Heart rate recovery after physical exertion tests in elderly hypertensive patients undergoing resistance training

Recuperação da frequência cardíaca após testes de esforço em idosas hipertensas submetidas a treinamento resistido

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Abstract

Introduction: Heart rate recovery after exercise is a valuable variable, associated with prognosis and it has been used as an indicator of cardiorespiratory fitness, especially in patients with heart disease, as hypertensive patients. **Objective:** This study aimed to analyze the response of heart rate recovery in elderly hypertensive patients undergoing a resistance training program. Methods: Sample was composed for 10 elderly women with a mean age of 70.7 ± 7.4 years. Exercise test and six-minute walk test were developed and we checked heart rate recovery in the 1st and 2nd minute post tests, before and after resistance training. **Results:** There was an increase in mean heart rate recovery in the analyzed minutes in both tests, but only in the 1st minute after six minutes walk test we found a significant increase (p = 0.02). **Conclusion:** The results suggest the efficacy of resistance training to improve cardiorespiratory fitness of elderly hypertensive patients.

Keywords: Heart rate. Hypertension. Exercise. Elderly. Exercise test.

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Resumo

Introdução: *A recuperação da freqüência cardíaca após o exercício é uma variável valiosa que está associada com o prognóstico e vem sendo utilizada como indicador do condicionamento cardiorrespiratório, principalmente em pacientes cardiopatas, como é o caso dos hipertensos.* ***Objetivo:*** *O presente estudo objetivou analisar a resposta da recuperação da freqüência cardíaca em idosas hipertensas submetidas a programa de treinamento resistido.* ***Métodos:*** *A Amostra foi composta de 10 idosas com média de idade de 70,7 ± 7,4 anos. Realizou-se o teste ergométrico, o teste de caminhada de seis minutos e verificou-se a recuperação da freqüência cardíaca no 1° e 2° minutos após a realização dos testes pré e pós-treinamento resistido.* ***Resultados:*** *Observou-se aumento na média da recuperação da freqüência cardíaca nos minutos analisados em ambos os testes, porém apenas no 1° minuto após o teste de caminhada de seis minutos encontrou-se aumento significativo (p = 0,02).* ***Conclusão:*** *Os resultados sugerem eficácia do treinamento resistido para melhorar o condicionamento cardiorrespiratório das pacientes.*

Palavras-chave*: Frequência cardíaca. Hipertensão. Exercício. Idoso. Teste de esforço.*

Introduction

Systemic arterial hypertension (SAH) is a multifactorial disease with high prevalence in elderly, especially in women, becoming a determining factor in high morbidity and mortality rates of these individuals (1). Estimates suggest the high growth of this disease in different countries, being one of the major public health problems worldwide (2).

Among the main causes for establishment of HAS we highlight the low level of physical activity and excessive body fat (3, 4). Thus, changes in lifestyle are primordial to hypertension prevention, treatment and control, being physical exercise an integral component of this program (5). Some studies have shown the efficacy of resistance training (RT) in reducing blood pressure levels in hypertensive individuals (6, 7).

Heart rate recovery (HRR) has a relationship with cardiovascular function, where slower reductions are directly related to the worsening of cardiovascular mortality and function (8). Recent studies have shown that the HRR decrease after exercise is associated with less favorable prognosis in patients monitoring (9). For this reason, studies have pointed HRR post exercise as a prognostic tool (10).

In this context, HRR has been used in several studies (11-13) also as an indicator of cardiorespiratory fitness. HRR immediately after exercise is considered a reactivation function of parasympathetic activity modulation and a reduction in sympathetic activity

modulation, that typically occurs during the first 30 seconds after exercise (9, 14).

In combination, the scientific literature offers several physical tests, such as six-minute walk test (6MWT), as well as exercise test (ET) on a treadmill, which are valuable tools for cardiac patients functional performance assessment (15, 16).

Thus, considering the high prevalence of hypertension in elderly, especially in women, and noticing the lack of research on the analysis of HRR after RT program in that population, this study aimed to analyze the HRR response in elderly hypertensive women undergoing a RT program.

Materials and methods

Sample selection

Patients with controlled hypertension diagnosis were recruited from the Program of Support and Care for Hypertension (PSCH), linked to a high complexity in cardiology hospital.

Females, aged 60 years or higher, with clinical stability, medical agreement based on clinical assessment and previous ET were considered eligible for this study. The study excluded patients who had inappropriate response of blood pressure (BP) and heart rate (HR) during the ET, ET-induced ventricular arrhythmias, severe pulmonary hypertension or

other serious lung disease, consumption of alcohol and / or tobacco, use of tranquilizers or sedatives, confusion or dementia, orthopedic limitation and/or cognitive impairment that could hinder the tests execution, pain or inability to perform the protocol established by the research and changes in medication during the study period. Besides, it was excluded patients who were absent in more than 15% of the proposed period for training or three consecutive absences, in order to diminish bias in the evaluation at the end of training, being held for all participants the conditioning obtained with RT program.

Previously, patients were informed about the study's purpose and it was asked to consent by signing a consent form approved by the Ethics Committee of the institution, under the number 223/08.

Study Dynamics

In this longitudinal study of quasi-experimental type, selected patients underwent a clinical evaluation for entry into the RT protocol, including resting electrocardiogram analysis, ET and 6MWT.

At baseline evaluation, a sheet was filled in addition to personal data, anthropometric measurements, such as weight and height, as well as information on pathological history. For body composition analysis, the volunteer's body weight was measured, through a Filizola® mechanical scale. Height was measured through a stadiometer and we calculated body mass index (BMI).

BP measurement was performed by indirect auscultation method using a BD® stethoscope and BD® sphygmomanometer. Procedures for BP measurements were based on VI Brazilian Guidelines on Hypertension (17).

Exercise testing

A Micromed® treadmill was used for exercise testing (Centurion 200 model). Ramp protocol was used, in which the load increase was given by a continuous and gradual manner during the entire duration of effort. The reason that the load was increased was defined individually for each patient, considering sex, age and physical condition. So, we had a good approximation of the individual maximum oxygen uptake (VO2max). From this, the protocol suggested the percentage of slope and speed, which would be necessary to take the patient to a maximal effort at a desired time, usually between 8 - 12 minutes (18).

Six minutes walk test

The 6MWT was performed on a 30 meters corridor, marked meter by meter, by a single examiner, following the American Thoracic Society (ATS) protocol (19).

Patients were instructed to walk as fast as possible without running, according to their exercise tolerance in the 6-minutes period. Before starting each test, respiratory rate and heart rate were obtained, measured by a pulse oximeter (Nonin® brand - Onyx-9500 model), and blood pressure was measured by a BD® sphygmomanometer and a Littman® stethoscope. The perceived exertion was measured using Borg Scale (20). At the end of each test, these parameters were recorded again, as well as the total distance walked in meters for the period of 6 minutes.

HRR measurement

HR was measured in supine position during every minute of the two stress tests developed, at peak exercise and on 1st and 2nd minutes of recovery after the tests. HRR was defined as HR at peak exercise — HR in the specified period after exercise and represented the fall of HR during this time interval (10).

Resistance training program

Before RT, volunteers underwent an adaptation period of exercise, lasting two weeks, to learn the correct techniques of movements execution.

After this adaptation process, tests of eight maximum repetitions (8-MR) were developed to the muscle groups to be trained. The 8-MR test corresponded to the maximum load that can be lifted by the participant throughout the normal range of motion, while maintaining the proper technique, in eight successive repetitions.

RT lasted eight weeks, with a weekly frequency of three times, every other day, held in two sets of eight repetitions, always in the afternoon. Training intensity was progressively increased throughout the training program, i.e., in the end of each week the

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patient was oriented to do two more repetitions of each exercise, and if possible, the current load was increased by 5% (21, 22).

The adopted training method was the alternate segments with exercises performed sequentially in the following order: leg press, bench press, leg extension, frontal pull chair, leg curl knee, shoulder abduction with dumbbells, hip abduction and barbell curl. The execution speed used was 2: 2 and a 2 - minute rest interval between each series (5).

During the movements execution, the patients were instructed to breathe properly and continuously during each exercise repetition, exhaling during the concentric contraction and inspiring during the eccentric contraction, and thus, reducing the chance of performing Valsalva maneuver.

Before RT, patients developed a 5 minutes heating, through a light walk, followed by self-stretching the major muscles used, which had been previously oriented. After each training session, self-stretching exercises were repeated.

Statistical analysis

Data were analyzed using the statistical software Statistical Package for Social Sciences version 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive analysis was presented as mean and standard deviation (SD). Normality test for the studied variables indicated data normal distribution using Kolmogorov-Smirnov test, which allowed the use of paired Student t test for dependent samples. Significance level was of 5%, with a confidence interval (CI) of 95% for all analyzes.

Results

15 volunteers were eligible for the study. However, five of these gave up participating for personal reasons, among them: cataract surgery, unfeasible driving until the training camp and family commitments. Thus, the sample consisted of 10 hypertensive patients, mean age 70 years and BMI > 25 kg / m². Among the comorbidities observed, it was evidenced hypercholesterolemia (80%), arthritis (50%) and obesity (50%). The patients' clinical characteristics are summarized in Table 1.

All patients in the study were able to complete 6MWT without stopping or interrupting the

examination. Regarding the execution of ET, we did not found arrhythmias or other symptoms that could avert the realization of RT protocol.

Table 1 - General characteristics of the study population

Age (years**)**	70.7 ± 7.4
Weight (Kg**)**	61.6 ± 9.04
Height (m**)**	1.55 ± 0.09
BMI (Kg/m2**)**	25.14 ± 3.34
Hemodynamic variables (rest)	
SBP (mmHg)	150 ± 15.63
DBP (mmHg)	94 ± 8.43
HR (bpm)	78 ± 18.67
Comorbidities	
Diabetes Mellitus	1 (10%)
Hypercholesterolemia	8 (80%)
Osteoporosis	1 (25%)
Arthritis	5 (50%)
Obesity	5 (50%)
Medications in use	
Beta-blocker	4 (40%)
ACE Inhibitor	6 (60%)
Diuretic	1 (10%)
Calcium channel blocker	4 (40%)

Note: BMI: Body mass index; ACE: Angiotensin-converting enzyme; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate.

Regarding HRR behavior after 6MWT, there was a significant difference (p = 0.02) between the results obtained in the 1st minute of recovery when comparing the moments before and after RT program. However, in the 2nd minute after the test, despite increase in mean values, there was no significant difference between HRR results obtained pre and post-training (p = 0.17). These values are described in detail in Table 2.

There was an increase in HRR mean values after ET when comparing the moments before and after RT program. However, this difference observed in 1st minute and 2nd minutes was not significant (p = 0.16 and p = 0.30, respectively), as described in Table 3.

Discussion

The sample consisted of elderly hypertensive women, who presented obesity and hypercholesterolemia

Table 2 - Average values, standard deviation and p value of HRR in the 6-minute walk test, developed in 10 patients diagnosed with hypertension.

6MWT	Pre RT	Post RT	p value
Heart rate recovery (bpm)			
1º minute	25.5 ± 8.8	31.6 ± 10.0	0.02*
2º minute	29.4 ± 12.7	34.3 ± 9.8	0.17

Note: 6 MWT: 6 - minute walk test, HR: heart rate, RT: resistance training; *significant difference (p < 0.05).

Table 3 - Average values, standard deviation and p value of HRR in exercise testing, developed in 10 patients diagnosed with hypertension.

Exercise Testing	Pre RT	Post RT	p value
Heart rate recovery (bpm)			
1º minute	27.0 ± 16.3	34.6 ± 11.8	0.16
2º minute	38.5 ± 11.9	42.5 ± 10.2	0.30

Note: HR: heart rate, RT: resistance training; * significant difference (p < 0.05).

as main comorbidities. It is known that females are associated with more rapid HRR (9) and that factors such as increasing age (9, 23), high BMI levels (BMI > 25kg/m^2) (24), increased abdominal girth, hypercholesterolemia and high systolic pressure (23, 25) are independently associated with attenuated response of HRR post exercise.

Recent studies (23, 25, 26) indicate that both individuals with prehypertension as those with hypertension may have delayed HRR when compared to healthy subjects, suggesting that this pathology is associated with autonomic dysfunction and confirms the importance of their assessment in hypertensive patients, especially when there are co-morbidities associated.

HRR evaluation, besides permitting infer a cardiovascular autonomic regulation dysfunction, as evidenced by a slow decline in the 1st and 2nd minutes after a stress test (27), can be considered a risk factor for cardiovascular disease and furthermore, shows correlation with mortality from all causes (28 - 30). There is also direct correlation of HRR with maximum oxygen uptake, so it is believed that patients with an attenuated response have lower exercise capacity (31, 32).

In this regard, it was noted that HRR values in 1st minute pre-intervention in this study (25 to 27 bpm, depending on the used test) corroborate with those found in the literature. Aneni *et al.* (26), evaluating individuals with hypertension, found a HRR in the 1st minute of 24 bpm, significantly lower when compared to that found in healthy individuals. However, in general, a decrease of 20 to 45 bpm in the 1st minute of recovery, as found in this study, is related to a good cardiovascular health and a favorable clinical outcome (28).

When observing HRR in the 2nd pre-intervention minute, the results of this research (29 and 39 bpm, depending on the assessment) show values that are still lower than those found by Aneni *et al.* (26), which also evaluated patients with hypertension and found a slower HRR in the 2nd minute post exercise (54 bpm) compared to normotensive subjects (65 bpm).

Among the results of this study, it is possible to highlight the increased speed of HRR found in patients after their participation in an eight-week resistance training program. This improvement was evidenced by the significant increase in HRR in the 1st minute post 6MWT, as well as an increase, although not significant, in one minute after ET. Regarding HRR in the 2nd minute after both tests, although also not significant, there was an increase in average after the training program.

It is necessary to resume the concept that heart rate after exercise has a slow and a fast phase recovery (11). It is suggested that a high drop in HR at 1st minute (fast phase) not necessarily result in a steepest HR in the following minutes (slow phase) (33). Maybe that is why there has been a significant difference in the 1st minute and has not occurred in the 2nd minute for any of the tests.

It is well established that aerobic exercise training can increase the delta between HR at the end of exercise and in early stages of recovery (34 - 36), and eight weeks of training would be sufficient to raise the recovery speed in the first 30 seconds after exercise (34). However, when compared to aerobic, little is known about the autonomic control post RT (37 - 40), especially in clinical populations of elderly hypertensive patients.

In the present study, it is supposed that the HRR response increase to RT program may be a reflection of the benefits that the regular practice of resistive exercise has (5). Among these benefits, some are directly related to HRR, for example, improvements in cardiorespiratory fitness (41), which can be a cause

of the improved HRR, found through the 6MWT after a RT program, in this study.

Therefore, it is suggested that the HRR evaluation should be considered in a RT program for elderly hypertensive people, once it could be able to reflect health risks, and possibly could be used for RT prescription and monitoring (38, 39).

Some limitations can be found in this study: 1) a small sample size, which may be one of the reasons it was not found significant difference between the tests in the 2nd minutes recovery; 2) although the HRR is a simple method to evaluate parasympathetic tone, the use of heart rate variability would provide a more sensitive and accurate assessment of autonomic nervous system function; 3) once the sample was composed only of women, there may be limitations to extrapolate the results for hypertensive men; 4) There was no control group.

However, these limitations do not invalidate this research results because, despite several studies about HRR post physical tests are found in the literature, there is still lack of researches in order to verify, through that variable, the effects of RT for elderly hypertensive population, since this group is leaning to develop cardiovascular diseases, showing a less favorable prognosis.

Conclusion

There was a significant increase in HRR in the 1st minute post 6MWT, and an increase, although not significant, of the remaining minutes average in both tests. This may reflect an improvement, directly or indirectly, of the cardiac post-exercise autonomic control, due to a RT program. In addition, it may mean, despite not having been this study focus, reduced risk of cardiovascular complications for elderly hypertensive patients.

It is suggested that HRR should be observed in future researches, especially involving clinical populations; other studies will also be needed to clarify mechanisms of increased parasympathetic activity in these patients after their participation in the RT program proposed, as well as the risk of cardiovascular events related to this autonomic modulation.

Potential Conflict of Interest

No potential conflict of interest.

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