

# Effects of a Cardiac Rehabilitation Program in Patients with Congenital Heart Disease

Nathalie Dedieu, Luis Fernández\*, Elvira Garrido-Lestache, Inmaculada Sánchez, Maria Jesus Lamas

Congenital Heart Diseases Unit, Hospital Ramón y Cajal, Madrid, Spain

Email: [\\*lfernandezp@hotmail.com](mailto:lfernandezp@hotmail.com)

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## Abstract

The beneficial effects of the programs of cardiac rehabilitation in adults are widely known. Nevertheless, the accomplishment of these programs in patients with congenital heart is scarcely developed. In this study, we want to evaluate the preliminary results of a program of cardiac rehabilitation. *Patients and methods:* Thirty-three patients aged 8 to 40 completed the rehabilitation program. Thirty-one of them had an operated congenital heart disease, one had an implantable cardioverter defibrillator, and another was a patient with arterial hypertension and obesity. Data before and after the program were compared. *Results:* Improvements were found in all of the measured parameters. We found a statistically significant difference in maximum heart rate, exercise duration, foreseen heart rate's percentage and increase of metabolic equivalents. Twenty-seven of 33 patients noticed a significant improvement in their quality of life at the end of the program. *Conclusion:* Initial results seem to be encouraging and we consider the experience very positive since the program achieved an improvement in the functional capacity of our patients. In our opinion, these observations and the results of our study provide strong arguments for the incorporation of cardiac rehabilitation into the care of many patients with congenital heart disease.

## Keywords

Congenital Heart Disease; Exercise Test; Quality of Life

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## 1. Introduction

The beneficial effects of the programs of cardiac rehabilitation in adults after a heart attack, cardiac surgery, or in patients with heart failure are widely known. These benefits include decrease of adiposity reserve, obesity and

\*Corresponding author.

arterial hypertension, improvement of lipid profile and insulin sensibility, improvement on exercise capacity, cardiac mortality and morbidity [1] [2]. Nevertheless, the accomplishment of these programs in patients with congenital heart is scarcely developed and there is only a few papers published related to this topic.

With medical advances and the development of new surgical techniques in the last few years, life expectation of patients with congenital heart disease has notably increased. However, their functional capacity is often depressed [3]-[7], undoubtedly as a consequence of surgery and its after-effects, but also due to an inappropriate restriction of physical activity [8]. Cardiac rehabilitation requires a program to improve the physical, psychological and social aspects of a patient who lives with the limitations imposed by his own disease.

Our aim was to improve the functional capacity and the self-esteem of children, teenagers and adults with congenital heart disease who are usually submitted to a restriction of their physical activity, as well as to increase their integration in schools, families and jobs. In this study, we want to evaluate the preliminary results of a program of cardiac rehabilitation on some of these aspects.

## 2. Methodology

In our cardiac rehabilitation program, we included patients operated of congenital heart disease after 1 - 2 months of convalescence or even more in case of persisting restrictions, and selected cases with cardiomyopathy, arterial pulmonary hypertension and severe arrhythmias that have required implant of a pacemaker or a implantable cardioverter defibrillator.

Exclusion criteria were:

- Electrocardiograms abnormalities or abnormalities during exercise test,
- Coronary artery disease that suppose risk of ischemia
- Systemic hypertension
- Severe pulmonary hypertension
- Severe aortic or pulmonary stenosis
- Significant cyanosis

### Program Description

At the beginning of the program, an exercise test was performed on each patient to measure cardiac maximum frequency reached, the cardiac maximum frequency foreseen, exercise duration and the energy consumption in metabolic equivalents. Thus, the functional capacity was derived. We use a treadmill ergometer and the modified Bruce protocol with progressive increase of belt speed and incline.

The first phase of the program consisted in relaxation exercises.

During the second phase, patients began with a few minutes of relaxations exercise followed by aerobic exercise in the cardiac rehabilitation unit, 2 days a week for approximately 2 months. A multidisciplinary team including nurses, specialists on physiotherapy and rehabilitation, and psychologists were at any moment ready for giving aid as better as possible.

The last phase consisted of physical exercise performed by the patients at home. Patients used to determining physical activity intensity the Borg Rating of Perceived Exertion. It is based on the physical sensations a person experiences during physical activity, including increased heart rate, increased respiration or breathing rate, increased sweating, and muscle fatigue. Although this is a subjective measure, a person's exertion rating may provide a fairly good estimate of the actual heart rate during physical activity.

After completion of the program another ergometry was performed and the results compared with the first ones. The final report was provided to the patients. Psychological aspects were also evaluated, by means of a questionnaire at the end of the program.

## 3. Statistical Analysis

Wilcoxon test was used to compare continuous variables before and after the program accomplishment.

## 4. Results

The group that has been submitted to the program consisted of 33 patients aged 8 to 40. Thirty-one of them had an operated congenital heart disease, one had an implantable cardioverter defibrillator, and another was a patient

with arterial hypertension and obesity. Diagnostics of the patients' group are shown in **Table 1**.

All of the patients completed the program without experiencing a rehabilitation related complication during the study.

At the beginning of the program, the mean maximum heart rate was  $166.5 \pm 24.2$  bpm and at the end of the rehabilitation program this increased to  $176.5 \pm 14.5$  ( $p < 0.05$ ). This improvement of cardiac capacity was also reflected in a statistically significant difference between exercise testing duration which improve from  $9 \pm 2$  minutes to  $10 \pm 1.7$  ( $p < 0.05$ ) and the raise of the foreseen heart rate's percentage. Nevertheless the increase of metabolic equivalents was not statistically significantly different ( $p < 0.07$ ) (**Table 2**).

With respect to the psychological aspects of the program, measured by the questionnaire that patient filled in at the end of the program, 24 of the 30 patients noticed a significant improvement in their quality of life. Patients with congenital heart disease have a chronic illness, reduced life expectancy, symptoms and in many cases fears for family and partner being left alone. Since childhood they have been treated differently by other people.

After the rehabilitation program most of them said having a more optimistic personality low anxiety, they declared being motivated to change their way of life in a few aspects because during the program they saw that they were able to do it.

**Table 1.** Cases included in the study.

<i>DIAGNOSTIC</i>	<i>Number of cases</i>
Tetralogy of Fallot. Complete correction (1 pulmonary prosthesis)	10
Transposition of great arteries. Complete correction (1 Switch operation, 2 Mustard, 1 Rastelli)	4
Pulmonary atresia + ventricular septal defect. Complete correction	4
Aortic coarctation. Complete correction	3
Left-to-right shunt (ASD, VSD, AV Canal). Complete correction	3
Mitral pathology. Mitral prosthesis	2
Pulmonary valve stenosis. Complete correction	2
Ebstein anomaly. Tricuspid anuloplasty	1
Hypoplastic left ventricle. Fontan procedure.	1
Aortic valve stenosis. Aortic prosthesis	1
Cardiomyopathy. Implantable cardioverter defibrillator	1
Arterial hypertension + Obesity	1

**Table 2.** Data before and after cardiac rehabilitation (Wilcoxon test).

	<b>N</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Median</b>	<b>p</b>
	33	8	40	$22 \pm 6.9$	
<b>MAXIMUM HEART RATE</b>					
<i>Before/after</i>	33	85/139	196/194	$166.5 \pm 24.2/176.5 \pm 14.5$	<0.05
<b>EXCERCISE TEST DURATION</b>					
<i>Before/after</i>	33	3/7	11/12.3	$9 \pm 2/10 \pm 1.7$	<0.05
<b>EXPECTED HEART RATE'S PERCENTAGE</b>					
<i>Before/after</i>	33	50/77	111/103	$83.5 \pm 14/89.5 \pm 8$	<0.05
<b>METS</b>					
<i>Before/after</i>	33	4/5.5	13/13.5	$9 \pm 2.6/10 \pm 2$	<0.07

## 5. Discussion

Our study shows that this type of cardiac rehabilitation program can improve the exercise function in patients with congenital heart disease. Past studies have already demonstrated that stroke volume and cardiac output can be enhanced after exercise training [9]-[15]. In our study group, the improvement has been observed in all the parameters measured except metabolic equivalents.

Over the last decades, clinical application of exercise as a therapeutic strategy has developed as a treatment for cardiovascular disease. The involved mechanisms in the beneficial effect of cardiac rehabilitation programs are increasingly understood. In stable coronary artery disease, a recent meta-analysis revealed a significant (31%) reduction in cardiac mortality [16] and the therapeutic benefits of regular exercise has also been confirmed in direct comparison with an interventional strategy [17]. In stable chronic heart failure physical activity was traditionally discouraged. A carefully designed exercise program at 50% - 70% of the maximal oxygen uptake was effective in improving exercise capacity by 12% - 32%. Other authors demonstrated that exercise therapy reduced the relative risk of chronic heart failure mortality by 35% and related hospitalization by 28% [18].

Benefits of exercise training are principally related to the cardiac function, vascular system, neurohumoral system, and respiratory and skeletal muscle systems. We believe that the improvements in exercise capacity and cardiovascular function achieved by our patients are related to and stress the important bidirectional nature of the interaction between the cardiovascular system and the skeletal muscles. While the cardiovascular system provides the blood flow necessary to accommodate the metabolic requirements of the skeletal muscles during exercise, the pumping action of the skeletal muscles in turn helps to maintain ventricular preload, making consequently a contribution to cardiac output during physical activity [19]. We think that the improvement identified in studies are related, at least in part, to the rehabilitation program inducing an increase in the skeletal mass and his pumping capacity. Furthermore training improves the left ventricle stroke volume, decreases the heart rate and cardiomegaly, raises endothelium dependant vasodilatation leading to a reduced cardiac after load and enhanced peripheral perfusion, muscle perfusion and diminish the peripheral vascular resistance. Training, on reducing sympathetic activation, raising vagal tone enhanced cardiac frequency variability and reducing baroreceptors sensitivity is associated with a decrease in sudden deaths events [20]-[26].

We believe that this interaction between the skeletal muscles and the cardiovascular system is an important clinical concept that may not be fully appreciated. This phenomenon probably explains the common observation that surgical and/or interventional catheterization procedures that achieve dramatic hemodynamic results often, in the short term, have a relatively minor impact on the exercise function [27]-[31]. Rhodes *et al.* [32]-[34], demonstrates, in patients with congenital heart disease, an improvement of exercise performance mediated by an increase in stroke volume and/or oxygen extraction during exercise, improving heart rate recovery following peak exercise and they also found an improvement in self- esteem and emotional state.

Most of our patients expressed satisfaction with this program because of an improvement of their quality of life during and after the 2 month second phase. The program enhanced the patients' perceptions of their physical fitness and many limitations previously perceived had disappeared.

### Limitations of Our Study

The number of patients involved in our study is small. Age limited our ability to realize an ergometric cycle test. Finally as the sustainability over time of the improvements observed in our patients would need to be confirmed. Additional studies are therefore needed to confirm our results.

## 6. Conclusion

Initial results seem to be encouraging and we consider the experience very positive since the program achieved an improvement in the functional capacity of our patients. In our opinion, these observations and the results of our study provide strong arguments for the incorporation of cardiac rehabilitation into the care of many patients with congenital heart disease. Indeed, the improvements achieved exceed or at least equal those obtained with many other medical or surgical interventions. Furthermore, no adverse events were encountered in conjunction with our rehabilitation program, suggesting that, in patients, cardiac rehabilitation has a low risk of cardiac events. Finally, cardiac rehabilitation improved the quality of life of these patients by diminishing psychosocial barriers to physical activity.

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