

Chronic Heart Failure: Does Cardiovascular Rehabilitation Promote Benefits to These Patients?

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ABSTRACT

Introduction: Supervised cardiovascular rehabilitation (SCR) is an essential adjuvant therapy for patients with heart failure. However, the idea that its benefits are restricted to the early stages of heart failure persists in clinical practice. **Objective:** To describe how SCR positively impacted the functional capacity, functionality, clinical condition and quality of life of a patient with chronic heart failure (CHF) with an implantable cardioverter defibrillator (ICD). **Case report:** Female, sedentary, 67 years old, hypertensive for 30 years, with an ICD (for seven years), history of coronary artery disease and myocardial infarction, developed dilated ischemic heart failure of functional class III. She was referred by her arrhythmologist to the SRC service. She remained in treatment for seven months. The SRC program consisted of resistance exercises, cyclic exercises, and inspiratory muscle training, adjusted every two months. **Results:** After the cardiovascular rehabilitation period, we observed a 100% increase in ejection fraction (20% *versus* 40%), functional capacity (< 5 METs *versus* 6.8 METs), and quality of life (↑ 47%), as well as a decrease in blood pressure (180/90 *versus* 130/80 mmHg) and withdrawal of one drug (digoxin). **Conclusion:** An individualized SRC program can promote clinical and functional benefits and improve the quality of life of patients with chronic heart failure, indicating that not only patients with recent complications or in the early stages of heart failure can benefit from these benefits.

KEYWORDS: Exercise; Quality of Life; Physical and Rehabilitation Medicine; Cardiovascular Diseases; Cardiac Rehabilitation.

INTRODUCTION

Heart failure is the final stage of various heart diseases, which represent the leading cause of death in Brazil and worldwide¹. Many of these individuals develop forms of heart failure that culminate in the need to use implantable electronic cardiac devices. Among these devices, the cardioverter-defibrillator is mainly used as preventive therapy to avert sudden death from complex tachycardias².

In this context, it is already well established how physical exercise is a differential adjuvant therapy for these patients in terms of improving functional capacity and functionality, generating an improvement in quality of life, which is so

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affected in this population³. However, there is still a misconception that the benefits of physical exercise on physical and clinical condition are only practical in the early stages of heart failure⁴. Similarly, it is believed that patients with electronic cardiac devices derive these benefits in the first few months after surgical implantation, rather than in chronic cases. This thinking reflects one of the main barriers to the medical team referring these patients to supervised cardiovascular rehabilitation services (SCR), thereby restricting this population from the benefits of physical exercise⁴.

Therefore, given the growing population with chronic heart failure (CHF) using electronic cardiac devices and the need to encourage the referral of these patients to cardiovascular rehabilitation services, this study aimed to describe how cardiovascular rehabilitation positively impacted the functional capacity, functionality, clinical condition, and quality of life of a patient with CHF who had an implantable cardioverter-defibrillator (ICD).

CASE REPORT

A 67-year-old sedentary female patient, hypertensive for 30 years, with a body mass index of 28 kg/m², a carrier of an ICD (for seven years) and a history of coronary artery disease and myocardial infarction, developed dilated ischemic heart failure of functional class III. She was taking the following medications: digoxin 0.25 mg once daily, atorvastatin 40 mg once daily, acetylsalicylic acid 100 mg, carvedilol 12.5 mg once daily, spironolactone 25 mg twice daily, and enalapril 10 mg twice daily.

During a routine visit to her electrophysiologist, the patient was advised to seek SCR due to complaints of fatigue that had been worsening over the years. She entered the SCR in August 2017. During the anamnesis, she reported great difficulty eating, speaking, bathing, walking, sweeping the house, dressing, climbing and descending stairs, and reaching objects in high or very low places due to dyspnea with minimal exertion, and also reported insomnia and dizziness. Subsequently, the Minnesota Living with Heart Failure Questionnaire (MLHFQ) was administered, with a score ranging from 0 to 105, and she obtained 77 points.

On physical examination, systemic blood pressure was 170/90 mmHg (right arm) and 180/90 mmHg (left arm), demonstrating grade III (severe) hypertension.

The most relevant findings on echocardiography were: end-diastolic volume of 224 mL, end-systolic volume of 180 mL, left ventricular mass of 255 g, and ejection fraction of 20% (Teichholz). The report attested to concentric hypertrophy and significant dilation of the left ventricle, moderate left atrial dilation (type II), and severe left ventricular systolic dysfunction.

Based on the assessment and the patient's clinical condition, the following functional objectives were established: to promote physical conditions to perform instrumental activities of daily living and to alleviate tiredness/fatigue during walking, consequently improving quality of life. The clinical objectives were: to reduce systemic arterial hypertension (achieving at least borderline blood pressure values), to promote reverse myocardial remodeling, and to improve ejection fraction (increase by at least 10%).

This case report was submitted to the Research Ethics Committee of the *Faculdade Adventista da Bahia* (Bahia Adventist College), Cachoeira, BA, Brazil, and approved under Certificate of Presentation for Ethical Consideration (Certificado de Apresentação para Apreciação Ética) nº 45463821.7.0000.0042.

Supervised cardiovascular rehabilitation program

The SCR program began in August 2017 and lasted 7 months. For the first three months, it occurred twice a week; subsequently, three times a week, with periodization every two months. The complete description of the physical exercise prescription is in Table 1. All exercise sessions were performed under electrocardiographic monitoring (ECAFIX multiparameter cardiac monitor, model Active, São Paulo, SP, Brazil).

We began the cardiovascular rehabilitation session with remote ischemic preconditioning, which consisted of inflating a blood pressure cuff to 200 mmHg on the left arm, maintaining occlusion for 5 minutes followed by 3 minutes of reperfusion, in three sets. Then, we moved on to inspiratory muscle training, prescribed with a load based on maximum inspiratory pressure

($PI_{\text{máx}}$) measured using the POWERbreathe K5. Initially, we used a load corresponding to 10% of $PI_{\text{máx}}$, progressing to 30%, in three sets of seven repetitions (Table 1). We finished the session with neuromuscular exercises. This program lasted two months. Initially, no cyclic exercise on a treadmill was used.'

Table 1. Description of the evolution of the supervised cardiovascular rehabilitation program (seven months).

Month/Year	Modality	Dosimetry	Interval	Intensity
August and September 2017	Remote ischemic preconditioning	Three 5-minute blocks of obstruction followed by 3 minutes of reperfusion.	-	-
	Inspiratory muscle training	Three sets of seven repetitions	1 minute recovery between sets	10% evolving to 30% of maximum inspiratory pressure
	Neuromuscular exercise	Two sets of 10 repetitions. Two or three exercises are divided into upper-body and lower-body days.	2 minutes of recovery between sets	Light OMNI = 3-4 Borg = 10-11
October, November and December 2017	Inspiratory muscle training	Three sets of 15 repetitions	2 minutes of recovery between sets	30% of maximum inspiratory pressure
	<i>Hand grip</i>	Bilateral with 3 sets of one minute of hold.	2 minutes of recovery between sets	30% of handgrip strength
	Neuromuscular exercise	Two sets of 15 repetitions. Two or three exercises are divided into upper-body and lower-body days.	2 minutes of recovery between sets	Light OMNI = 3-4 Borg = 10-11
	Cyclic exercise on a treadmill	Warm-up: 5 minutes (speed 0.5 km/h)	-	Light Borg = 7-9
		Conditioning: three blocks, 1:30 min at 1.2 km/h (interval training)	2 minutes of passive rest between blocks	Light Borg = 10-11
		Deceleration: 3 minutes decreasing	-	-
January and February 2018	Inspiratory muscle training	Three sets of 15 inspirations, three times a week.	2 minutes of recovery	30 cmH ₂ O
	Neuromuscular exercise	Three upper body exercises and three lower body exercises, two sets of 12 repetitions.	2 minutes of recovery	Moderate OMNI = 13-15
	Stair training	Two flights of stairs with 1 kg ankle weights Two sets	2 minutes of recovery between sets	Moderate Borg = 12-13
	Treadmill	Warm-up: 7 minutes (2 km/h)	-	Light Borg = 7-9
		Conditioning: 13 minutes (speed 4.5 km/h) (Interval training)	2 minutes of passive rest	Moderate Borg = 13-14
	Deceleration: 3 minutes decreasing	-	-	

Source: Elaborated by the authors.

After the first two months, handgrip training and treadmill exercise were added to the SCR program. The hand grip training was set at an initial load of 30% of the hand grip strength (HGS) obtained during the HGS assessment with the WCT Fitness digital hand grip dynamometer. We performed three sets of 1 minute with 2 minutes of rest bilaterally.

The execution of the cyclic exercise on a treadmill began with a warm-up phase, followed by conditioning performed in intervals (periods of exercise interspersed with periods of passive rest) and progressive deceleration. Table 1 describes how the cyclic exercise was initially applied. It is worth noting that at the end of the treatment, the patient reached a speed of 4.5 km/h in the conditioning phase, completing a total time (warm-up, conditioning, and deceleration) of 18 minutes. To determine the intensity of effort during neuromuscular resistance and treadmill cyclic exercise, the Borg Rating of Perceived Exertion (RPE) scale (cyclic exercise) and the OMNI-RES scale (neuromuscular resistance exercise) were used. These scales are composed as follows:

- Borg RPE Scale, applied in cyclic exercises (with measurements ranging from 6 to 20);
- OMNI-RES scale, used to determine the effort of the active musculature in neuromuscular exercises (ranging from 0 to 10).

In the last two months of SCR, stair training was also included. The program lasted 7 months. After this period, the patient was discharged; however, she continued SCR for another 5 months (maintenance) before independently taking over the exercise program, following the prescribed instructions in a printed document. The evolution of the SCR session prescription is summarized in Table 1.

RESULTS

Table 2 presents the results of the pre- and post-SCR echocardiogram. This table highlights the improvement in left ventricular ejection fraction, which increased from 20% to 40% (a 100% improvement), transitioning from a reduced to an intermediate ejection fraction.

Table 2. Echocardiogram results before and after supervised cardiovascular rehabilitation.

Variables [#]	Pre-SCR 20/1/2017	Post-SCR 4/5/2018	Reference values*	Percentage of improvement (%)
End-Diastolic Volume (EDV, mL)	224	180	46-106	20
End-Systolic Volume (ESV, mL)	180	108	14-42	40
Ventricular mass (g)	255	198	67-162	22
Ejection fraction (%)	20	40	54-74	100

[#]Values referring to the left ventricle; SCR: supervised cardiac rehabilitation; values according to the American Society of Echocardiography and the European Association of Cardiovascular Imaging⁹. Source: Elaborated by the authors.

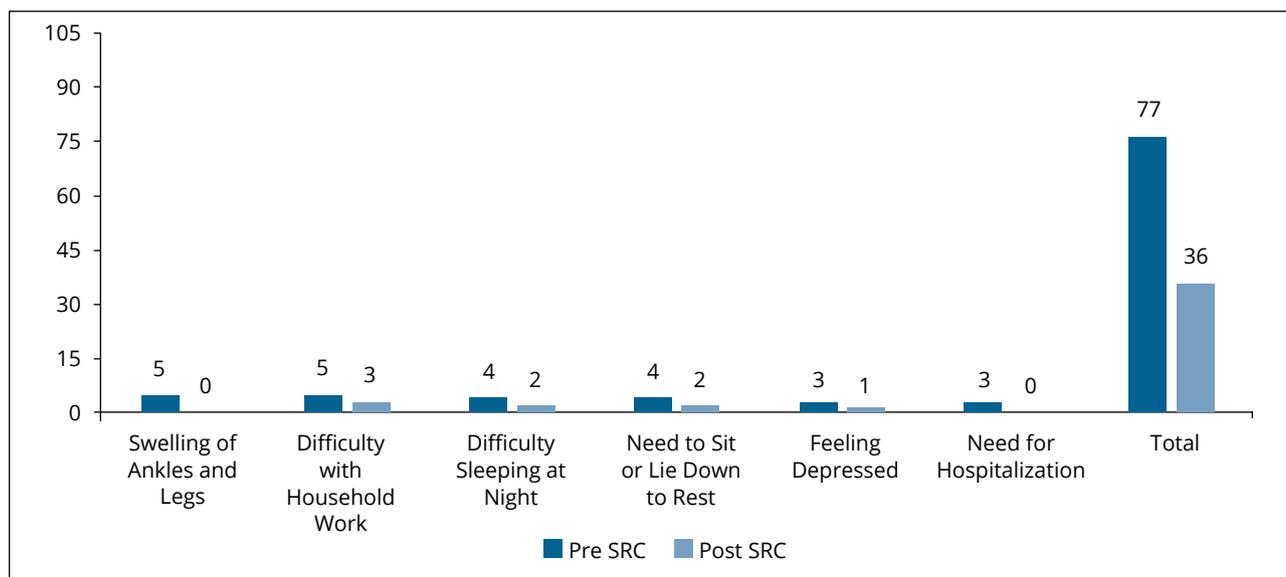
The results of the conventional treadmill exercise test performed after supervised cardiac rehabilitation (SCR) are presented in Table 3. Three variables stand out from this table: the maximum heart rate achieved (reaching 90% of the predicted maximum heart rate), which indicates that the exercise test was maximal; the resting values of systolic and diastolic blood pressure, which decreased by 28% and 11%, respectively, compared to the beginning of treatment; and the peak oxygen uptake (VO_{2peak}), which is above the cutoff point associated with higher risk of mortality from cardiovascular events and exacerbation of chronic heart failure (VO_{2peak} of 17 mL/kg·min). It should be noted that, initially, due to the patient's clinical and physical condition, the exercise test was contraindicated. In other words, at baseline, the patient's functional capacity was below 5 METs, and after the program, it reached 6.8 METs (VO_{2peak} of 24 mL/kg·min).

Table 3. Results of the exercise stress test after supervised cardiovascular rehabilitation.*.

Variables	Values obtained
Distance traveled (m)	2.600
Calculated VO ₂ max (mL/kg·min)	24
HRrest	66
HRmax (bpm)	129
Resting SBP/DBP (mmHg)	130/80
Maximal SBP/DBP (mmHg)	170/80
Chronotropic deficit (%)	16
Chronotropic reserve (bpm)	63
Calculated cardiac output (l/min)	11
Stroke volume (mL/systolic volume)	85

VO₂max: maximal oxygen uptake; HRrest: resting heart rate; HRmax: maximal heart rate; DBP: diastolic blood pressure; SBP: systolic blood pressure; *the patient has no data from the treadmill exercise test before supervised cardiac rehabilitation, as her clinical and functional conditions did not allow the test to be performed. Fonte: Elaborada pelos autores.

In the MLHFQ quality of life questionnaire, we observed a significant improvement in the score (pre-SCR = 77 *versus* post-SCR = 36), corresponding to a 47% improvement in quality of life. Figure 1 shows the main aspects that affected quality of life, along with their pre- and post-SCR scores.



Source: Elaborated by the authors

Figure 1. Evolution of the main aspects impacting quality of life. Pre- and post-supervised cardiovascular rehabilitation scores (by item and total).

Ultimately, the clinical and functional gains led to the discontinuation of digoxin.

DISCUSSION

This case report suggests that an SCR program can improve functional and clinical variables and enhance patients' quality of life with CHF. This case report challenges the idea that only patients with recent or early-stage cardiac conditions

benefit from the effects of physical exercise.⁴ This notion also applies to patients with implantable electronic cardiac devices, as we were able to observe in this report.

Among the most notable effects promoted by the SCR program described in this case are the improvement in functional capacity, ejection fraction, and quality of life, as well as the reduction in resting blood pressure and medication (digoxin). Together, these improvements reduce the risk of CHF exacerbations and hospitalizations, and increase survival^{6,7}. It should be noted that during the SCR period, there were no changes (dosage or active ingredients) to the medications being used.

According to Myers et al.⁶, both healthy people and individuals with cardiovascular disease can be subdivided into three categories based on functional capacity: below 5 METs, between 5 and 8 METs, and above 8 METs. Cardiovascular disease patients with functional capacity between 5 and 8 METs have a lower relative risk of all-cause mortality compared to their counterparts with capacity below 5 METs (2.4–3.7 versus 3.3–5.2, respectively), and each 1-MET increase in functional capacity confers a 12% improvement in survival.

The patient in question went from a functional capacity of less than 5 METs pre-SCR to 6.8 METs at the end of the program, as described in the results. Continuing this idea of reducing the risk of cardiovascular complications, an important cohort study found that a change in EF classification (from reduced to intermediate) decreases the probability of readmissions and exacerbations in patients with CHF and also increases survival in this population⁸. In this study, we observed an improvement in EF, going from reduced to intermediate (Table 1).

The prominent gain in systolic function, reflected in the EF, associated with reverse myocardial remodeling (reduction of left ventricular dilation) has already been reported in the scientific literature. Dörr and Halle⁹ point out that physical exercise can reorganize cellular signaling in cardiac tissue and reverse concentric hypertrophy and ventricular dilation, which, as indicated by another study, is associated with increased systolic cardiac function and improved prognosis¹⁰. In this case, the improvement in systolic function was evident to the point that digoxin could be discontinued, which, in the medium and long term, reduces the occurrence of adverse effects from this drug¹¹.

Furthermore, just as important as the clinical and functional improvement was the improvement in quality of life, which determines not only more time lived, but also time with greater quality and autonomy⁷. For all these reasons, in a recent review published by the journal affiliated with the European Society of Cardiology, SCR was recognized as the fifth essential pillar of heart failure treatment⁷.

Therefore, the benefits promoted by physical exercise, although determined by the idiosyncrasy¹² and specificity of the prescription (personalized and supervised prescriptions show better effects)⁹, can also be observed in chronic cases, as reported in this case, and are not restricted to cases of recent evolution. Given the above, we recommend that cardiovascular health institutions and clinics commit to disseminating the potential benefits of SCR to their patients, including patients with chronic heart failure, providing this population with another therapeutic tool in addition to pharmacological ones.

CONCLUSION

This case report suggests that an individualized supervised cardiovascular rehabilitation program can promote clinical and functional benefits, as well as improve the quality of life of patients with chronic heart failure, indicating that not only patients with recent complications or in early stages of heart failure can obtain these benefits.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR CONTRIBUTIONS

Conceitualization: Petto J, Pinna Júnior BJB; **Data Curation:** Petto J, Pinna Júnior BJB, Oliveira AM, Santos LF, Souza PES, Oliveira EC; **Project Administration:** Petto J, Oliveira AM; **Writing – Original Draft:** Petto J, Oliveira AM, Oliveira EC, Santos LF, Souza PES; **Writing – Review & Editing:** Petto J, Oliveira AM, Oliveira EC, Santos LF, Souza PES; **Final approval:** Petto J.

DATA AVAILABILITY STATEMENT

All data sets were generated or analyzed in the current study.

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DECLARATION OF USE OF ARTIFICIAL INTELLIGENCE TOOLS

No artificial intelligence tools were used to create this article.

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