O MUNDO DA SAÚDE

DOI: 10.15343/0104-7809.202448e16252024I

Cardiovascular rehabilitation after myocardial revascularization: a case report

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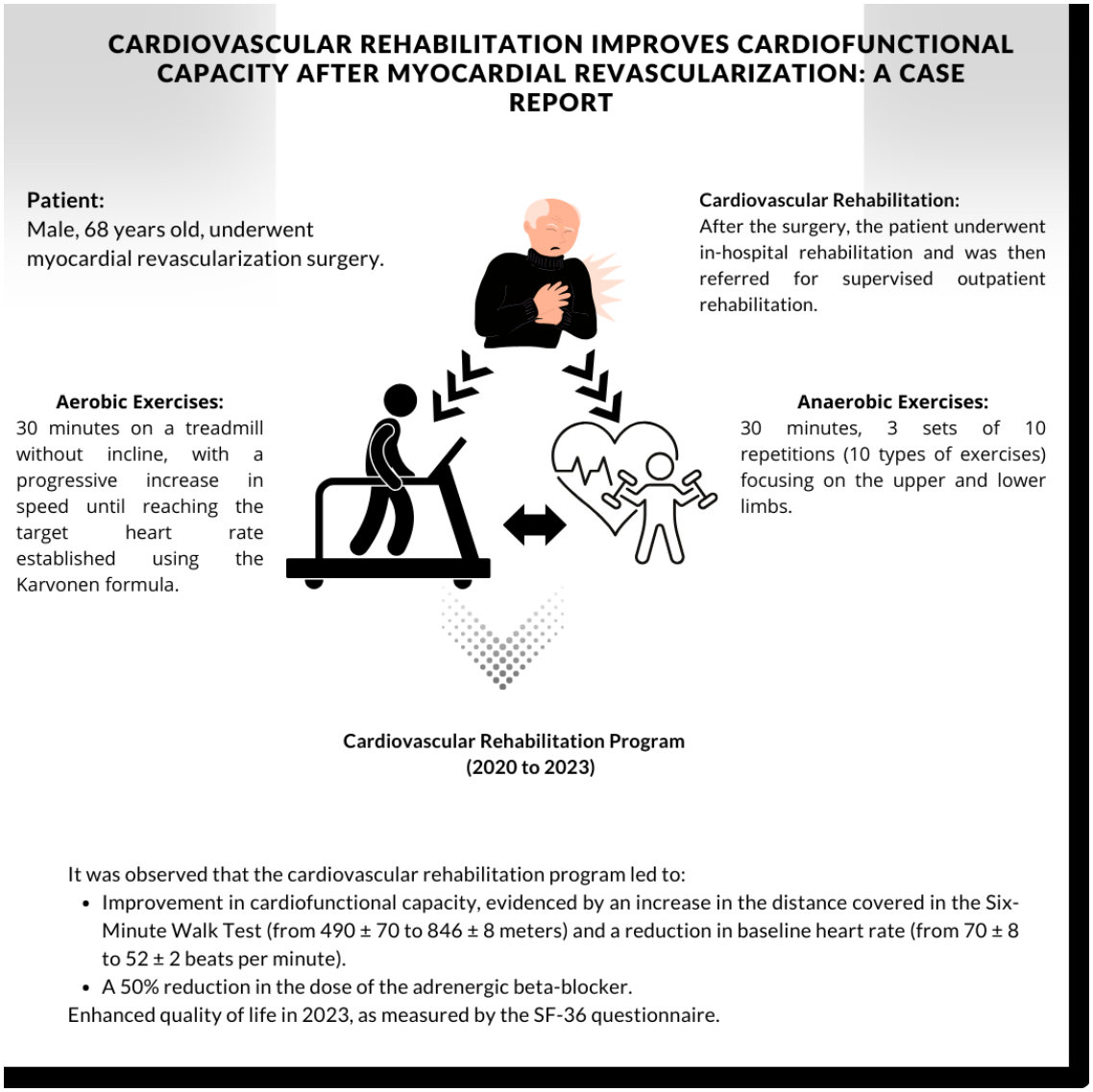
Graphic Abstract



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Abstract

Cardiovascular rehabilitation (CR) is an essential component of non-pharmacological treatment for heart disease patients, used to modify cardiovascular risk factors and improve exercise tolerance. This report presents the case of a patient with ischemic cardiomyopathy who underwent coronary artery bypass surgery and participated in a CR program, describing the changes in their physical performance and quality of life over three years of follow-up. A 68-year-old patient, following coronary artery bypass surgery and participation in CR, showed significant improvement in cardiorespiratory capacity. This was evidenced by an increase in the distance covered during the Six-Minute Walk Test (6MWT) (from 490 ± 70 to 846 ± 8 meters) and a reduction in the average resting heart rate (from 70 ± 8 to 52 ± 2 beats per minute), along with a decrease in the dose of beta-blockers. The analysis of 6MWT results and the SF-36 questionnaire revealed improvements in physical performance and good quality of life, respectively. The results highlight the importance of CR as an integral part of treatment for patients with ischemic heart disease, demonstrating a reduction in pharmacological load and an improvement in cardiorespiratory capacity.

Keywords: Physical Exercise. Myocardial Ischemia. Cardiovascular Rehabilitation.

INTRODUCTION

Among the various etiologies of cardiovascular diseases (CVDs), ischemic cardiomyopathy is defined as an imbalance between the supply and demand of oxygen to the heart muscle, the myocardium[1]. Like most chronic degenerative diseases, it is believed that there is an interplay of environmental and genetic factors that may contribute to the development or non-development of the disease[2].

CVDs are responsible for more than 17 million deaths annually[3,4]. Among them, ischemic heart disease (IHD) is the leading cause of morbidity and mortality in developed countries[5]. In Brazil, it is estimated that 14 million people have some form of CVD, and at least 400,000 people die annually from cardiovascular problems, representing 30% of the country's deaths. According to the Brazilian Society of Cardiology, as of 2022, deaths from CVDs had already surpassed 269,000, with a predominance in men, the elderly, and individuals with low educational levels[6].

The treatment of heart disease patients includes adherence to both pharmacological and non-pharmacological treatments and, when necessary, cardiac surgery, aiming to reduce comorbidities imposed by the disease and achieve significant lifestyle changes for patients[7]. Pharmacological treatment is classified according to its mechanism of action, with beta-adrenergic receptor blockers being the most recommended for the treatment of patients with IHD[7]. The distinction between them lies in their liposolubility, receptor selectivity, and vasodilatory action of each drug[7,8].

On the other hand, cardiovascular rehabilitation (CR) is part of the non-pharmacological treatment for heart disease patients and is considered a method used to modify cardiovascular risk factors and help with exercise tolerance. Didactically, CR is divided into four stages, with phase 1 being in-hospital and phases 2 to 4 outpatient. All stages aim at either progressing the benefits or, at the very least, maintaining the gains achieved during the process[9]. Consistency in treatment is essential for favorable changes, as it produces long-term benefits, some of which include: reduction in cardiac output, a 20% to 60% increase in muscle strength, improved balance, endurance, body mass index (BMI), and decreases in blood pressure (BP) and heart rate. Additionally, there is an improvement in patients' aerobic capacity, which facilitates recovery and even serves as a form of prevention for other coronary conditions[10]. This occurs with both resistance and aerobic exercises, both interval-based, resulting in an improvement in physical con-

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ditioning that can be assessed through the Six-Minute Walk Test (6MWT), leading to better quality of life and prognosis for heart disease patients. This test provides several useful pieces of information, such as functional capacity, which evaluates a person's ability to perform daily physical activities like walking, climbing stairs, and doing household tasks, as well as exercise tolerance. An improvement in the distance covered during the test may indicate a positive response to treatment[11].

CVDs impair the quality of life (QoL) of heart disease patients due to the physical impairment caused by heart dysfunction, as well as the limitations that the disease itself brings, with biopsychosocial aspects also needing to be considered[12]. A well-utilized tool in the literature to assess quality of life is the Medical Outcome Study Short Form 36 (SF-36), which was translated and validated into Portuguese by Ciconelli *et al.*[13].

In light of the above, the present study aims to report a case of a patient diagnosed with ischemic heart disease (IHD), who underwent coronary artery bypass surgery (CABG), participated in a cardiovascular rehabilitation (CR) program, and to describe the changes in physical performance, assessed by the Six-Minute Walk Test (6MWT), and in quality of life over three years of follow-up.

CASE REPORT

A 68-year-old man underwent coronary artery bypass surgery (CABG) and, after completing phase 1 of in-hospital cardiovascular rehabilitation (CR), was referred to outpatient rehabilitation in the cardiology department. At this stage, the patient participated in a supervised exercise program, with a frequency of 4 times per week and a duration of 1 hour. The session was divided into 30 minutes of aerobic exercises on a Movement® treadmill (without incline, with progressive speed increases until reaching the previously established training heart rate) and 30 minutes of anaerobic exercises in a circuit format, consisting of three sets of 10 repetitions of 10 types of exercises targeting the lower limbs, combined with arm elevation to involve the upper limbs and breathing techniques focusing on exhalation to avoid the Valsalva maneuver, with 2-minute intervals between sets. Exercise intensity was based on heart rate parameters using the Karvonen formula[14].

The patient's progress was analyzed through retrospective data from medical records, covering the period from 2020 to 2023, available at a physical therapy teaching clinic in a university located in the interior of São Paulo state. The data extracted from the medical records included: pharmacological treatment used throughout the recorded period, resting heart rate obtained at the beginning of each session, and the distance in meters covered in the Six-Minute Walk Test (6MWT) to assess cardiorespiratory capacity. Additionally, in 2023, quality of life was evaluated using the SF-36 questionnaire.

Regarding the pharmacological treatment administered to the patient, data were collected on the implications of the medication dosage (reduction or increase) of adrenergic beta-blockers or beta-adrenergic receptor antagonists, such as Carvedilol and Atenolol. The physiotherapeutic adjunct treatment performed was analyzed concurrently and simultaneously.

To assess physical conditioning through the 6MWT, the distance covered was recorded. It is known that, during this test, the patient is instructed to walk as far as possible over a six-minute period in a 30-meter hallway, under the supervision of a healthcare professional. The patient receives clear instructions about the test and is informed about what to expect. It is important to ensure that the patient is in adequate condition

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to perform the test, including proper comfort and appropriate footwear. During the test, the patient is encouraged to walk as far as possible but may take breaks if necessary. An observer records the distance walked by the patient in meters, and vital signs such as heart rate (HR), blood pressure (BP), and oxygen saturation are monitored before, during, and after the test. The test results include the total distance covered in meters and the patient's response to the exertion, such as the presence of dyspnea (shortness of breath), fatigue, and other symptoms. The distance covered during the 6MWT is the primary parameter used to evaluate the patient's functional capacity[15].

The analysis of the patient's functional capacity was obtained through the 6MWT data, by evaluating the longest distance covered and applying the test formula for healthy men (Men: 6MWT distance (meters) = (7.57 x height cm) – (5.02 x age) – (1.76 x weight kg) – 309 meters)[16].

For the analysis of the SF-36 Quality of Life instrument scores, the 36 items were considered, incorporated into 8 dimensions: functional capacity, physical aspects, pain, general health status, vitality, social aspects, emotional aspect, and mental health. These items rate responses from 0 to 100, indicating that a higher score corresponds to better health status, with the last item (question 2) assessing the retrospective health change compared to one year ago, which is not scored. For score analysis, the calculation is done using the following formula: Domain: (Value obtained in the corresponding questions - Lower limit) X 100 / Range (Score Range)[13].

This study was approved by the Ethics Committee (CAEE: 74846123.3.0000.5495), and the participant signed the Informed Consent Form (ICF), authorizing the analysis of their data from the physical therapy records. The study results were analyzed using the SPSS 11.0® statistical package. Data are presented as mean and standard deviation (SD) of the mean.

The analysis of the mean resting heart rates recorded from 2020 to 2023, as well as the distance covered in the 6MWT, was performed using the paired Student's t-test. Statistical significance was considered for p-values < 0.05.

RESULTS

In the present study, a 50% reduction in the dosage of the adrenergic beta-blocker (BB) medication was observed, decreasing from 50 mg/day to 25 mg/day. Dosages were adjusted by the responsible cardiologist, as needed, following the analysis of the physiotherapy report, which included resting heart rate (HR) data. The goal was to optimize the patient's heart health. The annual mean HR over the analyzed period showed a significant reduction ($p < 0.001$), as shown in Table 1, which justified the reduction in medication.

In the analysis of cardiorespiratory capacity, a significant increase in the distance covered in the 6MWT ($p < 0.001$) was observed when comparing the averages from 2020 and 2023, as shown in Table 1. During this period, exercise intensity was progressively increased every 6 months.

In the analysis of the SF-36 questionnaire results, Table 2 presents the maximum and acquired score values. It is observed that the participant achieved the maximum score in three of the eight evaluated domains, indicating a good quality of life. Specifically, the patient reached the maximum score in physical, social, and emotional aspects (100 in each), reflecting excellent performance in these areas. Functional capacity was well-rated with a score of 85, and mental health scored 68, suggesting a relatively favorable

state. However, the participant scored low in general health (40) and vitality (55), indicating a reduced perception of well-being and energy.

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Table 1 - Analysis of the mean resting heart rates and the distance covered in the Six-Minute Walk Test, obtained over the years 2020 and 2023.

Variable	2020	2023	p-value
Mean HR (bpm)	70 ± 8	52 ± 2	< 0.001
6MWT Distance (meters)	490 ± 70	846 ± 8	< 0.001

Values are expressed as mean ± standard deviation. HR: heart rate, bpm: beats per minute, 6MWT: six-minute walk test. Source: research data, 2023.

Table 2 - Values of the domains assessed by the SF-36 in 2023.

Domains	Maximum Score	Acquired Score
Functional capacity	100	85
Physical aspects	100	100
Pain	100	82
General health status	100	40
Vitality	100	55
Social aspects	100	100
Emotional aspects	100	100
Mental health	100	68

DISCUSSION

The combination of medications, such as beta-blockers (BBs), and physical exercise is essential in the management of patients with CVDs. The vasodilatory property of BBs occurs through the antagonism of the alpha-1 adrenergic receptor or by increasing the release of nitric oxide[7]. In the cardiovascular system, these medications inhibit the inotropic, chronotropic, and vasoconstrictive responses to epinephrine and norepinephrine at the receptors, which may be of the beta 1 subtype, related to increased cardiac output; beta 2, predominant in smooth muscle and associated with the relaxation of visceral organs; or beta 3, which have metabolic activity. These drugs are well tolerated, and their adverse reactions depend on the receptor involved[7,8].

The action of this group of medications, when combined with physical exercise, prevents unfavorable outcomes such as increased cardiac collagen and avoids hypertrophy of cardiomyocytes, as it participates in the reverse remodeling process of the heart by reducing the calcineurin signaling pathway. Additionally, it is capable of minimizing proteins associated with fibrosis, a set of factors that reduces the progression of myocardial failure. Despite this, the prescription of physical exercise for patients with CVD who are using BBs requires caution and a thorough analysis within an Individualized Therapeutic Plan, carried out by a multidisciplinary team, to ensure that the benefits outweigh the risks for the patient[17,18,19,20].

One of the long-term benefits of aerobic exercise, an essential part of the CR program, is the reduction in sympathetic nervous sys-

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tem activity and the increase in parasympathetic activity, resulting in a decrease in heart rate (HR)[21,22]. This resting bradycardia effect is also observed with the use of BBs, as well as the increase in the left ventricular (LV) end-diastolic volume and systolic ejection time, which increases myocardial oxygen consumption (MVO2)[8]. Thus, the combination of physical exercise with the use of BBAs reduces heart rate, making it necessary to adjust the dosage over time, resulting in an improvement in cost-effectiveness and a positive change in the patient's cardiovascular risk[23].

Additionally, the literature highlights that regular physical exercise promotes a reduction in resting HR and BP values[9,24,25,26]. In the case studied, we also observed these results in a patient who was enrolled in a CR program after CABG surgery, with a notable 50% reduction in the BB dosage and a significant improvement in physical performance. This underscores the importance of long-term CR, which improves prognosis and allows for the gradual reduction of BBA dosage, reflecting a positive change in the patient's cardiac function. Additionally, other benefits, such as improved quality of life due to the reduced BB dosage and the consequent decrease in side effects, as well as the reduction in hospitalization rates and overall mortality, can be observed, especially with good patient adherence to CR[27].

The application of the 6MWT enables the personalization and optimization of the patient's treatment and rehabilitation plan. Based on the data obtained during the test, healthcare professionals can adjust medications, prescribe specific exercises, and provide guidance on the intensity and duration of physical activities. This contributes significantly to improving the quality of life for heart disease patients, promoting effective disease management, and reducing the risk of cardiovascular complications[28]. Regular performance of the 6MWT allows for monitoring the progression of the disease over time and evaluating the effectiveness of the treatment. Changes in walking capacity and cardiovascular performance during the test can indicate improvements or declines in the patient's health, enabling early interventions and adjustments to the care plan[29].

The SF-36 Quality of Life Questionnaire is a valuable tool that allows for a comprehensive assessment of patients' quality of life following cardiac revascularization via saphenectomy[30]. This multidimensional tool examines various aspects of life, including physical and mental health, and provides significant insights into the patient's health status and overall well-being[30]. The SF-36 results consistently demonstrated improvements in the quality of life of patients who underwent cardiac revascularization with cardiovascular rehabilitation[31], especially in the domains of physical, social, and emotional limitations, where the patient achieved the maximum score. In the functional capacity domain, the patient scored 85, a value close to the maximum, indicating a positive change in this aspect. The recovery of physical health and the reduction of cardiac symptoms are reflected in higher scores in domains related to physical health, such as functional capacity. Additionally, cardiovascular rehabilitation after saphenectomy, combined with medication and cardiovascular physiotherapy, also results in significant gains in patients' mental health, with higher scores in mental health-related domains such as emotional well-being, highlighting the importance of a holistic approach to recovery.

The SF-36[31] also reveals an improvement in patients' ability to perform their daily and social activities, reflected in higher scores in the physical role and social function domains. This suggests greater independence and integration into daily life. The individualization of the cardiovascular rehabilitation program plays a key role in the positive outcomes of the SF-36[31], as the specific needs of each patient are addressed in a personalized manner.

The combination of medication and cardiovascular rehabilitation not only improves patients' quality of life in the short term but also has the potential to reduce cardiovascu-

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lar risk factors in the long term, preventing future complications. The regular application of the SF-36[31] during the cardiovascular rehabilitation process provides valuable information for adjusting treatment and monitoring patients' progress over time. Post-saphenectomy CR not only accelerates initial recovery but has also been associated with lower hospital readmission rates and improved long-term survival, underscoring its importance in the management of patients undergoing CABG[32].

However, despite its relevance, this case report has some limitations that should be considered. The primary limitation is the focus on a single patient, which restricts the generalizability of the results to the broader population. Additionally, it was not possible to assess the patient's adherence to all the guidelines provided outside the controlled environment of the CR program, which may have influenced the observed outcomes. These limitations highlight the importance of further studies, including larger samples and more rigorous follow-up, to validate the findings and expand knowledge about the effectiveness of the CR program in different populations.

CONCLUSION

The results of the present study highlight the significant benefits of the CR program on the patient's health. Regular physical exercise within the context of this program not only enabled a 50% reduction in the BBA dosage but also resulted in a marked improvement in physical performance, as evidenced by the increased distance covered in the 6MWT and the significant reduction in average heart rate over three years. Additionally, the patient demonstrated a good quality of life, achieving the maximum score in three of the eight domains of the SF-36 questionnaire, specifically in physical, social, and emotional aspects. These results underscore the importance of long-term follow-up and the positive impact of participating in a CR program, reinforcing the relevance of physiotherapeutic intervention in optimizing the patient's health and well-being.

CRediT author statement

Conceptualization: Balduino, AJM; Oliveira, BG; Bachur, CK. Methodology: Avelino, MC; Silva, JVMB; Bachur, JA. Validation: Bachur, JA; Bachur, CK. Formal analysis: Silva, JVMB; Bachur, JA; Bachur, CK. Investigation: Balduino, AJM; Oliveira, BG; Avelino, MC. Resources: Bachur, JA; Bachur, CK. Writing-original draft preparation: Balduino, AJM; Oliveira, BG; Avelino, MC; Bachur, CK. Writing-review and editing: Silva, JVMB; Bachur, JA; Bachur, CK. Visualization: Balduino, AJM; Oliveira, BG; Avelino, MC; Silva, JVMB; Bachur, JA; Bachur, CK. Supervision: Bachur, JA; Bachur, CK. Project administration: Bachur, CK.

All authors have read and agreed to the published version of the manuscript.

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Received: 19 may 2024.
Accepted: 10 september 2024.
Published: 20 september 2024.