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Walking Exercise in Phase II Cardiac Rehabilitation After PCI: A Case Report

Fitri Aulia Naufal[1], Farid Rahman[2], Ridwan Andi Susilo[3]

[1]Professional Physiotherapy Program, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Central Java, Indonesia
[2]Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Central Java, Indonesia
[3]Cardiac Rehabilitation Unit, Dr. Moewardi Regional General Hospital, Surakarta, Central Java, Indonesia

Corresponding author:
Name: Farid Rahman
E-mail: fr280@ums.ac.id

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Abstract

Background: Coronary artery disease (CAD) remains a leading cause of global morbidity and mortality. Despite successful revascularization with percutaneous coronary intervention (PCI), many patients experience reduced functional capacity, underscoring the importance of structured cardiac rehabilitation.
Objective: To describe the implementation of walking exercise in phase II cardiac rehabilitation and its effects on functional capacity in a patient following PCI.
Methods: This case report involved a 61-year-old woman diagnosed with CAD two-vessel disease after PCI. The patient participated in a phase II cardiac rehabilitation program consisting of supervised walking exercise performed 3–5 times per week for 30–60 minutes at moderate intensity (40–60% heart rate reserve or rating of perceived exertion 11–13), combined with a home-based program. Outcome measures included vital signs, the 6-Minute Walking Test (6MWT), estimated maximal oxygen uptake (VO_2max), and metabolic equivalents (METs).
Results: After six supervised rehabilitation sessions, the 6MWT distance increased from 396 m to 510 m. Estimated VO_2max improved from 22.4 to 27.3 $mL \cdot kg^{-1} \cdot min^{-1}$, and METs increased from 6.4 to 7.8. No adverse events or cardiovascular complications were observed during the intervention period.
Conclusion: Walking exercise as part of phase II cardiac rehabilitation was safe and associated with clinically meaningful improvements in aerobic capacity and functional tolerance in a patient after PCI.

Keywords
Walking; Cardiac Rehabilitation; Coronary Artery Disease; Percutaneous Coronary Intervention; Aerobic Capacity.

Introduction

Coronary artery disease (CAD) remains one of the most prevalent cardiovascular disorders worldwide and continues to be a leading cause of morbidity and mortality.[1] The global burden of CAD has increased substantially over recent decades, reflecting population aging, persistent cardiovascular risk factors, and lifestyle transitions.[1] In low- and middle-income countries, including Indonesia, CAD represents a major public health challenge due to its growing prevalence and associated healthcare costs.[2,3]

Pathophysiologically, CAD is characterized by progressive atherosclerotic narrowing and obstruction of the coronary arteries, resulting in impaired myocardial perfusion and ischemia.[4] The development and progression of CAD are strongly influenced by modifiable risk factors such as physical inactivity, unhealthy dietary patterns, smoking, and metabolic disorders, as well as non-modifiable factors including age and sex.[3] Even after optimal medical management and coronary revascularization, many patients experience persistent reductions in aerobic capacity and functional performance.

Percutaneous coronary intervention (PCI) is a widely performed, minimally invasive revascularization procedure that effectively restores coronary blood flow and alleviates ischemic symptoms.[5] Although PCI improves short-term clinical outcomes, it does not fully address the underlying functional limitations and deconditioning that often follow acute coronary events. Consequently, patients frequently present with reduced exercise tolerance, impaired cardiopulmonary fitness, and decreased independence in daily activities after hospital discharge.[6]

Cardiac rehabilitation is a comprehensive, multidisciplinary intervention designed to address these limitations and reduce the risk of recurrent cardiovascular events. Phase II cardiac rehabilitation, which is initiated after the acute recovery phase, plays a crucial role in improving aerobic capacity, functional independence, and quality of life.[6] Supervised exercise training constitutes the core component of this phase and has been consistently shown to enhance cardiovascular efficiency, reduce symptoms, and improve long-term prognosis in patients with CAD.[7]

Aerobic exercise is the cornerstone of exercise-based cardiac rehabilitation. According to international guidelines, aerobic training should be prescribed at moderate to vigorous intensity and performed regularly to elicit meaningful physiological adaptations.10 Walking exercise represents one of the most practical and widely recommended aerobic modalities, particularly for older adults and individuals recovering from coronary interventions. Walking is low cost, easy to implement, and associated with a low risk of adverse events when appropriately supervised, making it suitable for phase II cardiac rehabilitation programs.[8,9]

Previous studies have demonstrated that structured walking-based exercise programs can significantly improve functional capacity, as measured by parameters such as the 6-Minute Walking Test (6MWT), maximal oxygen uptake (VO_2max), and metabolic equivalents (METs).[9,10] Improvements in these outcomes reflect enhanced cardiopulmonary efficiency, increased peripheral oxygen utilization, and improved tolerance to physical activity. These adaptations are clinically relevant, as they are associated with improved independence, reduced symptom burden, and better overall prognosis in patients with CAD.[11]

Despite the growing body of evidence supporting the benefits of walking exercise in cardiac rehabilitation, most available data originate from randomized controlled trials or group-based interventions conducted in controlled research settings.[7,12] In contrast, detailed case reports describing the real-world implementation of walking exercise within phase II cardiac rehabilitation programs, particularly in Indonesian clinical settings, remain limited. Such reports are valuable for illustrating practical considerations, safety monitoring, patient adherence, and functional outcomes in routine clinical practice.

Therefore, this case report aims to describe the implementation of a structured walking exercise program as part of phase II cardiac rehabilitation and to document changes in functional capacity in a 61-year-old woman with CAD two-vessel disease following PCI. By presenting objective functional outcomes and clinical observations, this report seeks to contribute practical evidence supporting walking exercise as a feasible and effective component of post-PCI cardiac rehabilitation.

Methods

Study Design

This study was conducted as a clinical case report describing the implementation of phase II cardiac rehabilitation in a patient with coronary artery disease (CAD) following percutaneous coronary intervention (PCI). The case report design was selected to provide an in-depth description of physiotherapy management, exercise prescription, and functional outcomes in a real-world clinical setting, in accordance with the CARE (CAse REport) guidelines.

Ethical Approval

The study protocol was reviewed and approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (Ethical Approval No. 1662/KEPK-FIK/XI/2025). Written informed consent was obtained from the patient prior to data collection and publication. All clinical data were anonymized to ensure confidentiality and compliance with ethical research principles.

Patient Information

The patient was a 61-year-old woman (initials: S), working as a homemaker and small restaurant owner, with a confirmed medical diagnosis of CAD two-vessel disease following PCI. The patient was referred to the cardiac rehabilitation outpatient clinic at Dr. Moewardi Regional General Hospital, Surakarta, for participation in a phase II cardiac rehabilitation program.

Clinical History and Findings

At the initial physiotherapy assessment, the patient reported no current chest pain, dyspnea, or diaphoresis. She had experienced an acute myocardial infarction four months prior to enrollment, characterized by dizziness, shortness of breath, and cold sweats during nighttime activity, which required hospitalization for three days and subsequent PCI. Her past medical history included hypertension, ischemic stroke, and type 2 diabetes mellitus. The patient was on standard pharmacological therapy, including antiplatelet agents, beta-blockers, angiotensin-converting enzyme inhibitors, and statins, as prescribed by the cardiologist.

Physical examination revealed the patient to be fully conscious, cooperative, and hemodynamically stable. Vital signs at baseline were within acceptable limits for participation in supervised exercise training. Static and dynamic posture assessment demonstrated normal alignment and gait pattern. Palpation revealed warm extremities without chest wall tenderness or abnormal sweating.

Outcome Measures

Functional capacity and physiological responses were evaluated using objective and standardized measures. The primary outcome measure was the 6-Minute Walking Test (6MWT), which is a valid and reliable tool for assessing submaximal functional capacity in patients with cardiovascular disease.[10] Estimated maximal oxygen uptake (VO_2max) and metabolic equivalents (METs) were calculated using established prediction equations derived from 6MWT performance.[9,10] Additional assessments included resting and post-exercise vital signs (blood pressure, heart rate, respiratory rate, and oxygen saturation) and echocardiographic parameters, including left ventricular ejection fraction (LVEF) and tricuspid annular plane systolic excursion (TAPSE), to ensure cardiac safety and monitor physiological adaptation.[13,12]

Intervention Protocol

The patient participated in a supervised phase II cardiac rehabilitation program consisting primarily of aerobic exercise in the form of structured walking training. Exercise prescription followed the FITT principle (Frequency, Intensity, Time, and Type) and was individualized based on baseline functional capacity, hemodynamic responses, and perceived exertion.[8]

Walking exercise was prescribed at a moderate intensity, corresponding to 40–60% heart rate reserve (HRR) or a rating of perceived exertion (RPE) of 11–13 on the Borg scale.[8] The patient performed walking sessions 3–5 times per week, with each session lasting 30–60 minutes. Walking distance was progressively increased from 1200 m to 1800 m based on tolerance, symptom response, and stability of vital signs.

Each supervised session began with a 10-minute warm-up period consisting of low-intensity walking and gentle mobility exercises to gradually increase heart rate and blood pressure and reduce the risk of musculoskeletal injury.[12] During the main exercise phase, continuous monitoring of heart rhythm and vital signs was performed using a portable cardiac monitor to ensure patient safety.

Exercise intensity and duration were adjusted if abnormal symptoms or excessive physiological responses occurred. Following the walking exercise, a cool-down period was conducted to allow gradual recovery of cardiovascular parameters. At the end of each session, the physiotherapist reassessed vital signs and inquired about symptoms such as chest discomfort, shortness of breath, dizziness, or excessive fatigue.

Home-Based Exercise Program

In addition to supervised sessions, the patient was prescribed a home-based walking program to reinforce training adaptations and promote independence. The home program consisted of walking at moderate intensity (40–60% HRR or RPE 11–13) for approximately 30 minutes, five times per week. The patient received education regarding exercise safety, symptom monitoring, and activity pacing. Adherence to the home program was reviewed during follow-up visits.

Safety Monitoring

Throughout the intervention period, exercise safety was prioritized. The patient was categorized using a traffic light system to guide exercise supervision. During supervised sessions requiring continuous monitoring, the patient was considered within a highalert category, necessitating close observation. Upon demonstrating stable hemodynamic responses and absence of adverse symptoms, the patient progressed toward a lower-risk category, allowing increased independence under physiotherapist supervision.

Results

The patient completed six supervised phase II cardiac rehabilitation sessions without adverse cardiovascular events. All exercise sessions were conducted as planned, with an average duration of approximately 45 minutes per session. Hemodynamic parameters were monitored before and after each session to ensure safety throughout the intervention period.[8,12]

Clinical Timeline

The chronological course of the patient's clinical condition, rehabilitation phases, and functional assessments is summarized in Table 1**.**

Table 1. Clinical Timeline of Phase II Cardiac Rehabilitation

Time point	Clinical events and assessments
4 months before baseline	Acute myocardial infarction with dizziness, dyspnea, and cold sweats; hospitalized for three days and underwent percutaneous coronary intervention (PCI).
Post-PCI (inpatient)	Completion of phase I cardiac rehabilitation during hospitalization.
Baseline (start of Phase II)	Initial physiotherapy assessment; hemodynamically stable; 6MWT 396 m; estimated VO_2max 22.4 $mL \cdot kg^{-1} \cdot min^{-1}$; METs 6.4; no chest pain or dyspnea at rest.
Session 1	Initiation of supervised walking exercise at moderate intensity; vital signs monitored; no adverse symptoms reported.
Session 3	Continued supervised walking exercise with progressive distance; hemodynamic responses remained within the prescribed training zone.
Session 6 (end of observation)	Post-intervention assessment; 6MWT 510 m; estimated VO_2max 27.3 $mL \cdot kg^{-1} \cdot min^{-1}$; METs 7.8; no exercise-related adverse events observed.

Baseline Clinical Characteristics

At baseline, the patient was hemodynamically stable and eligible for supervised aerobic exercise. Anthropometric data, vital signs, echocardiographic findings, and functional capacity parameters are summarized in Table 1**.**

Table 1. Baseline Clinical and Functional Characteristics

Parameter	Value
Blood pressure	134/89 mmHg
Heart rate	97 $beats \cdot min^{-1}$
Respiratory rate	18 $breaths \cdot min^{-1}$
Oxygen saturation	97%
Height	152 cm
Body weight	46 kg
Body mass index	19.91 $kg \cdot m^{-2}$
Waist circumference	81 cm
Echocardiography	LVEF 57%; TAPSE 2.1 cm
6-Minute Walking Test	396 m
Estimated VO_2max	22.4 $mL \cdot kg^{-1} \cdot min^{-1}$
METs	6.4

Hemodynamic Responses During Rehabilitation

Across the six supervised sessions, post-exercise blood pressure demonstrated a gradual reduction, from 151/91 mmHg during the initial session to 133/84 mmHg at the final session. Heart rate responses remained within the prescribed training zone and returned toward baseline values during the recovery period. Oxygen saturation remained stable, ranging from 98% to 99%, while respiratory rate remained between 18 and 19 $breaths \cdot min^{-1}$ throughout the intervention. No symptoms of chest pain, dizziness, excessive fatigue, or dyspnea were reported during or after exercise sessions.

Table 2. Hemodynamic Parameters During the Rehabilitation Program

Parameter	Initial Session	Final Session
Post-exercise blood pressure	151/91 mmHg	133/84 mmHg
Post-exercise heart rate	Within target zone	Within target zone
Oxygen saturation	98%	99%
Respiratory rate	19 $breaths \cdot min^{-1}$	18 $breaths \cdot min^{-1}$

Functional Capacity Outcomes

Functional capacity outcomes were assessed at baseline and after completion of the sixth rehabilitation session. Changes in 6MWT distance, estimated VO_2max, and METs are presented in Table 3. The 6MWT distance increased from 396 m at baseline to 510 m at post-intervention assessment. Estimated VO_2max increased from 22.4 to 27.3 $mL \cdot kg^{-1} \cdot min^{-1}$. METs increased from 6.4 to 7.8.

Table 3. Changes in Functional Capacity Outcomes

Outcome measure	Baseline	Post-intervention
6-Minute Walking Test distance	396 m	510 m
Estimated VO_2max	22.4 $mL \cdot kg^{-1} \cdot min^{-1}$	27.3 $mL \cdot kg^{-1} \cdot min^{-1}$
METs	6.4	7.8

Exercise Adherence and Safety

The patient attended all scheduled supervised sessions and reported adherence to the prescribed home-based walking program. No exercise-related adverse events, including angina, arrhythmia, or abnormal hemodynamic responses, were observed during the rehabilitation period.

Discussion

This case report demonstrates that a structured walking exercise program implemented during phase II cardiac rehabilitation is associated with improvements in functional capacity and aerobic performance in a patient with coronary artery disease (CAD) following percutaneous coronary intervention (PCI). The observed changes in functional outcomes occurred without adverse cardiovascular events, supporting the feasibility and safety of walking-based aerobic exercise in this clinical context.

The increase in 6-Minute Walking Test (6MWT) distance observed in this case reflects an improvement in submaximal functional capacity, which is a clinically meaningful outcome in patients undergoing cardiac rehabilitation. The 6MWT is widely used to evaluate functional performance and exercise tolerance in cardiovascular populations, as it closely reflects activities of daily living. Improvements in walking distance following aerobic training have been consistently reported in patients with CAD after PCI, indicating enhanced cardiopulmonary efficiency and improved peripheral oxygen delivery.[10,14]

In addition to functional walking capacity, estimated maximal oxygen uptake (VO_2max) and metabolic equivalents (METs) increased following the rehabilitation program. VO_2max is a key indicator of aerobic fitness and cardiovascular health, reflecting the integrated function of the cardiovascular, respiratory, and muscular systems. An increase in VO_2max suggests improved stroke volume, enhanced oxygen extraction at the muscular level, and more efficient metabolic processes during exercise. Previous studies have reported similar improvements in VO_2max following phase II cardiac rehabilitation programs incorporating aerobic exercise in post-PCI patients, supporting the findings observed in this case.[11]

The improvement in METs further indicates enhanced functional capacity and energy utilization during physical activity. METs are commonly used in cardiac rehabilitation to quantify exercise intensity and functional performance, and increases in MET levels are associated with improved prognosis and reduced cardiovascular risk. Aerobic training has been shown to improve myocardial efficiency, peripheral circulation, and mitochondrial function, all of which contribute to improved MET performance in patients with CAD.[12]

Walking exercise represents a particularly suitable aerobic modality for phase II cardiac rehabilitation, especially in older adults and individuals with multiple comorbidities. Compared with more complex exercise modalities, walking is simple, accessible, and associated with a low risk of musculoskeletal or cardiovascular complications when appropriately prescribed and supervised. International guidelines emphasize walking as a recommended form of aerobic exercise in cardiac rehabilitation due to its adaptability to individual fitness levels and high patient adherence.[8]

Patient adherence is a critical determinant of successful cardiac rehabilitation outcomes. In this case, the patient demonstrated high adherence to both supervised sessions and the prescribed home-based walking program. Home-based exercise has been increasingly recognized as an effective adjunct to center-based cardiac rehabilitation, particularly in maintaining training adaptations and promoting long-term lifestyle changes. Previous studies have shown that home-based walking programs can significantly enhance functional capacity and quality of life in patients following PCI.[12,11]

The safety profile observed in this case is also noteworthy. Throughout the rehabilitation period, the patient remained hemodynamically stable, and no adverse symptoms such as angina, arrhythmia, or excessive fatigue were reported. Continuous monitoring during supervised sessions and structured progression of exercise intensity likely contributed to the absence of complications. These findings align with previous evidence indicating that appropriately supervised aerobic exercise during phase II cardiac rehabilitation is safe for post-PCI patients.[12]

Despite the positive outcomes observed, this case report has several limitations. First, the single-patient design inherently limits the generalizability of the findings. Second, the relatively short duration of follow-up, consisting of six supervised sessions, does not allow assessment of long-term adaptations or sustainability of functional improvements. Third, the absence of a control condition precludes comparison with other exercise modalities or standard care. Additionally, estimated VO_2max and METs were derived from prediction equations rather than direct cardiopulmonary exercise testing, which may limit measurement precision.

Nevertheless, this case report provides valuable practical insight into the real-world implementation of walking exercise within a phase II cardiac rehabilitation program in an Indonesian clinical setting. The use of objective functional measures, adherence to international exercise prescription guidelines, and systematic safety monitoring strengthen the clinical relevance of the findings.

Future research should include larger observational studies or randomized controlled trials with longer follow-up periods to confirm the effectiveness of walking-based cardiac rehabilitation and to compare its outcomes with alternative aerobic training modalities. Incorporating direct measures of cardiopulmonary fitness and patient-reported outcomes may further enhance the understanding of functional and quality-of-life benefits associated with walking exercise after PCI.

Conclusion

This case report demonstrates that the implementation of structured walking exercise as part of phase II cardiac rehabilitation was safe and associated with meaningful improvements in functional capacity and aerobic performance in a patient with coronary artery disease (CAD) following percutaneous coronary intervention (PCI). Improvements in objective functional parameters, including the 6-Minute Walking Test (6MWT), estimated maximal oxygen uptake (VO_2max), and metabolic equivalents (METs), indicate enhanced cardiopulmonary efficiency and improved tolerance to physical activity.

Walking exercise represents a practical and accessible aerobic training modality that can be effectively integrated into phase II cardiac rehabilitation programs. Its simplicity, low cost, and adaptability to individual fitness levels make walking particularly suitable for older adults and patients with multiple comorbidities. In this case, the structured progression of exercise intensity and distance, combined with close physiological monitoring, allowed the patient to participate safely in rehabilitation without adverse cardiovascular events.

Adherence to both supervised sessions and the prescribed home-based walking program appeared to play an important role in supporting functional improvements. The inclusion of a home-based component may facilitate continuity of physical activity beyond the clinical setting and promote long-term lifestyle modification, which is essential for secondary prevention in patients with CAD.

Although the findings of this case report cannot be generalized due to the single-patient design and limited follow-up duration, the results provide practical clinical insight into the real-world application of walking-based cardiac rehabilitation after PCI.

This report supports the use of walking exercise as a feasible and effective component of phase II cardiac rehabilitation programs. Future studies involving larger samples, longer follow-up periods, and comparative designs are needed to confirm these findings and to further evaluate the long-term clinical benefits of walking exercise in post-PCI populations.

Author Contribution

Fitri Aulia Naufal: Conceptualization; Methodology; Data curation; Formal analysis; Writing—original draft; Writing—review & editing.
Farid Rahman: Conceptualization; Formal analysis; Writing—review & editing; Supervision.
Ridwan Andi Susilo: Conceptualization; Methodology; Data curation; Supervision.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (Ethical Approval No. 1662/KEPK-FIK/XI/2025). Written informed consent was obtained from the patient prior to participation and publication of this case report.

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