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An overall view of physical exercise prescription and training monitoring for heart failure patients

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Abstract

Physical training for chronic heart failure (CHF) patients is well known in the scientific realm, although there are many different methods of physical exercise prescribed and different ways of monitoring such training. The object of this review is to discuss prescription and monitoring methods of physical exercise for CHF patients. (Cardiol J 2010; 17, 6: 644–649)

Key words: heart failure, exercise, cardiac rehabilitation

Introduction

Chronic heart failure (CHF) is seen as the endpoint of all cardiopathies and is an important worldwide cause of death [1–3]. The syndrome has an alarming mortality rate of approximately 50% within five years, which surpasses many types of cancer [4]. In Brazil, CHF is the major cause of hospital admittance due to heart disease and represents 6.3% of all causes of death [5].

CHF is defined as a heart dysfunction that leads to an inadequate blood supply for the metabolic demands of the body when faced with the normal venous blood return or under high input pressures [6]. This inadequate blood supply triggers a compensatory mechanism aiming for the normalization of cardiac output through an increase of sympathetic activity, an important increase of peripheral vasoconstriction, and volemic increase associated with a diuresis decrease. The basis for this adrenergic mechanism is to increase the heart's inotropism and chronotropism, besides redirecting the blood flow to the body's vital organs such as the brain and the heart. Through the volemic increase, there is also the possibility of using the Frank-Starling mechanism to restore cardiac output.

As a result of this compensatory mechanism, skeletal musculature can suffer due to blood flow deprivation, generating a consequent muscle mass loss and an endothelial dysfunction that contributes to a lower physical capacity [7]. Therefore, CHF is clinically characterized by a low tolerance to physical exercise [8, 9], a high morbidity/mortality [10] and poor quality of life [11]. Pathologically speaking, it is characterized by a compromising of the heart function, persistent neurohormonal activity [12] and endothelial dysfunction [13].

Physical training for CHF patients is well known in the scientific realm, although there are many different methods of physical exercise prescribed and different ways of monitoring such training. The object of this review is to discuss prescription and monitoring methods of physical exercise for CHF patients.

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Exercise in patients with chronic heart failure: a brief historical context

Drug therapy is the basic treatment for patients with CHF. Drugs such as beta-blockers and angiotensin converting enzyme inhibitors, among others, have already shown a positive effect on CHF patient survival [14]. On the other hand, supporting therapies have been becoming better known in the scientific community in recent years.

Until relatively recently, bed rest and the restriction of physical activity were recommended. From 1980 onward, this concept began to change, and in 1990 the first research that used a well controlled methodology to study the effects of physical exercise in CHF was published. In this study, the authors showed that physical training led to an improvement of maximum and sub-maximum physical capacity, as well as an improvement of CHF symptoms in a safe way, without adverse events throughout the physical activity. The authors concluded that the belief that bed rest was beneficial in preserving the hearts of CHF patients could no longer be accepted [15]. Since that history-making report, the CHF physical exercise program has gradually become accepted and modified [16]. Today, a physical exercise program is formally recommended as an important and safe treatment for CHF patients [1, 17, 18].

Benefits of physical exercise

Many physical activity benefits for CHF patients have been documented, such as improvements in physical capacity (an increase of 10 to 30% of the maximum physical capacity) [19, 20], improvements in quality of life [21], endothelial dysfunction [22], catecholamines serum levels [23], and in morbidity and hospital re-admission [24]. Other benefits of exercise training have yet to obtain the necessary proof, the classic examples being reductions in all-cause mortality [25] and improvements in resting cardiac function [26].

The unaltered cardiac function during rest with physical training, and the absence of a correlation between left ventricular ejection fraction and physical capacity, leads scientists increasingly to believe that the main effects of physical training on CHF are more peripheral than central.

Programming physical training

Before initiating physical training, a stress test is necessary to identify any potentially dangerous electrocardiographic abnormalities and to stratify risks in CHF patients [27]. It is also very useful in the prescription of physical exercise, since it evaluates heart rate (HR) dynamics, identifies the metabolic transition during stress, and quantifies the maximum and sub-maximum physical capacity in CHF patients (specifically through ergospirometry) [28–30].

The prescription of aerobic exercise uses a maximum physical capacity percentage, represented by the maximum oxygen consumption (VO_2max). Normally, we use the relative heart rate of 50% to 80% of VO_2max or 50% to 90% of peak heart rate or 60% to 80% of the reserve HR or, more specifically, the HRs referring to the metabolic transition points [27]. Although there is no consensus as to which methods and physical exercise intensities are better for the treatment of CHF patients, the sub-maximum (those performed between the aerobic threshold and the respiratory compensation point) seem to offer a better safety/efficiency balance [31]. Physical exercises of high intensity, i.e. those beyond the respiratory compensation point, are associated with great displeasure [32] and significantly reduce patient compliance with the training [33].

A typical training session comprises a warm-up (10–15 min), endurance training (15–30 min) and cool-down (3 to 6 min) [1, 17]. However, resistive exercise training has grown in importance over the years and nowadays deserves special attention as part of a cardiovascular rehabilitation program [34]. Initial improvements are normally seen after four weeks of exercise training. A progression of exercise training is recommended: duration, then frequency, then intensity [1].

Compliance with the rehabilitation program

CHF patient compliance with the physical exercise program represents a great challenge for physical training professionals. Data is very vague and varies according to the parameter used to evaluate compliance, but about 28% to 37% of heart disease patients leave the physical training program [35]. Many factors contribute to this high drop-out rate, such as social-cultural background, advanced age, female gender, low physical capacity, depression, excessive tiredness during exercise, low motivation and prolonged time periods in the rehabilitation program [35, 36].

Developing strategies to increase physical training program compliance is of great relevance in helping to improve patient health and decrease costs. Developing exercise prescription methods that offer patients autonomy and the possibility to self-regulate his/her efforts and to self-adapt to his/her physical training to achieve the target of the training, using simple tools, could be very useful in increasing compliance with physical exercise programs. The consequence would be improved physical capacity with decreased financial costs. Therefore, the patient could contribute in a more independent way with his/her physical training program manager and with his/her own health.

Monitoring physical training

A commonly used tool to monitor and prescribe physical training is the HR [27, 28]. This cardiovascular variable is an inexpensive and relatively easy way of measuring, something that can be done via a heart monitor or self-palpation of the radial or jugular artery. Using the HR offers a relative autonomy to the patient, but the evolution and adaptation of his/her physical training and effort target depends on serial cardiopulmonary exercise tests. Since the physical conditioning of the patient will change over time, the HR related to the training target can also change.

Concerning the HR, until recently the belief persisted that it did not increase during physical effort (chronotropic response) in CHF patients using beta-blockers. This meant that its use in the prescription of physical exercise could be invalidated. Nowadays, it is known that a chronotropic response (heart rate reserve) to effort exists and does not depend on the clinical situation of the patient concerning the optimization or non-optimization of beta-blockers [28]. The great advantage of using HR as a variable for physical exercise prescription and monitoring is its close relation to oxygen consumption (VO_2), both in healthy individuals [37] and in CHF patients [29]. In healthy individuals, this relation is even closer when we analyse the reserve HR percentage compared to the VO_2 reserve percentage [29]. In CHF patients, this closer relationship only appears to be true for those who use a full dose of beta-blockers and with a resting HR of 50 to 60 beats per minute [29]. Nevertheless, the use of the HR related to the anaerobic threshold and the respiratory compensation point is still the most precise method for aerobic physical exercise prescription for CHF patients who use beta-blockers [38].

Another simple, practical and inexpensive method of physical training monitoring in CHF is through a subjective effort perception, using the commonly known Borg scale. The Borg scale was formulated in the 1970s by the Swedish physiologist Gunnar Borg with the objective of quantifying the symptoms of patients such as breathlessness and chest pain [39, 40]. There are two versions of the Borg scale: the original going from 6 to 20 and a modified one that goes from 0 to 10 (Table 1). The Borg scale has become the most widely used tool for measuring effort intensity self-perception. It is practical, inexpensive, and relates to important physiological variables, although it does contain some contradictions [41].

Table 1. Original and modified Borg scales.

Original Borg scale		Modified Borg scale	
6		0	Nothing at all
7	Very very light	0.5	Very very light
8		1	Very light
9	Very light	2	Light
10		3	Moderate
11	Fairly light	4	Something hard
12		5	Hard
13	Somewhat hard	6	
14		7	Very hard
15	Hard	8	
16		9	
17	Very hard	10	Very very hard
18			
19	Very very hard		
20			

Many of the relations found among the physiological variables and the subjective perception of effort are associated with the reflexes of the metabolic transition of the patient's ventilatory effort throughout a progressive exercise. The magnitude of the respiratory system response seems to be related to dyspnea and the subjective perception of effort.

In essence, there are three metabolic phases in progressive exercise. The first is the phase where the metabolism is predominantly aerobic. The second phase is the aerobic metabolism associated to the anaerobic in its compensated phase. The third is when the metabolism is predominantly anaerobic. The transition point between the first and second phases is called the 'anaerobic threshold', while that between the second and third phases is called the 'respiratory compensation point'. These metabolic transition points are accompanied by an expressive increase of ventilatory effort (tidal volume and respiratory rate, or what is commonly called ventilation). The increased ventilation at the first threshold is motivated by an increase of carbon gas production, the reflex of the acid buffer by bicarbonate and, in the second threshold, the fall of blood pH [42].

Based on this relation between the metabolic transition and the subjective effort perception, using the Borg scale to map progress from 'relatively easy' to 'slightly tiring' has been proposed to guide the physical exercise and guarantee a sub-maximum effort in CHF patients [9, 43].

It is recommended that patients with CHF should be under direct monitoring and supervision, especially to begin with [44]. Telemetry monitoring is also recommended initially [42]. It would be prudent to monitor patients who have demonstrated exercise-induced arrhythmias during an exercise test, and those patients in an advanced form of CHF [17].

Hydrotherapy as an alternative rehabilitation method

Hydrotherapy, in other words physical exercise performed in warm water, was once considered dangerous for CHF patients due to the supposed exacerbated increase of venous blood return caused by hydrostatic pressure. However, we now know that the cardiac function presents an expressive improvement when the patient is immersed in warm water. This occurs due to the increase in the diastolic input and the decrease of the HR, leading to an increase of systolic volume and left ventricular ejection fraction [45]. The attenuating mechanism of the plasmatic rennin activity and the increase of diureses, possibly motivated by the activation of renal baroreceptors and the increase of splanchnic blood flow during immersion, has been described [46].

Apart from concern about the hemodynamic response to the immersion of CHF patients in a warm pool, there was also concern about the respiratory system response. However, we now know that respiratory alterations that occur due to immersion in a heated pool are small, and similar in CHF patients to that in healthy individuals [47].

Hydrotherapy seems to have advantages compared to physical training performed out of the water [48–50]. These advantages seem to be related to the combined effect of the benefits concerning physical training for the attenuation of the sympathetic activity and improvements of vascular function, among others, with the benefits offered by the heat [51]. These findings suggest that hydrotherapy could be a potential additional treatment for CHF patients, although very few studies are as yet available.

Interval physical training as an alternative method in rehabilitation

Interval physical training has shown itself to be an effective, safe and well tolerated method for heart failure patients [52]. This technique consists in alternating the intensity of training from moderate to high. In a previous study with heart failure patients, a higher VO_2 gain and a significant improvement of vascular function was demonstrated than among those individuals who performed steady exercises. We believe that the main mechanism responsible for the better results in the interval training is shear stress. It promotes a vascular workout with NO release and significantly improves vascular function. This method stands out for the substantial improvement of a particular prognostic factor involved with heart failure: endothelial dysfunction. Despite this, the few studies available have had very limited samples and none have studied the acute effect of interval exercise compared to a steady one in the same patient [53–55].

Conclusions

Physical training is a safe and efficient tool in patients with CHF. Careful exercise prescription and training monitoring are crucial in achieving good results. Some new modalities in cardiovascular rehabilitation are getting stronger and may contribute to greater patient adherence, despite the lack of studies.

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