BLOOD PRESSURE AND HEART RATE VARIABILITY AFTER AEROBIC AND WEIGHT EXERCISES PERFORMED IN THE SAME SESSION

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

Purpose: To verify the systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR) and heart rate variability (HRV) response after resistance and aerobic exercises in different combinations. Methods: Nine normotensive men performed in non-consecutive days a single session of aerobic exercise (cycle ergometer; 60% of VO2 peak; 50 min) plus resistance exercises (eight exercises; three sets; 10-15 reps; 60% of 1RM) and a single session of resistance exercises plus aerobic exercise. SBP, DBP, MAP, HR and HRV were evaluated at rest and at each 10 min (during 60 min) after exercises. Results: Difference between sessions has not been found. In the session which initiated with the aerobic exercise, SBP decreased in the total mean post-exercise period (resting = 121.3 ± 3.9; post = 114.4 ± 2.1 mmHg) while HR increased (resting = 75.8 ± 4.3; post = 89.5 ± 5.8 bpm). On the other hand, there was no difference in the DBP, MAP or HRV. Conclusion: The exercise sessions order does not alter cardiovascular and autonomic post-exercise response in normotensive subjects.

Keywords: blood pressure, heart rate variability, exercise.

INTRODUCTION

Over the last years many experiments studied the blood pressure (BP) behavior after a single physical exercise session, either aerobic[1-11] or resistance[12-17]. It is expected that BP reduces after physical exercise in values below the ones at rest, in what it is termed post-exercise hypotension (PEH)[18]. PEH presents relevant clinical implication, both in normotensive and hypertensive individuals, especially when BP reduction lasts for many hours[19].

The literature has many references on PEH related to aerobic exercise[1-11], but information on resistance training is less frequent[12-17]. A possible explanation for this fact is that aerobic exercise is easier to be prescribed and controlled; moreover, it is the training model which provides the most reduction in rest BP in the long run. However, the current recommendations of physical exercise for health include the two trainings[20], including for subjects with cardiovascular diseases[21].

Thus, in practical terms, it is possible that both activities are performed in the same session. However, the physiological mechanisms involved in the PEH seem to be different for aerobic exercise[22] and resistance training[13]. It is possible that the performance order of such exercises implies in the cardiovascular behavior after exertion. An example of this hypothesis may be illustrated by a recent study[15], which compared a session of aerobic exercise, a session of resistance training and a session composed of the two exercises in a sequence. The results show that the hypotensive effect was basically observed for the SBP; however, there were not differences between the experimental sessions; that is to say, the combination of both modalities did no cause higher PEH. However, the vagal reactivation was different from the isolate exercises when the session composed of the two modalities was performed. Therefore, it is possible that the autonomic activity is differentiated regardless of the BP behavior.

The aim of this study was to verify the systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), heart rate (HR) behavior and the heart rate variability (HRV) after sessions of aerobic exercise and resistance training combined in different orders.

METHODS

Sample

The sample was composed of nine men (24.8 ± 1.1 years; 175.9 ± 2.8cm; 77.0 ± 3.7kg; 24.7 ± 0.5kg.m^{-2}): physically active, normotensive, non-smokers and non-patients of any kind of metabolic and/or osteoarticular disease. Moreover, they did not make use of any medication which could compromise the cardiovascular responses. All subjects were volunteers and signed a free and clarified consent form after approval by the Ethics in Research Committee of the State University of Londrina under the legal resolution 022/08.

Outlining

The study had duration of four non-consecutive days. On the first day, the anthropometric measurements were collected (weight and height), BP at rest was checked (after 15 min at sitting position) and the peak oxygen consumption test was conducted($\dot{V}O_{2peak}$) with progressive test protocol[22]. One cycle ergometer (Monark, São Paulo, Brazil) andone gas analyzer K4 b[2] (Cosmed, Rome, Italy)were used for determination of $\dot{V}O_{2peak}$. For this analysis, a sample of expired gas at every 10 seconds was obtained. The protocol consisted of five min of standard warm-up with 50W load and from this moment, increase of 25W at every two minutes was added until voluntary exhaustion. This interruption was determined by the momenta t which the subject could not keep the work rate performed. Oxygen consumption used in the present study was set at 60% of $\dot{V}O_{2peak}$ and calculated by linear regression equation.

On the second day, after minimum interval of 48h, the one repetition maximum test was performed (1RM) in the bench press, leg press 45º, upright row, leg extension, articulated military press, leg flexion, biceps curl with bar and triceps pulley exercises. The test started with warm-up using load considered light, performing approximately 10 repetitions. After a two-minute interval, the trials for 1RM load were initiated. The sample was told to try to perform two repetitions. In case more than one repetition was suitably performed or the subject could not complete a single repetition, the load was adjusted and the trial repeated after an interval between two and five min. 1RM load was determined by up to three trials. If it was not possible to find the 1RM load, the subject returned after 48h for new testing.

On the third and fourth days, the subjects randomly performed a session composed of aerobic exercise followed by resistance exercise (AER) or one session composed of resistance exercise followed by aerobic exercise (REA).The subjects were distributed through a table with random numbers and their place was hidden, minimizing hence learning. A minimum interval of 24h between sessions was adopted. The aerobic exercise was performed in cycle ergometer at intensity of 60% of $\dot{V}O_{2peak}$, with duration of 50 min. In the resistance exercise, the sequence adopted was the same applied in the 1RM test, and three setsof 10-15 repetitions, intensity of 60% of 1RM and recovery interval between sets and exercises of two min were also adopted. Before each session, the subjects were told not to ingest any caffeinated and/or alcoholic drink, avoid excessive use of sodium 12h prior the collections and keep their habitual activities and eating habits during the study period.

Blood pressure measurement

SBP and DBP were checked with an automatic oscillometric instrument (Omron HEM 742-E, Bannockburn, USA). The measurements were taken before the exercise (after a 15 min-period at sitting position) and after exercise (during 60 min at 10 min-intervals) in a calm environment, with monitored temperature and air relative humidity. Measurements were taken on the right arm[23]. After identification of the SBP and DBP values, the MBP was calculated through the equation MBP = DBP + [(SBP-DBP) ÷ 3].

Heart rate variability measurement

HRV was continuously monitored before, during and after the exercise by a HR monitor(Polar S810i, Kempele, Finland). The data were recorded in the instrument and transferred to a computer so that they could be analyzed by the software Polar Precision Performance (release 3.00, Kempele, Finland). The HRV parameters were analyzed according to the low frequency (LF), high frequency (HF) components, after the transformation by Fourier and sound filtering through the program HRV Analysis Software version 1.1 (Kuopio, Finland), adopting five-min intervals.

STATISTICAL ANALYSIS

Data were analyzed with the Shapiro-Wilkand Levene tests so that data distribution and variances homogeneity respectively could be verified. Two-way ANOVA with repeated measures was used, followed by the Fisher LSD post hoctest, considering as significance level value lower than 0.05. Data were treated in the program Statistica 7.0 (Statsoft, Tulsa, OK, USA).

RESULTS

Table 1 presents the values of the 1RM and $\dot{V}O_{2peak}$ tests of the sample. Table 2 illustrates the SBP, DBP, MBP and HR behavior between the sessions during the time. In all cases ANOVA did not point out significant values for the group factor (AERvsREA). However, significant values were found for the time factor (number of post-exertion measurements). In the post-exercise measurements, the AERsession presented significant lower values for SBP in minutes 10, 20, 30 and 50. In this session again, both DBP and MBP were significantly lower compared to rest in minutes 10, 20 e 40 and finally, HR remained high in the entire follow-up period. On the other hand, the REA promoted small alterations in the analyzed variables, in which only SBP was significantly lower in the 40th min and HR significantly higher in the 10^{th} and 20^{th} min post-exertion.

When the mean of the 60 min of the recovery period is observed, significant differences were only observed in the time factor for the AER session, being the values significantly lower for the SBP variable and significantly higher for the HR compared to rest (table 3). Differences have not been found for the HRV variables neither between rest and the recovery period nor for between the experimental sessions.

Tabela 1. Values obtained in the $\dot{V}O_{2peak}$ test and one repetition maximum test by the sample (mean± standard deviation).

Parameters	Values
$\dot{V}O_{2peak}$ (ml. kg-1. min-1)	36.5 ± 1.7
Maximum load (watt)	233.3 ± 7.9
HRmaximum predicted (bpm)	195.2 ± 1.05
HRmaximum test (bpm)	191.6 ± 4.03
% HRmaximum predicted	98.2%
Bench press(kg)	47.2 ± 2.5
Leg press 45º (kg)	109.6 ± 2.7
Upright row (kg)	75.9 ± 3.1
Leg extension (kg)	56.7 ± 2.6
Biceps curl (bar W) (kg)	18.1 ± 0.8
Leg flexion (kg)	52.3 ± 2.0
Triceps pulley (kg)	66.7 ± 1.9
Articulated military press (kg)	25.9 ± 1.6

Table 2. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP) and heart rate (HR) at rest and after exercise sessions (aerobic + resistance training and resistance training + aerobic) (mean ± standard deviation).

	Session	Rest	10 min	20 min	30 min	40 min	50 min	60 min
SBP (mmHg)	Aerobic + RT	121.3 ± 3.9	110.3 ± 3.5*	114.9 ± 3.1*	114.5 ± 2.9*	116.6 ± 2.7	114.8 ± 3.3*	115.3 ± 2.8
	RT + aerobic	116.7 ± 3.7	117.4 ± 2.8	112.7 ± 2.7	113.6 ± 2.5	108.8 ± 4.4*	113.9 ± 2.2	112.1 ± 3.5
DBP (mmHg)	Aerobic + RT	72.8 ± 3.4	64.6 ± 2.5*	64.4 ± 2.3*	70.4 ± 2.4	67.0 ± 2.1*	69.8 ± 2.3	72.3 ± 1.8
	RT + aerobic	70.1 ± 5.1	71.9 ± 2.7	68.9 ± 2.6	72.8 ± 2.2	70.8 ± 1.9	70.9 ± 2.1	71.1 ± 2.9
MBP (mmHg)	Aerobic+ RT	88.9 ± 3.3	79.8 ± 1.9*	81.2 ± 1.5*	85.1 ± 1.8	83.5 ± 1.9*	84.9 ± 1.6	86.5 ± 1.3
	RT+ aerobic	85.6 ± 4.2	87.1 ± 2.1	83.5 ± 1.9	86.4 ± 2.2	83.4 ± 2.0	85.2 ± 2.1	84.8 ± 2.4
HR (bpm)	Aerobic + RT	75.8 ± 4.3	96.5 ± 6.2*	92.8 ± 5.7*	91.5 ± 5.7*	87.0 ± 5.9*	85.6 ± 5.7*	83.5 ± 6.0*
	RT + aerobic	74.2 ± 3.3	88.1 ± 4.7*	79.3 ± 4.1*	76.5 ± 3.9	78.1 ± 4.5	74.2 ± 3.5	75.9 ± 3.7

* Significant difference ($p < 0.05$) concerning rest.

Table 3. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), heart rate (HR) and linear indices at the frequency domain (LF and HF) at rest and in the mean of the 60 min after exercise sessions (aerobic + RT and RT + aerobic) (mean ± standard error).

		Aerobic + RT	RT + aerobic
SBP (mmHg)	Rest	121.3 ± 3.9	116.7 ± 3.7
	Mean of the 60 min	114.4 ± 2.1*	113.1 ± 2.7
DBP (mmHg)	Rest	72.8 ± 3.4	68.1 ± 1.9
	Mean of the 60 min	70.1 ± 5.1	71.1 ± 2.2
MBP (mmHg)	Rest	88.9 ± 3.3	85.6 ± 4.2
	Mean of the 60 min	83.5 ± 1.3	85.1 ± 2.0
HR (bpm)	Rest	75.8 ± 4.3	74.2 ± 3.3
	Mean of the 60 min	89.5 ± 5.8*	78.7 ± 3.8
LF (un)	Rest	72.2 ± 3.8	77.5 ± 3.5
	Mean of the 60 min	79.1 ± 4.1	77.1 ± 2.1
HF (un)	Rest	27.8 ± 3.8	22.5 ± 3.5
	Mean of the 60 min	22.8 ± 3.5	21.4 ± 2.8

* Significant difference ($p < 0.05$) concerning rest.

DISCUSSION

The main findings of the present study were that the AER session reduced SBP, DBP and MBP in some moments. On the other hand, the REA session promoted minimum alterations in the pressoric values. Moreover, after the AER session, reduction in the mean of the 60 min of follow-up period was observed for the SBP and increase in the mean of the HR without any significant alteration after the REA session in the mean of the follow-up period. Finally, none differences have been identified between the ERA and REA sessions.

Some studies analyzed the isolate effect of aerobic exercise and weight exercise in the post-exertion cardiovascular behavior[25-27]. For example, MacDonald et al.[27] observed that after 15 min of aerobic exercise in cycle ergometer (65% $\dot{V}O_{2max}$) and continuous weight exercise (65% of 1RM) significant decrease of SBP and MBP was present. Nevertheless, in this experiment, the weight exercise (leg press) was performed with no interruption. Due to its unconventional nature, such protocol decreases the external validity of the results. Other experiments[7,17] investigated the impact of different work volume, resistance and aerobic exercises performed separated, on the PEH. Thus, both after resistance exercise[17]and after aerobic exercise[7], greater work volume seems to promote more remarkable drop in post-exercise BP. In this context, the performance of a session of aerobic and resistance exercises could cause more remarkable decrease of BP due to the high volume. However, Ruiz et al.[15] observed that the performance of the two exercise models in one session did not promote more remarkable BP decrease, which is similar to what was observed in the present experiment. In this study, though, it was decided to have the exercise sessions combined in different orders, considering that the cardiovascular adjustment mechanisms after exercise are different between aerobic and resistance exercises. Decrease in peripheral vascular resistance[24] and decrease of the cardiac debt[13] seem to be responsible for the decrease of BP after aerobic and resistance exercise, respectively. Thus, theoretically, the performance order of a session composed of aerobic and resistance exercises could interfere in the post-exertion BP.

However, the literature does not have much information on this issue. We identified only one investigation which studied the BP behavior after performance of aerobic and resistance exercises in the same session[15]. Although the authors have used only the exercises combined in one order (aerobic followed by resistance exercise), reduction in SBP, maintenance in the DBP values and HR increase were observed, corroborating the results of the present study when the mean of the 60 min of the recovery period of the AER session is observed. In the study under consideration[15], the authors have not identified differences in the BP behavior after each exercise alone and after the session combined with the two exercises either. Therefore, it seems there is no additional effect of the amount of exercise over the PEH.

Conversely, the autonomic activity may be related with the amount of exercise. In the study by Ruiz et al.[15], the vagal reactivation was different from the separate exercises when the session composed of the tow modalities was performed. In the present study, we analyzed the HRV after both sessions.Although there was HR increase after the ERA session, there were not alterations of the LF and HF components. HR increase in performance of one aerobic or resistance session is common and was reported in other studies[13,16,25,27]. Such HR behavior may be associated with the increase in the sympathetic activity and with decrease in the parasympathetic activity to the heart, mediated by the baroreflex control in a trial to compensate for the BP decrease after exercise. In the preset study, the maintenance of the LF and HF suggests other ways of increasing the post-exertion HR, but due to methodological constraints, further investigation was not possible.

Regardless of the results found in the present study, it is important to consider that there were not differences between the experimental sessions. Such fact suggests that the cardiovascular behavior may be similar after the different combinations of aerobic and resistance exercises. The fact one of the sessions presented decrease compared to the rest values may be connected to uncontrolled characteristics, such as the level of anxiety. In addition to that, slight alterations in the initial cardiovascular values may have contributed.

The limitations of the present study include monitoring of the cardiovascular behavior for a short period of time, where the BP follow-up for a longer period would enable better conclusions on the possible differences between sessions. Moreover, the present study used as sample young, active and normotensive men. Thus, the results cannot be generalized for hypertensive, elderly, sedentary or female individuals. Therefore, further research is necessary to investigate the post-exercise BP response in these populations.

All authors have declared there is not any potential conflict of interests concerning this article.

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