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ORIGINAL

ACUTE HYPOTENSOR EFFECT OF THE VASCULAR OCCLUSION EXERCISE ON ELDERLY ADULTS

EFFECTO HIPOTENSOR AGUDO DEL EJERCICIO DE OCLUSIÓN VASCULAR SOBRE ADULTOS MAYORES

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ABSTRACT

The objective of this study was to evaluate the acute cardiac response after performing an exercise session with vascular occlusion in elderly adults (EA). Twenty-two volunteer participants underwent the experimental protocol of dynamic manual grip exercise with 30% occlusion pressure (OP), after recording the baseline values and resting systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR). All measures were taken in basal conditions and between 5 and 30 minutes' post-occlusion. At the end of the protocol, there was a significant reduction in SBP and HR at 15', 20' and 25' ($p < 0.05$) and for DBP at 10' and 20' ($p < 0.05$). The acute effect of exercise with vascular occlusion generates a significant reduction of SBP, Basal Diastolic Pressure (BDP) and HR up to 25 minutes' post-occlusion, in the EA analyzed.

KEYWORDS: Hypertension; Post-Exercise Hypotension; Therapeutic Occlusion.

RESUMEN

Objetivo: El objetivo de este estudio fue evaluar la respuesta cardíaca aguda después de realizar una sesión de ejercicio con oclusión vascular en adultos mayores (AM). **Sujetos y método:** 22 participantes voluntarios, fueron sometidos al protocolo experimental de ejercicio dinámico de presión manual con un 30% de presión de oclusión (PO), después de registrar los valores basales y en reposo de presión arterial sistólica (PAS), presión arterial diastólica (PAD) y frecuencia cardíaca (FC). Evaluadas en condiciones basales y entre los 5 y 30 minutos post-oclusión. **Resultados:** Al finalizar el protocolo se observó una reducción significativa en la PAS y FC a los 15', 20' y 25' ($p < 0,05$) y para la PAD a los 10' y 20' ($p < 0,05$). **Conclusión:** El efecto agudo del ejercicio con oclusión vascular genera una reducción significativa de PAS, PAD y FC hasta 25 minutos post-oclusión, en los AM analizados.

PALABRAS CLAVES: Hipertensión; Hipotensión post ejercicio; Oclusión terapéutica.

INTRODUCTION

Exercise Intolerance is a common feature of multiple chronic non-communicable diseases, including high blood pressure (HBP). Several mechanisms have been postulated in order to explain this low tolerance to exertion, such as, metabolic myopathies, alterations in the absorption and muscle oxygen uptake, and particularly muscle blood flow restrictions ⁽¹⁾.

Hypertension (HT) is a disease and a cardiovascular risk factor, characterized by a high, progressive and sustained increase in systolic blood pressure (SBP), diastolic blood pressure (DBP) or both. HT is more frequent in older adults⁽²⁾, as a result of changes linked with aging^(3,4). In HT, the regulation of vascular tone can be altered, generating a predominance of vasoconstriction over vasodilation, which results in an increase in peripheral vascular resistance (PVR), which can be accompanied by a restriction of peripheral blood flow⁽⁵⁾. Several factors have been involved in PVR, such as: increased vasomotor tone, irregular lumen of vessels and low-grade inflammation processes; all these resulting in an increase of blood flow resistance. However, studies conducted in various models suggest that these factors are not ample to explain the increase in PVR, so other factors that are closely related have been taken into account for evaluation, such as, blood flow properties and restriction of flow by a macromolecular lining on the endothelial surface ⁽⁶⁾.

Regular exercise is a well-established intervention for the prevention and treatment of hypertension ⁽⁷⁾. Individuals may benefit clinically from post-exercise hypotension (HPE) ^(8,9) which has a longer duration when performed 2-3 times per week ^(10,11). The hypotensive effects of exercise seem to be mainly induced by an improvement in baroreflex sensitivity ⁽¹²⁾, suppression of sympathetic activity ⁽⁹⁾, increase in cardiac output⁽¹³⁾ and the release of vasodilators⁽¹⁴⁾.

Based on this premise, this study has considered approaches that are able to reduce PVR, with a resulting decrease in blood pressure (BP), as well as hyperemia during exercise, the latest response still remaining a controversy. Some mechanisms involved in this response are: neural regulation, endothelial response and regulation of cardiac function. Among the most commonly used methodologies it is mentioned a high-intensity interval training (HI), which has shown very good effects in muscle hypertrophy and acute (post-exercise) and chronic BP decrease with a planned exercise program⁽¹⁵⁾. However, it has been shown in AM population that HI training presents high risks of injury, making it difficult for subjects to adhere to treatment⁽¹⁶⁾. In this context, vascular occlusion has been highlighted for its safety and similar effects as to those obtained by HI training, but at lower intensities and with lower risk of injury⁽¹⁷⁾. Different uses and benefits have been identified from vascular occlusion, of which the most studied are the increase in muscle strength and hypertrophy. These results would cause greater peripheral vasodilation and an increase in muscle Metabolism^(18,19). These effects support the thesis for training with vascular occlusion, as a safe method, highly applicable in EA population and with similar effects to HI.

In the study by Neto (20), it was shown that normotensive subjects experienced a decrease in BP after the application of the occlusive exercise, from 119 ± 8.9 mmHg of mean arterial pressure at rest, to 113 ± 11.1 mmHg, after 60 min post-training⁽²⁰⁾.

Based on these findings, vascular occlusion training could be a useful tool for working with at-risk populations, such as EAs, since evidence shows that normotensive patients can acutely control BP with this method; however, its effects on EA with high blood pressures are unknown.

Therefore, the purpose of this study is to evaluate the acute effects in EA after carrying out one set of exercise under vascular occlusion.

MATERIAL AND METHODS

Sample was selected by convenience, where the participants were invited through a letter addressed to the AM "Luz de Luna" group from Los Vilos county, IV region of Chile, which was accepted by a total of 22 subjects of both genders. All participants read and signed the informed consent before participating in the study. The process of selection and treatment of the subjects was approved by the Center / North Ethics Committee of the Santo Tomás University. Subjects selected met the following inclusion criteria: age ≥ 65 years old, to be residing in the Los Vilos county, and having signed the informed consent. In the other hand, the following exclusion criteria was applied: a dependence level that interferes with doing exercise, having a chronic cardiovascular disease, having a thrombotic history or cardiovascular event in the last 2 years, and having exercised vigorously during the last 24 hours prior to data collection (Fig 1).

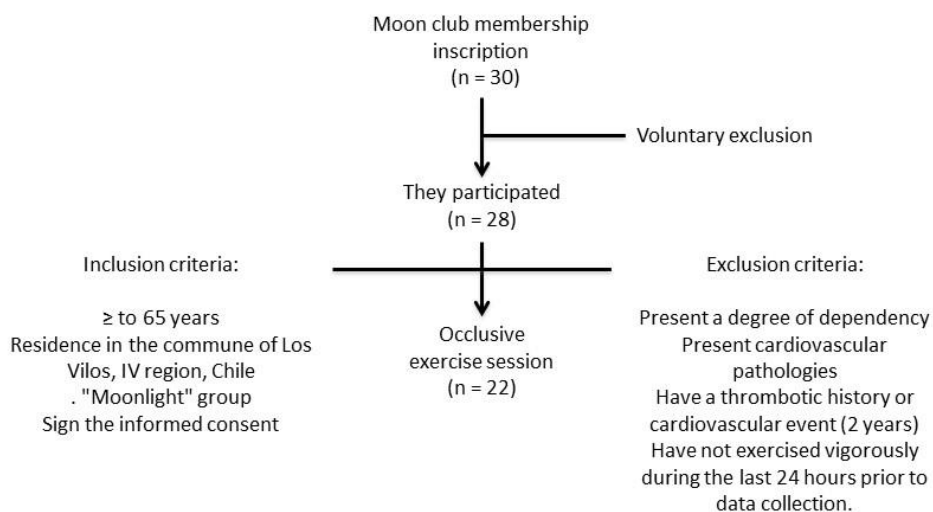


Fig 1: Study design. Thirty subjects responded to the invitation to participate in this study. Two subjects did not show up for the session and six did not meet the inclusion / exclusion criteria. Twenty-two subjects performed the exercise session.

Study procedures

Clinical history and body weight, height and body mass index (BMI) measures were collected from each selected subject.

Occlusive exercise protocol

Each session lasted 40 minutes, starting with pre-exercise measures of blood pressures. Baseline blood pressure (BBP) was recorded after 5 minutes of rest in the supine position and the resting blood pressure (RBP) was then measured after 3 minutes in the seated position. Sitting blood pressure was then used to determine the occlusion pressure (OP) for the procedure, calculated as $OP = (SBP * 0.3) + SBP$.

Subsequently, 1 minute of dynamic exercise was performed with the dominant member, where the forearm segment was supported on a table, with the elbow joint at a 90 ° angle. Once the OP was applied, the patient was asked for a minute of manual grasping or until muscle failure.

Then, post-exercise BP was evaluated at 5, 10, 15, 20, 25 and 30 minutes' post-occlusion. BP measurements were taken according to what was described by the clinical guideline of primary or essential HT in people with age 15 years and older.

Statistical analysis

To carry out this analysis, descriptive statistics were used, using a measure of central tendency via average or arithmetic mean, and dispersion via standard mean error. To check the normal distribution, the Shapiro Wilk test was conducted. For inferential statistics, the data was processed with paired t-

student test for groups that had a normal distribution, and the Wilcoxon test for those that did not have a normal distribution. The values are shown as mean \pm SD and the statistical significance was defined with a $p < 0.05$.

RESULTS

A total of 22 participants, 17 women and 5 men, completed the entire protocol. Table 1 summarizes the demographic characteristics of the study participants. 53% of women and 60% of men are in the category of overweight for their age range⁽²¹⁾. In addition, 11.76% of women and 20% of men had baseline SBP above normal range for their age. When DBP values were registered, 5.9% of women and 20% of men showed values above normal for their age. Likewise, when measuring their SBP and DBP at rest, a similar percentage of women and men were outside the normal range (SBP = 17.64%, 40%, DBP = 17.64%, 0%, women and men respectively).

The changes that occur in the SBP and DBP before and after the exercise session with vascular occlusion are shown in figure 2. There is a significant increase in the SBP when going from the basal to the resting sitting position ($p < 0.05$) and in the DBP ($p < 0.001$). This increase persists up to 5 minutes after performing the occlusion exercise session, both for the SBP and the DBP ($p < 0.01$). At 10', 15' and 20' there is a significant decrease in relation to the baseline value for DBP ($p < 0.05$, $p < 0.01$, $p < 0.05$ respectively).

Finally, there was a significant reduction in SBP in relation to RBP at 15', 20' and 25' ($p < 0.05$) and for DBP at 10' and 20' ($p < 0.05$).

Table 1: Demographic characteristics of the sample (n = 22).

| | Mean \pm standard deviation | Confidence interval (95%) | Mínimum | Maximum |
|--------------------------|-------------------------------|---------------------------|----------|----------|
| Age (years) | 71,86 \pm 4,06 | (68,5-74,5) | Min 65 | Max 81 |
| Weight (Kg) | 74,45 \pm 12,78 | (64,5-85,5) | Min 49 | Max 97 |
| Height (m) | 1,573 \pm 0,1 | (1,52-1,63) | Min 1,34 | Max 1,84 |
| BMI (Kg/m ²) | 29,95 \pm 3,4 | (27,5-32) | Min 24 | Max 36 |
| SBPB (mmHg) | 131,4 \pm 8,4 | (124-138,5) | Min 116 | Max 149 |
| DBPB (mmHg) | 72,86 \pm 10,95 | (61-79) | Min 58 | Max 96 |
| SBPR (mmHg) | 135,1 \pm 10,59 | (126,5-141,5) | Min 119 | Max 163 |
| DBPR (mmHg) | 79,05 \pm 7,98 | (61-85,5) | Min 65 | Max 95 |

BMI, body mass index; SBP, basal systolic blood pressure; PADB, basal diastolic blood pressure; PASR, resting systolic blood pressure; PADR, resting diastolic blood pressure; IC, confidence interval; Min, minimum value; Maximum, maximum value.

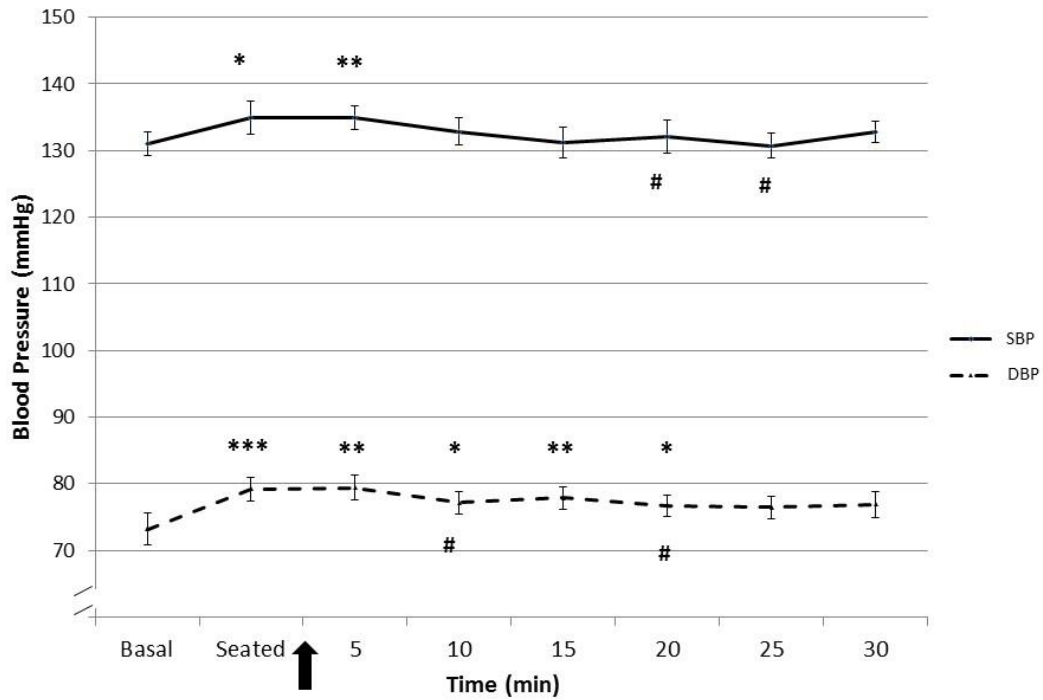


Fig 2: Changes in systolic blood pressure and diastolic blood pressure, before and after the exercise session with vascular occlusion. SBP: systolic blood pressure (continuous line), DBP: diastolic blood pressure (dashed line). *: Significant difference with respect to the basal value, #: significant difference with respect to rest. * = $p < 0.05$; ** = $p < 0.01$; ***; $p < 0.001$; # = $p < 0.05$.

With respect to the changes that occur in the HT, these are shown in figure 3. There is a significant increase between the basal and resting position and that remains elevated at 5 'and 10' after performing the exercise with vascular occlusion ($p < 0.01$ for resting position and 5 ', $p < 0.05$). In contrast, it shows a significant decrease ($p < 0.05$) at 10 'after the execution of the exercise session with vascular occlusion and shows a significant mounting decrease, which extends up to 30' after having completed the exercise ($p < 0.05$ at 15 ', 20', 25 'and 30' respectively).

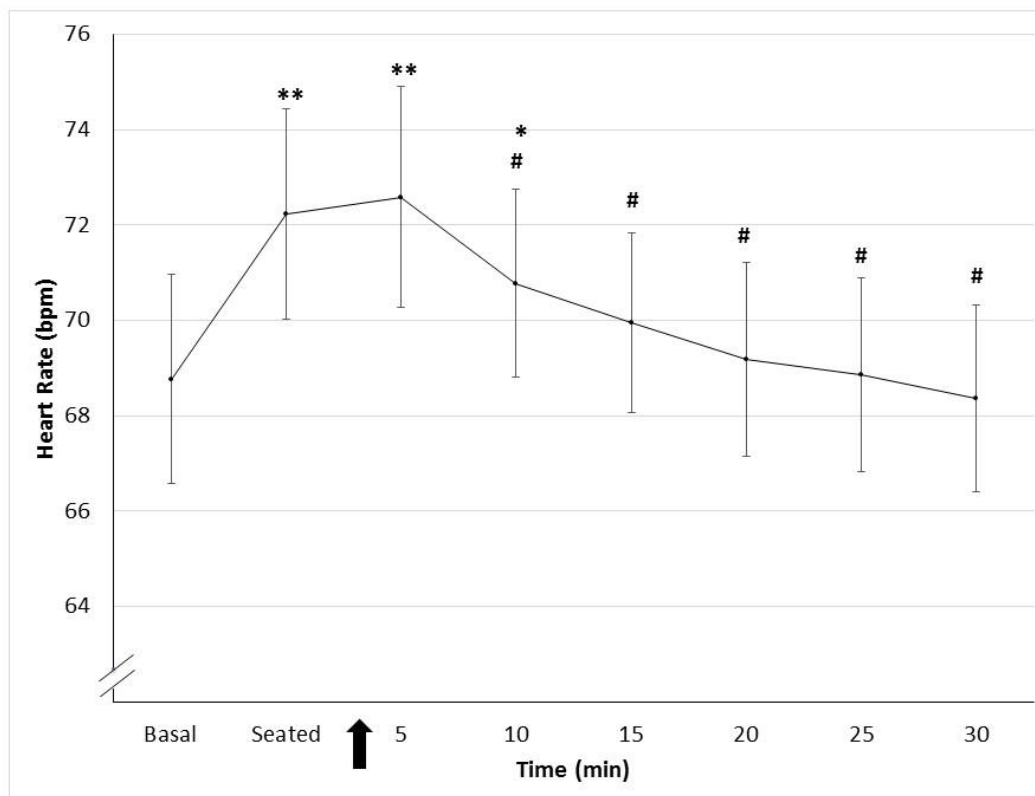


Fig. 3: Changes in heart rate, before and after the exercise session with vascular occlusion. *: Significant difference with respect to the basal value, #: significant difference with respect to rest. * = $p < 0.05$; ** = $p < 0.01$; # = $p < 0.05$.

DISCUSSION

The aim of the present was to evaluate the acute response on BP and HR after performing an exercise session with vascular occlusion in EA. In this context, the results obtained in the present investigation revealed a significant reduction in SBP ($p < 0.05$) at 15', 20' and 25'; and of the DBP at 10', 15' and 20' ($p < 0.05$, $p < 0.01$, $p < 0.05$ respectively), after carrying out an exercise session with vascular occlusion.

These data confirmed that BP can decrease up to 25 minutes after exercise, and its prescription modality, with a short duration and high perceived intensity by the occlusion, is safe for EA (as changes in pressure were not risky). Although significant decreases in SBP and DBP were produced after the procedure, prior to the exercise session, BP levels were adequately controlled according to international guidelines⁽²²⁾.

Our results showed an increase in the SBP and DBP when going from the basal to the resting position and this change persists up to 5' after performing the exercise with vascular occlusion. It is worth mentioning that the lower muscle mass and lower capillarity of the upper limbs, in conjunction with the increased resistance to blood flow imposed by vascular occlusion, leads to an increase in BP. This effect is similar to what happens when performing the last repetitions of one set of exercises by an increase of intra-stress BP⁽²⁶⁾. It has been

postulated that performance of resistance exercise of large muscle groups generates an HPE ^(28,29) both in normo-tense and hypertensive people, and that the greatest effect of BP reduction would be in the latter. In addition, the effect of performing this type of exercise was compared 2 to 3 times a week, where no significant differences were found in the reductions in BP values according to the number of weekly training sessions.

A study carried out in 2010⁽²¹⁾ compared the HPE of a dynamic exercise with vascular occlusion in sedentary hypertensive EA versus trained ones. It was found a significant decrease of BP in both groups, but the biggest change was seen in the sedentary group. This would indicate that it is possible to perform this type of exercise in EA patients with hypertension and that it could generate a significant change in BP values with or without the pharmacological treatment as complement.

Both pharmacological treatments and physical exercise contribute to reducing BP and the risks associated with its increase. It is well known that the benefits of physical exercise are manifested in the long term and when there are chronic adaptations to exercise and these effects have been mainly associated with different types of aerobic exercise ^(23,24,25). Thus, in one study it was observed only a significant reduction of the SBP at 60 'of performing the high intensity protocol in leg press. In contrast, another study reported no significant changes when performing an exercise with vascular occlusion, at 20% of 1 maximum repetition (RM) and with an occlusion of 200 mm Hg, at 30 'and 60' after performing the exercise. Although it is true there were no significant differences, it was considered that the OP was not intense enough to develop an HPE and that there would be a direct relationship between increased resistance to be overcome and the hypotensive response, where the higher the occlusion, the greater the decrease in BP variables.

Although some physiological mechanisms have been postulated to explain HPE, a consensus on this matter has not yet been reached. The reduction of sympathetic autonomic activity is one of the hypotheses identified as responsible for HPE, which in turn would be associated with vasodilators that lead to a reduction in RVP and, consequently, a decrease in BP ⁽³⁰⁾. Another aspect worth mentioning in relation to a possible reduction of sympathetic activity is a decrease of HR. Our results showed a significant reduction after performing the exercise session with vascular occlusion, with a clear decreasing tendency which extends up to 30 '. These two characteristics of reduction of BP and HR, may be due to a reduction of sympathetic autonomic activity or due to an improvement in tissue perfusion, which would result in greater cardiac work efficiency ⁽³¹⁾.

All the effects mentioned so far are the product of periods of training, that is, the chronic response of hypotensive response to resistance or vascular occlusion exercises, but the acute response to vascular occlusion exercise had not been investigated. This seems to be similar to the chronic response, but limited in time, not extending beyond the 30 ' period; but then again, when considering the response to a single session of vascular occlusion exercise, in addition to what was documented as a chronic response, it would set the bases for the

application of this type of training in the non-pharmacological management and control of HT.

The data reported in this study successfully adds to the current evidence regarding the clinical usefulness of this type of methodology in the management and control of HT. There are still many physiological aspects to be explored and clarified, since, it has been postulated that exercises with large muscle groups, as well as the OP used, influence the intensity and duration of the post-exercise response.

CONCLUSION

The acute effect of a dynamic exercise with vascular occlusion produces a significant decrease in BP and HR during the first 25 minutes after exercise in the EA studied, thus it could be considered a non-pharmacological treatment option for HT.

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