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ORIGINAL ARTICLE

Supervised exercise improves autonomic modulation in participants in cardiac rehabilitation programs☆

Pablo Marino Corrêa Nascimento[a,*], **Marcelo Carvalho Vieira**[a], **Sandro Sperandei**[b], **Salvador Manoel Serra**[a]

[a] *Centro de Cardiologia do Exercício, Instituto Estadual de Cardiologia Aloysio de Castro, Rio de Janeiro, Brazil*
[b] *Instituto de Comunicação Científica e Tecnológica em Saúde, FIOCRUZ, Rio de Janeiro, Brazil*

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Abstract
Background and Objectives: An attenuated heart rate recovery (HRR) response after exercise testing is a robust predictor of mortality. Regular exercise can enhance various physiological parameters. Studies indicate that participation in a cardiac rehabilitation program can improve heart rate recovery. The aim of this study was to analyze changes in functional capacity and autonomic modulation in patients following a cardiac rehabilitation program.
Methods: Between 2009 and 2014, 248 individuals were assessed through exercise testing, at baseline and after six months of participation in a cardiac rehabilitation program. The exercise test was performed on a treadmill using a ramp protocol. The first minute of active recovery was standardized at a speed of 1.5 mph and slope of 2.5%. The degree of parasympathetic modulation was assessed by the difference between peak exercise heart rate and heart rate at one minute of recovery. The subjects were divided into two groups according to pre-training HRR ($\leq$12 bpm and >12 bpm).
Results: Exercise training resulted in a similar increase in metabolic equivalent values in both groups, but only the HRR $\leq$12 bpm group showed improvement after training ($F=16.13$; $p<0.001$), with a mean increase from 7.4±3.69 bpm to 13.0±9.74 bpm.
Conclusions: The cardiac rehabilitation program had a positive impact in a group that had both low functional capacity and reduced parasympathetic activity, producing a favorable effect on these recognized prognostic markers.

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* Corresponding author.
E-mail address: marino_pablo@yahoo.com.br (P.M.C. Nascimento).

PALAVRAS-CHAVE
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Sistema nervoso autónomo

Atividade física supervisionada melhora a modulação autonómica de participantes de reabilitação cardíaca

Resumo
Introdução e objetivos: A resposta atenuada da recuperação da frequência cardíaca após o teste de exercício é um robusto preditor de mortalidade. A prática regular de atividade física é capaz de aprimorar diversos parâmetros fisiológicos. Estudos indicam que a participação em programa de reabilitação cardíaca pode melhorar a recuperação da frequência cardíaca. Assim, o objetivo deste estudo foi avaliar as modificações na capacidade funcional e na modulação autonómica de participantes de um programa de reabilitação cardíaca.
Métodos: Entre 2009-2014, 248 indivíduos foram avaliados, através do teste de exercício, antes e após seis meses de participação em programa de reabilitação cardíaca. O teste de exercício foi realizado em esteira rolante, aplicando-se o protocolo em rampa. A recuperação foi ativa e o primeiro minuto da recuperação foi padronizado, com velocidade de 1,5 mph e inclinação de 2,5%. A intensidade da modulação autonómica foi avaliada através da diferença entre a frequência cardíaca do pico do exercício e a do primeiro minuto da recuperação. Os indivíduos foram divididos em dois grupos, de acordo com a recuperação da frequência cardíaca pré-treinamento (RFC $\leq$ 12 e RFC > 12).
Resultados: O treinamento promoveu aumento similar na capacidade funcional de ambos os grupos. No entanto, apenas o grupo RFC $\leq$ 12 mostrou acentuação na recuperação da frequência cardíaca (F = 16,13; p < 0,001), aumentando, em média, de 7,4 $\pm$ 3,69 bpm para 13,0 $\pm$ 9,74 bpm.
Conclusões: O programa de reabilitação cardíaca foi capaz de atuar favoravelmente em um grupo que possuía, simultaneamente, baixa capacidade funcional e reduzida atividade autonómica parassimpática, interferindo efetivamente nestes dois marcadores de prognóstico.

Introduction

A slow decrease in heart rate (HR) after the end of incremental exercise is associated with reduced cardiac parasympathetic autonomic modulation and higher all-cause mortality.[1,2]

Supported by previous studies,[1,2] Cole et al.[3] demonstrated that an attenuated heart rate recovery (HRR) response after peak exercise is a robust predictor of mortality. A more recent study, using a reversible anticholinesterase agent during exercise, confirmed that parasympathetic activity is the main reason for variations in HR fall in the recovery period.[4]

Since then, several other studies have confirmed that individuals with an attenuated HRR response at one minute after exercise testing present a greater risk of death, independent of their exercise capacity, severity of coronary artery disease (CAD) and left ventricular function, even in patients with no cardiovascular symptoms.[5–7] Most studies use a fall in HR of 12 bpm between peak exercise and one minute of recovery as the cut-off when assessing parasympathetic modulation, a figure endorsed by the Brazilian Society of Cardiology in its latest guidelines on exercise testing.[8,9] A decrease of >12 bpm represents a normal response, while a fall of $\leq$12 may indicate parasympathetic dysautonomia.

Patients with cardiovascular disease undergoing a cardiac rehabilitation (CR) program, based mainly on regular exercise, show clear functional improvement with a favorable impact on prognosis.[10] Previous studies have shown that the exercise component of a CR program improves HRR after peak exercise.[11–16] However, Currie et al.[17] found no effect on HRR after 12 weeks of high-intensity interval and moderate-intensity endurance exercise training in patients with CAD.

Against this background, the aim of the present study was to analyze the effects of a CR program on functional capacity and autonomic modulation, bearing in mind the strong prognostic impact of these variables.

Methods

The study population consisted of all patients with stable CAD who completed at least six months of a supervised CR program at a tertiary cardiology center between May 2009 and December 2014. Data collected from medical records included baseline and post-CR exercise test results, use of negative chronotropic drugs and diagnosis of diabetes, together with demographic and anthropometric data. Patients with permanent atrial fibrillation and those with pacemakers were excluded, since these can affect HRR response.

Patients were assessed through exercise testing immediately before and after participation in the CR program. The test was performed on a treadmill using an individualized ramp protocol designed to achieve peak exercise in 10 min. There was an active recovery period of at least 5 min. The first minute of recovery was standardized at a speed of 1.5 mph and slope of 2.5%, as in Cole et al., which defined