EFFECT OF RESISTENCE TRAINING IN BLOOD PRESSURE AT REST IN NORMOTENSIVE ELDERLY

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

Introduction: Resistance training (RT) has been widely used for older adults in order to minimize or reverse the deleterious effects of aging in the neuromuscular system. However, the potential benefits of RT on arterial blood pressure and resting heart rate in older adults remain controversial. Objective: To analyze the effect of eight weeks of RT on systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR) in older women without hypertension. Methods: Seventeen women (aged 66.0 ± 5.8 years) without previous experience in RT were randomly assigned to either a training (TG, n = 10) or control (CG, n = 7) groups. Hemodynamic parameters at rest were evaluated by auscultatory method (mercury sphygmomanometer) and HR monitor (Polar), before and after eight weeks of experimental period. Results: Reduction possibly caused by RT were found only to SBP (-13.4 mmHg, p <0.01). Although significant reductions were observed for DBP and MAP, the analysis of covariance showed no interaction Group x Time significant. Conclusion: RT proved to be an effective training to promote adaptations in the cardiovascular system of older women without hypertension. Eight weeks of RT can significantly reduce resting SBP in older women.

Keywords: aging, exercise, cardiovascular system.

INTRODUCTION

The aging process is associated with structural and functional alterations of the cardiovascular system which lead to linear increase of the rest pressoric levels[1,2]. With age progresses, differences in the resting blood pressure behavior (BP) are observed between genders, with women presenting higher prevalence of high blood pressure (HBP) from the fifth decade of life [3-6]. When considering that high BP levels represent an isolate and continuous risk factor for cardiovascular morbidity and mortality, the adoption of strategies to primarily prevent HBP, especially for borderline individuals, has been recommended[7].

One of the non-pharmacological strategies adopted for HBP prevention and control is the regular practice of physical exercises. In the elderly, the prescription of resistance exercises has been widely recommended due to their countless metabolic, morphological and functional benefits[8]. However, the chronic effect of resistance training (RT) in the cardiovascular function of the elderly remains controversial. In normotensive elderly subjects, some studies have not verified any significant alteration in systolic blood pressure (SBP) and diastolic blood pressure (DBP) at rest after performance of RT[9]. On the other hand, different studies have shown isolated reduction in SBP[10], DBP[11] or in both simultaneously[12]. The differences observed in the magnitude of BP alteration after RT may be related to the influence of the manipulation of the variables involved in the prescription of RT and the characteristics of the studied sample[13-15].

Therefore, many studies which investigated the chronic effect of RT in rest BP in elderly subjects had different RT methods and individuals of both genders in their samples. Due to differences related to gender in aging and adaptation responses of the cardiovascular system to physical exercise[16], studies which investigate only older women and which apply current recommendations for RT prescription may help in the comprehension of the possible effectiveness of RT programs in reducing rest BP of this population. Thus, the aim of the present study was to analyze the effect of eight weeks of RT on the SBP, DBP, mean arterial pressure and rest heart rate in elderly women without high blood pressure.

MATERIALS AND METHODS

Subjects

Twenty-one elderly women from the community were randomly sorted out in two groups: Training Group (TG; n = 11) and Control Group (CG; n = 10). All participants underwent a clinical assessment and the adopted inclusion criteria were: absence of HBP according to the criteria adopted by the Brazilian Society of Cardiology[7], absence of musculoskeletal and/or known neurological disorders and lack of regular participation in any kind of physical exercise training in the last three months preceding the beginning of the study. One participant of the TG and three of the CG did not complete the experimental period due to personal reasons or orthopedical problems not related to the intervention. Thus, 10 subjects comprised the TG (age: 61.7 ± 4.8 years) and seven the CG (age: 65.0 ± 5.1 years). The participants received verbal information about the procedures which they would be submitted to and signed a Free and Clarified Consent Form approved by the local Ethics Committee (protocol n°: 6.086).

Anthropometry

Body mass was measured on a Welmy mechanical scale (model R 110), with accuracy of 0.1 kg, while stature was determined with a metallic stadiometer by Sanny (model ES2020) attached to the wall, with resolution of 1 mm. All assessment procedures were performed according to the recommendations by Gordon *et al.*[17]. From these measures, the body mass index (BMI) was calculated with the ratio between body mass (kg) and the square of the height (m^2).

Evaluation of the hemodynamic variables at rest

In both groups (TG and CG), SBP, DBP and rest heart rate (HR) were measured by a single experienced evaluator, on three alternated days, before and after the eight-week experimental period. All procedures followed the recommendations by Pickering *et al.*[18]. BP measurement was through the auscultatory method with a mercury column sphygmomanometer by Sankey and a stethoscope by Rappaport – Premium. The HR values were also obtained at these conditions through a heart frequency meter by Polar (model FS1). mean arterial pressure (MAP) at rest was determined through the equation: MAP = [(2 X DBP) + SBP]/3. The measure technical error for the SBP and DBP was of 3.5 and 3.0 mmHg, respectively. The intraclass correlation coefficient for SBP was of 0.98 (95% CI; 0.89 – 0.99) and of 0.96 for the the DBP (95% CI; 0.80 – 099).

Resistance training protocol

The RT program had duration of eight consecutive weeks and comprised three weekly sessions on alternated days. The protocol was composed of seven exercises performed in the following order: fly (pectoralis); leg press (quadriceps femoris and gluteus); front pulldown (latissimus dorsi); triceps pulley (triceps brachii); leg press calf raise (gastrocnemius); dumbbell screw curl (biceps brachii) and abdominal bench (rectus abdominis). All exercises were performed on machines by Righetto (Campinas, SP), except for the screw curl and abdominal exercises.

Initial training loads for each exercise were determined on the week prior to the beginning of the experimental protocol through a maximum load test (RM)[19]. All the participants were submitted to three sessions of tests on alternated days, with 48-hour interval between sessions. Each session was composed of a warmup set with 50% of estimated load for the first attempt and three consecutive attempts for determination of the loads referring to 10-12 RM. The rest interval between attempts was of five minutes.

The training sessions were performed in three sets of 10 to 12 RM, with rest interval between sets and exercises of 90 seconds. Exercise cadence was of approximately two seconds for the concentric phase and three seconds for the eccentric phase. A digital lap watch was used to determine the mean time of each repetition (total time of the set/number of repetitions performed) and verbal instructions were given whenever the cadence was not respected (except for repetitions close to fatigue). The training loads were adjusted whenever the pre-set maximum number of repetitions (12 RM) was surpassed in two repetitions in the last set. Therefore, external resistance was sufficiently incremented (2 to 10%) so that the number of repetitions on the last set returned to the pre-set lower threshold (10 RM). The exercise for the abdomen muscle group was performed on a bench without inclination; with the body own weight, in two steady sets of 15 repetitions. All test and training sessions were performed at the same time of the day and supervised by the researchers.

Statistical treatment

The Shapiro-Wilk test was used to verify whether the data were different from normal distibution. Student's t test for independent samples was applied for analysis of possible diferences between groups at initial conditions. The possible effect related to the RT in the physical characteristics and hemodynamic variables of the participants were examined by analysis of variance 2 x 2 ANOVA (Group x Moment), with repeated measures in the last factor. Analysis of covariance (ANCOVA) was applied when initial conditions between groups were statistically different, with the measures pre-set before the experimental period being adopted as covariables. Levene's test did not evidence differences in the variance/covariance between groups. The size of the effect (η_p^2) for the Group x Moment interaction was also calculated. Significance level adopted for all analyses was of $p < 0.05$. The statistical package used was the SPSS, version 17.0.

RESULTS

The engagement level for the RT was high, with the participants being present in 97% of the training sessions. Two participants were absent from two sessions and three of them from one. No adverse effect was observed with the RT.

The physical characteristics of the participants from both groups, at the pre and post-experimental period moments, are presented in table 1. None significant difference was observed between groups at initial condition. Height and BMI did not alter after the experimental period for the two groups. Although a significant interaction Group x Moment had been verified for body mass, the size of the effect observed was small ($\eta_p^2 = 0.24$). Table 2 presents the values of SBP, DBP, MAP and rest HR at the pre and post-experimental period moments for both groups. Reduction delegated to the RT were observed only for SBP ($\eta_p^2 = 0.51$). When the DBP and MAP values were corrected by the difference of the initial condition, ANCOVA did not present significant Group x Moment interaction ($\eta_p^2 = 0.01$; 0.11, respectively).

DISCUSSION

The present study had as main aim to analyze the effect of eight weeks of RT in SBP, DBP, MAP and HR in elderly women without high blood pressure. The tested hypothesis was that RT would promote significant decrease in SBP, DBP and MAP in elderly women without previous experience in RT. According to the American College of Sports Medicine[8], the RT protocol applied in the present investigation was designed for beginners, being characterized with moderate intensity, low to moderate volume for each exercise (three sets of 10-12 RM) and with slow to moderate movement velocity. Based on the results, the RT protocol with these characteristics was efficient in reducing SBP at rest (table 2).

Different studies involving older adults have shown contradictory results concerning the BP behavior after practice of RT [9,10,20-22]. Wood *et al.*[9] reported reduction in HR, with no alteration

Table 1. Physical characteristics of the participants of the resistance training group (TG and control group CG) at the pre and post eight weeks of experimental period moments (values in mean ± standard deviation).

Variables	TG (n = 10)	CG (n = 7)	Effects	F	P
Body mass (kg)			ANOVA		
Pre	62.1 ± 12.4	63.6 ± 11.2	Group	0.03	0.86
Post	62.7 ± 12.8*	63.3 ± 10.7	Moment	0.96	0.34
Δ	0.6	-0.3	Group x Moment	4.91	0.04
Stature (cm)			ANOVA		
Pre	157.3 ± 7.7	156.6 ± 5.3	Group	0.10	0.75
Post	157.4 ± 7.4	156.4 ± 5.5	Moment	0.85	0.37
Δ	0.1	-0.2	Group x Moment	1.40	0.25
BMI (kg/m2)			ANOVA		
Pre	25.0 ± 4.2	26.1 ± 5.4	Group	0.19	0.67
Post	25.2 ± 4.4	26.2 ± 5.5	Moment	1.76	0.20
Δ	0.2	0.1	Group x Moment	0.08	0.78

Δ = Absolute mean change; * Significant difference ($p < 0.05$) concerning the pre-training moment

Table 2. Systolic and diastolic blood pressure (SBP and DBP, respectively) and mean arterial pressure (MAP) behavior during rest for the resistance training (TG) and control groups (CG) at the pre and post-experimental eight-week periods moments (values in mean ± standard deviation).

Variables	TG (n = 10)	CG (n = 7)	Effects	F	P
SBP (mmHg)			ANOVA		
Pre	130.6 ± 5.0	120.6 ± 16.7	Group	0.18	0.67
Post	117.4 ± 9.2*	126.0 ± 13.3	Moment	2.70	0.12
Δ	-13.2	6.6	Group x Moment	15.49	<0.01
DBP (mmHg)			ANCOVA		
Pre	86.2 ± 8.5	74.6 ± 7.5	Group	0.02	0.89
Post	75.2 ± 8.5*	71.4 ± 6.6	Moment	11.17	<0.01
Δ	-11.0	-3.2	Group x Moment	0.02	0.89
MAP (mmHg)			ANCOVA		
Pre	101.5 ± 7.7	89.9 ± 10.4	Group	1.73	0.21
Post	89.8 ± 7.2*	89.6 ± 8.5	Moment	5.56	0.03
Δ	-11.7	-0.3	Group x Moment	1.73	0.21
HR (bt/min)			ANOVA		
Pre	75.7 ± 7.6	76.6 ± 9.7	Group	0.08	0.78
Post	77.4 ± 10.7	74.7 ± 7.8	Moment	0.01	0.97
Δ	1.7	-1.9	Group x Moment	0.53	0.48

Δ = Absolute mean change; * Significant difference ($p < 0.05$) concerning the pre moment.

in SBP, DBP or MAP after 12 weeks of RT in elderly adults of both genders. Taaffe *et al.*[20] found significant reduction only for DBP after application of two different RT volumes in older men and women (one and three sets of 8-RM). Contrary to these findings, Tsutsumi *et al.*[22] demonstrated reduction in SBP when applied RT protocols with different intensities (55-65 and 75-85% of 1-RM). Concerning DBP, significant reduction was observed only for training performed with lower intensity. The main intervenient factors in the different results found may be related to the characteristics of the studies sample (e.g.: genetic influence)[23] and manipulation of the RT variables, which may alter the magnitude of the stress imposed to the cardiovascular system[24] and its autonomic modulation[25]. Janning *et al.*[26] have shown, for example, that the manipulation of the resistance exercises order alone is able to promote alteration in the post-exercise hypotensive response in elderly women.

In the present study, reduction of 13.2 mmHg in the mean values of SBP was higher than the report in young subjects[27]; however, it is in agreement with the results observed in older adults. Terra *et al.*[21], for example, observed reduction of 10.5 mmHg in SBP of hypertensive elderly women after 12 weeks of RT, without significant alteration of DBP. Castaneda *et al.*[28] have also reported isolate reduction in SBP of 9.7 mmHg in diabetic older subjects. These findings are indication that RT may be an important strategy in the SBP control and, consequently, present positive impact in the reduction of the risk to development of different cardiovascular diseases in older subjects. In fact, reduction of 40% in the risk of cerebrovascular accidents and of 15% in the risk of acute myocardial infarction has been reported after persistent reduction of 5 mmHg in rest SBP[29].

Polito[15] has highlighted that although RT may present important effects on the cardiovascular system, the main applicability of this kind of training is the alteration in the different expressions of muscle strength. Therefore, increase in muscle strength may provide reduction in muscular activation and metabolic demand for the same absolute effort. These adaptations positively reflected on the hemodynamic responses, leading to lower cardiovascular stress during a submaximal aerobic effort in older adults[30]. Additionally, RT has been shown as an important factor in the control of muscular aging and incidence of chronic-degenerative diseases, especially metabolic syndrome, since it positively reflect on insulin resistance, abdominal obesity and dyslipidemia. Although the results of the present study help in the comprehension on the RT effect on HR of elderly women, the present experimental protocol does not let us discard the possibility that nutritional factors have contributed to the observed responses. The absence of immediate care monitoring of the blood pressure should be considered when interpreting the results of the present study. Although there are limitations concerning the measures of the pressoric values by the auscultatory method, this method is widely applied in the clinical practice and can be an independent predictor of alterations in the central SBP and DBP[20].

CONCLUSION

The results suggest that RT acts as a safe and efficient model to promote adaptations in the cardiovascular system of elderly women without high blood pressure. Eight weeks of training may positively affect the SBP, leading to significant decrease in the rest values of older women and helping in the primary prevention of high blood pressure and other comorbidities associated with the aging process.

All authors have declared there is no potential conflict of interests concerning this article.

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