every day, so that the daily exercise content is clear and easy for patients to master. In addition, the 7-day gradual early functional exercise program clearly corresponds to the postoperative period and the content of the rehabilitation exercise, and provides patients with scientific exercise guidelines, so that patients can complete the rehabilitation exercise with the assistance of the intervention staff, whilst also improving compliance (18).

This study found that the daily living ability of the observation group was better than that of the control group after the intervention. The physical activity, emotional response, diet, adverse drug reactions, and anxiety medication scores of the observation group after the intervention were significantly lower than those of the control group. The results showed that the 7-day gradual early functional exercise program could effectively improve daily life ability and quality of life. The 7-day gradual early functional exercise program is based on the patient's postoperative body recovery, and scientific and

gradual early postoperative functional exercise measures are formulated specifically for them. The exercises are devised in line with the recovery progress of the patient's normal cardiac physiological load after surgery, and can promote the patient's coronary blood flow perfusion, establishing collateral circulation as soon as possible (19,20). The 7-day gradual early functional exercise program can also improve the enthusiasm of the patients' daily life self-care ability, help patients build confidence in overcoming their disease, relieve the psychological burden caused by the disease, and form a good subjective awareness of rehabilitation exercises. In terms of vascular remodeling, the program may also play a positive role in coronary atherosclerotic processes, thereby contributing to improvements in daily life ability and quality of life (21,22).

The results of this study also showed that after 1 year the postoperative complications and the total complication rate of the observation group was significantly lower than the control group. Rehabilitation exercises will not cause complications due to increased physical activity, and instead they prevent the multiple complications that can be caused by prolonged bed rest. The 7-day gradual early functional exercise program is based on the characteristics of sports metabolism in the young and middle-aged population, and includes specially devised scientific rehabilitation exercises to improve the body's anti-thrombotic ability, accelerate vascular remodeling, and reduce the incidence of postoperative angina, arrhythmia, and other complications (23,24).

Conclusions

In summary, the application of a 7-day gradual early functional exercise program in young and middle-aged patients with AMI after PCI can improve functional exercise compliance, daily life ability, quality of life, and reduce the incidence of complications. While previous studies on this field are limited, and the sample size of this study is not enough. In the next study, we will increase the sample size

and supplement research indicators to conduct more in-depth research on this.

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Footnote

Reporting Checklist: The authors have completed the CONSORT reporting checklist. Available at <http://dx.doi.org/10.21037/apm-20-2243>

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/apm-20-2243>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was approved by the Ethics Committee of the Affiliated Hospital of Jiangnan University [Ethics approval number: [(2018) KY043]] and conducted in accordance with the Declaration of Helsinki (as revised in 2013). All subjects provided informed consent.

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