

# ACUTE RESPONSES OF CARDIOVASCULAR VARIABLES IN HYPERTENSIVE PATIENTS UNDERGOING A THERAPEUTIC EXERCISES PROGRAM

Danielle da Silva Pinto Henriques <sup>1</sup>, Rodrigo da Silva Fernandes <sup>2</sup>, Leandro Alberto Calazans Nogueira <sup>3</sup>

## Abstract

**Objective:** To evaluate the effects after treatment and the benefits of participation in hypertensive patients in a supervised program of therapeutic exercises. **Method:** Patients were submitted to a kinetic-functional evaluation; measurements of height and weight; analysis of resting heart rate (FCR) and measurement of blood pressure (BP). The intensity of training was done by calculating the heart rate training (FCT), between 60% and 75% heart rate reserve (FCR) and indirect value of VO<sub>2</sub> demarcated by pulse frequency meters. **Results:** There was a reduction of the values of resting heart rate, systolic blood pressure and systolic maximum pressure with significant increase in VO<sub>2</sub> after the period of indirect intervention. **Conclusions:** The program supervised therapeutic index obtained significant acute change in cardiovascular variables.

**Keywords:** Hypertension; Blood Pressure Monitoring, Ambulatory; Heart Rate; Physical Therapy Department, Hospital

## Resumo

**Objetivo:** Avaliar os efeitos pós tratamento e os benefícios da participação de pacientes hipertensos num programa supervisionado de exercícios terapêuticos. **Método:** Os pacientes foram submetidos a uma avaliação cinético-funcional; medições de peso e altura; análise da frequência cardíaca de repouso (FCr) e aferição da pressão arterial (PA). A intensidade de treinamento era feita através do cálculo da frequência cardíaca de treinamento (FCT), estabelecida entre 60% e 75% da frequência cardíaca de reserva (FCR), e o valor de VO<sub>2</sub> indireto demarcado através do freqüencímetro de pulso. **Resultados:** Houve redução dos valores de Frequência cardíaca de Repouso, Pressão arterial sistólica e Pressão sistólica máxima com significante aumento de VO<sub>2</sub> indireto após o período de intervenção. **Conclusões:** O programa terapêutico supervisionado obteve índices significativos quanto a mudança aguda das variáveis cardiovasculares.

**Palavras-chave:** Hipertensão; Monitorização Ambulatorial da Pressão Arterial; Frequência Cardíaca; Serviço Hospitalar de Fisioterapia

<sup>1</sup> Mestranda em Cardiologia (Fisioterapeuta)

<sup>2</sup> Graduação em Fisioterapia (Fisioterapeuta)

<sup>3</sup> Doutorando em Neurociências (Fisioterapeuta - Coordenador Técnico)

1 Casa de Saúde N.SRA. do Carmo/ Fisioterapeuta Especialista em Cardio-respiratória (Unidade Ambulatorial de Reabilitação Cardíaca/ FisioCarmo/ Rio de Janeiro/ RJ)  
Rua Pedro de Carvalho, 681/ apt. 303 - Méier - Rio de Janeiro Tel: (21) 3273-3031 / 8848-7922 / 78770678 e-mail: fisiorespcomdani@yahoo.com.br

---

## INTRODUCTION

Systemic Arterial Hypertension (SAH) is a disease that affects about 5-20 % of the adult population and may reach 50% in the elderly<sup>[1]</sup>. In Brazil, the prevalence of arterial hypertension (AH) ranges from 22.3% to 43.9% and the national and international epidemiological data demonstrate that the elevation of blood pressure (BP)<sup>[2,3]</sup>, is closely related to the aging process, directly influences the increased cardiovascular risk, and therefore should be treated<sup>[4,5]</sup>.

The treatment of hypertension is divided into two categories: pharmacological treatment and changes in lifestyle, such as loss of body mass, adopting an exercise routine, decrease in salt intake, in addition to the reduction or abolition of alcohol intake<sup>[6]</sup>.

In the context of change in lifestyle, the role of physiotherapy has promoted benefits on prescription and guidance of physical exercise regularly through exercise programs with an interdisciplinary team, with the aim of adapting the exercises to the different clinical conditions, improving control of blood pressure and preventing SAH sequelae<sup>[7]</sup>.

Physical activity should be assessed and prescribed in terms of intensity, frequency, duration and mode progression. Training should be individualized to meet more specific needs of each patient<sup>[8]</sup>. Nevertheless, we need to take some precautions to increase as much as possible the safety of patient care. Quantification of cardiovascular overload associated with exercise, or that is, the measurement and monitoring of variables such as heart rate (HR) and blood pressure (BP), is one of the strategies to make physical activity more secure<sup>[9,10]</sup>.

The observation of these variables alone is not enough, however, the associations between them can provide data that correlate with myocardial oxygen consumption, which is usually called the double product (DP), calculated by multiplying the systolic arterial pressure (SAP) by resting HR. The DP is a variable whose correlation with myocardial oxygen consumption (MVO<sub>2</sub>) makes it considered the most reliable indicator of the heart work during continuous physical activity<sup>[11]</sup>.

Given the above, the present study aims at evaluating the post-treatment effects and the benefits of hypertensive patients participating in a supervised program of therapeutic exercises.

## METHODS

The sample of this study was selected by convenience and consisted of 11 patients (7 women and 4 men),

all controlled hypertensive and treated at Hospital Nossa Senhora do Carmo, in Campo Grande, Rio de Janeiro. These patients were referred to the Specialized Physical Therapy Unit (FISIOCARMO Clinics) to start a physical conditioning program supervised by a physiotherapists' team.

On the first day, patients underwent a kinetic-functional assessment; measurements of height and weight, to establish the individual body mass index (BMI); analysis of resting heart rate (RHR), measured for 5 minutes with patients sitting in a proper chair, and measurement of blood pressure (BP) at rest, using the sphygmomanometer (K. TAKAOKA), through the conventional auscultatory method. Subsequently, we calculated the heart rate training (HRT) which was established between 60% and 75% of heart rate reserve (HRR), and the value of indirect VO<sub>2</sub> by rate monitors Polar brand, model M61.

## Protocols

The program consisted of two phases: aerobic training and exercise counter resistance circuit. In aerobic workout, patients performed walks up to 30 minutes<sup>[12]</sup>, on a treadmill brand Moviment (model LX160), charged individually adjusted to maintain effort in the area of 60% to 75% of HRR, being monitored throughout time through the frequency counter, and every 5 minutes was recorded HR and measured BP. The training respected phases for patients with SAH according to the recommendations of the American College of Sports Medicine<sup>[13]</sup>: heating period, period of conditioning and cooling, both for safety and for the health of patients. Once ended this stage the patients were guided to perform counter resistance exercises circuit.

First, a maximum load test (1RM) was performed, in the specific devices of the circuit, so that patients reached a load appropriate to their clinical conditions and that it does not take them to mechanical stress or the failure by muscle fatigue. The circuit comprised 6 to 8 types of exercises involving both the upper and lower limbs, performing three series of 10 to 12 repetitions each. In all runs the subjects were instructed to avoid the Valsalva maneuver.

At the end of the two phases of the therapeutic program, was checked and RHR and HR, given a rest break of 10 minutes after activity.

Patients were assessed within 2 months after inclusion in the program, and all the variables described in the first assessment were compared. Comparative assessment before and after the exercise program was performed with the variables BMI, RHR, SAP, SD; MSP, and indirect VO<sub>2</sub>.

Demographic variables were assessed and descri-

bed by measures of central tendency. We performed the paired Student's t test for comparison between the values found in physiological variables before and after intervention. Statistical analysis considered  $p < 0.05$  as a criterion of significance.

## RESULTS

The average age of patients was 63 (SD =  $\pm 10$ ) years of age, body weight of 70 (SD =  $\pm 15$ ) kg and height 163 (SD =  $\pm 10$ ) cm. Of these, two had a diagnosis of mild hypertension and the other nine were classified as having moderate hypertension.

No patient had cardiovascular complications or events that were considered at risk. There was an episode of interruption of service due to the sharp rise in BP, with a gradual return to the resting state in accordance with the guidelines for physical activity in hypertension.

According to the results shown in Table 1, significant differences were found between the variables. There was a reduction of the values of resting heart rate, systolic blood pressure, peak systolic pressure and indirect VO<sub>2</sub>.

Regarding pre-program indirect VO<sub>2</sub> the average value found was 27.8 ml/kg/min. The average found after the program was 29.8 ml/kg/min (Figure 1). The significance after the intervention to VO<sub>2</sub> ( $p < 0.01$ ) showed difference.

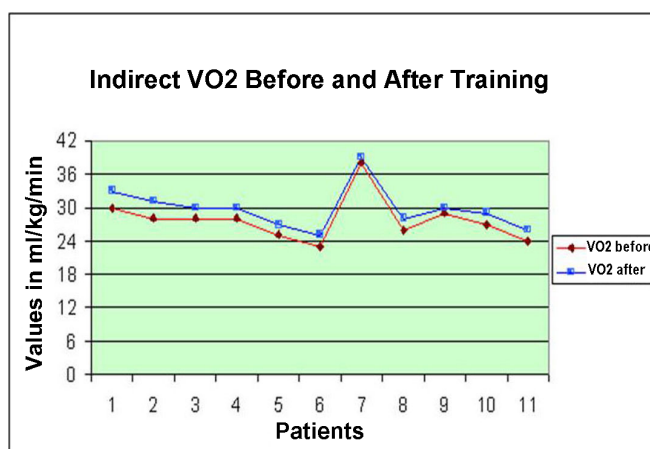
Regarding the pre-program double product (DP) its average value was 17478, and post-program was an average of 15017 (Fig. 2). The significance between values obtained before and after had  $p=0.06$ , showing the difference after the period of joining to the Therapeutic Programme.

**Table 1.** Behavior of cardiovascular variables in 11 hypertensive patients before and after Therapeutic Programme.

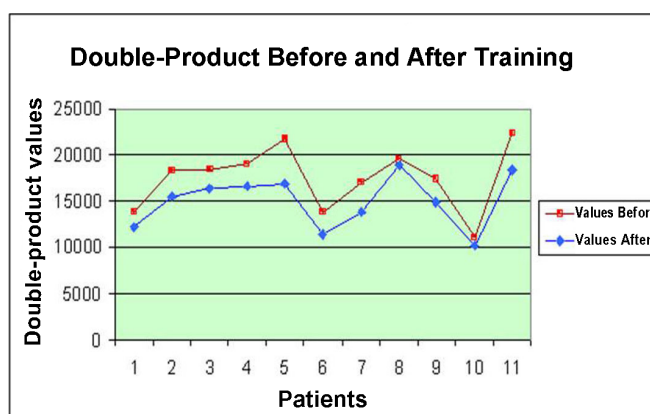
Variables Assessed	Before Average $\pm$ SD	After Average $\pm$ SD	Pvalue
Body mass index (Kg/m <sup>2</sup> )	25,73 $\pm$ 4,6	23,52 $\pm$ 8,0	0,06
Resting Heart Rate (bpm)	79,55 $\pm$ 11,2	73,73 $\pm$ 8,4	<b>0,00*</b>
Systolic blood pressure (mmHg)	133,18 $\pm$ 11,0	121,82 $\pm$ 7,5	<b>0,03*</b>
Double-Product	17478 $\pm$ 3435	15017 $\pm$ 2841	0,06
Maximum systolic pressure (mmHg)	153,64 $\pm$ 8,9	140,00 $\pm$ 6,3	<b>0,00*</b>
Indirect VO <sub>2</sub> (ml/kg/min)	27,8 $\pm$ 3,9	29,8 $\pm$ 3,8	<b>0,00*</b>

(\*)  $p < 0.05$

SD = Standard Deviation



**Fig. 1** - Outcomes of indirect VO<sub>2</sub> before and after intervention



**Fig. 2** - Outcomes of DP before and after intervention

## DISCUSSION

Currently, hypertension is one of the diseases with the highest incidence in the adult population and especially in the elderly, and these are the main beneficiaries of the practice of supervised exercise programs related to preventing the development of hypertension. This study shows acute changes in hemodynamic variables commonly used to assess the cardiovascular effort, following the participation of hypertensive patients in a therapeutic exercise program. The mean age of hypertensive patients assessed is consistent with the average found in other studies, such as Taddei et al.<sup>[14]</sup>, which highlighted the prevalence of hypertension in 53% of consultations assessed in patients between 65-96 years. Also according to Vasan et al.<sup>[15]</sup>, people in adulthood have a 90% risk of becoming hypertensive when they reach an older age.

With regard to the behavior of the cardiovascular variables, we highlight the final values of indirect VO<sub>2</sub> and double product, and these are directly correlated with

SAP and HR, which therefore had significant differences when comparing before and after therapeutic intervention values.

There was an increased aerobic capacity of patients found by an increase in indirect VO<sub>2</sub> measuring, as found by Okazaki et al.<sup>[16]</sup> who had progressive increases in oxygen consumption, but they only performed resistance strength training. The authors confirmed this finding in the elderly, aged from 64 years, with parameters similar to the circuit of exercises of this study, or that is, using loads between 60-80% of 1RM (maximum load test), 2-3 sets of 8 reps, training 3 times a week, the only difference being that the intervention period was 18 weeks instead of eight weeks in this series. This proves even greater gains by extending for more weeks the treatment period of the patients.

Given the presence of studies confirming the positive effects of aerobic training<sup>[17]</sup> and resistance exercise<sup>[18]</sup> for the control of BP levels, we opted for combining the methods, aiming at the best possible outcome regarding comfort and safety of patients. It is worth mentioning that the proposed activity was mild to moderate and prescribed after clinical and laboratory tests, respecting the limitations and conditioning of each patient.

With respect to the fall of the absolute values of both systolic BP as RHR, we should highlight the consequent decrease in the double product in the course of training. Studies by Gotshall et al.<sup>[19]</sup> and Fleck and Kraemer<sup>[20]</sup> compared values of double product during exercise, aimed at assessing myocardial stress on counter-resistance exercising. Already in this study, the comparison between the double product values aims to find differences between the initial state of the patient and possible improvement on the balance between supply and energy consumption by the myocardium after a period of cardiovascular training. So, instead of finding values larger than the base, the success of the treatment is directly related to values lower than originally planned.

The resting heart rate had decreased significantly after the regular adherence to the program at the end of two months. Moreover, the protocol established regarding the level of exercise intensity ranged around 60% of heart rate reserve, which depends directly on the resting heart rate. Therefore, the development of muscle strength will decrease the response of HR and BP for a given load during treatment, leading patients to suffer less impact on cardiovascular risk during activities of daily living that involve both static and dynamic efforts.

One limitation of this study was the number of patients undergoing therapeutic program. A more significant number of hypertensive participants of the treatment would be needed, in order to make the conduct held is ac-

cepted and prescribed more broadly. Moreover, the form of VO<sub>2</sub> measurement was made indirectly, increasing the chances of under- or overestimation of values. However, this is still the best and far less uncomfortable measure to be performed, non-invasive, with no contraindications (serves as an alternative for those patients who are not able to perform stress test) and less cost-effective.

## CONCLUSION

According to the adopted procedures and results, we can conclude that the association of aerobic exercise with resistance proved to be safe, pointing to another therapeutic option in hypertensive individuals. The supervised therapeutic exercise program achieved a reduction in systolic blood pressure, resting heart rate and consequent double product, and increased cardio-respiratory capacity through VO<sub>2</sub>.

## REFERENCES

1. Lomeo RC. Ações da equipe de Saúde da Família e a adesão de pacientes hipertensos à atividade física sistemática, 2004. [citado 2006 Nov 23]. Disponível em URL: <http://www.sobral.ce.gov.br>
2. World Health Organization. International Society of Hypertension Guidelines for the Management of Hypertension. *J. Hypertens.* 1999; 17: 151-83.
3. Franklin SS, Pio Jr, Wong ND, Larson MG, Leip EP, Vasan RS, Levy D. Predictors of new-onset diastolic and systolic hypertension. *The Framingham Heart Study.* *Circulation.* 2005; 111: 1121-7.
4. Gennari FJ. Hypertension in the elderly: management issues. *Coron Artery Dis.* 1998; 9: 719-24.
5. Gueyffier F. Antihypertensive drugs in very old people: a subgroup meta-analysis of randomized controlled trials. *Lancet.* 1999; 356: 793-6.
6. Camargo Junior A. Análise do comportamento da Pressão Arterial sob duas intensidades de exercício aeróbica em hipertensos, 2001. [citado 2006 Jan16]. Disponível em URL: <http://www.cardiol.br>
7. Botelho APV, Lima MRS, Oehling GAC. Atividades físicas como prevenção dos fatores de Risco da Doença Arterial Coronariana. In: Regença MM. *Fisioterapia em Cardiologia da UTI à Reabilitação.* São Paulo: Roca; 2000. p. 217-238.
8. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckel R, Froelicher VF, Fleg J, Leon AS, Piña IL, Rodney R, Simons-Morton DA, Williams MA, Bazzarre T. Exercise standards for testing and training. A Statement for Healthcare Professionals From American Heart Association. *Circulation.* 2001; 104: 1094-40.
9. Leite T, Farinatti P. Estudo da frequência cardíaca, pressão arterial e duplo-produto em exercícios resistidos diversos para grupamentos musculares semelhantes. *Rev Bras Fisiol Exerc* 2003; 2: 68-88.
10. McCartney N. Acute responses to resistance training and safety. *Med Sci Sports Exerc* 1999; 31: 31-7.
11. Gobel FL, Norstrom LA, Nelson RR, Jorgensen CR, Wang Y. The rate-pressure product as an index of myocardial oxygen consumption during exercise in patients with angina pectoris. *Circulation* 1999; 57: 549-56.

- 
12. Mion Junior D, et al. IV Diretrizes Brasileiras de Hipertensão Arterial, 2004. [citado 2006 jul 22]. Disponível em URL: <http://www.scielo.br>
  13. American College of Sports Medicine (2000). ACSM's Guidelines for Exercise Testing and Prescription. 6 ed. Baltimore: Lippincott Williams & Wilkins.
  14. Taddei, C. F. G; Ramos L., Moraes J. C; Wajngarten M; Libberman A; Santos S. C; Savioli F; Dioguardi G; Franken R - Estudo multicêntrico de idosos atendidos em ambulatórios de cardiologia e geriatria de instituições brasileiras; Arq Bras. de Cardiol, 1997; 69(5): 327-333.
  15. Vasan R. S.; Beiser A.; Seshadsi S. - Residual lifetime risk for developing hypertension in middle-aged women and men - The Framingham Heart Study; JAMA, 2002; 287: 1003-1010.
  16. Okazaki K., Kamijo Y., Takeno Y., Okumoto T., Masuki S., Nose H.- Effects of exercise training on thermoregulatory responses and blood volume in older men; J.Appl. Physiol., 2002; 93: 1630-1637.
  17. Kelley GA, Kelley KS (2000). Progressive resistance exercise and resting blood pressure: a meta-analysis of randomized controlled trials. Hypertension, 35: 838-43.
  18. Whelton SP, Chin A, Xin X, He J (2000). Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann Intern Med, 136 (7): 493-503.
  19. Gotshall R, Gootman J, Byrnes W, Fleck S, Valovich T(1999). Noninvasive characterization of the blood pressure response to the double-leg press exercise. JEP-on line, 2(4): 1-6, 1999.
  20. Fleck, Steven J. & Kraemer, William J. (1997). Fundamentos do treinamento de força muscular. Porto Alegre: artmed.
  21. Rondon MUPB, Brum PC. Exercício físico como tratamento não farmacológico da hipertensão arterial. Rev Bras Hipertens 2003; 10: 134-7.
  22. Fuchs FD, Moreira DM, Ribeiro JP. Eficácia anti-hipertensiva do condicionamento físico aeróbio. Uma análise crítica das evidências experimentais. Arq Bras Cardiol 1993; 61: 187-90.
  23. Negrão CE, Rondon MUPB, Kuniyosh FHS, Lima EG. Aspectos do treinamento físico na prevenção da hipertensão arterial. Revista Hipertensão, 2001; 4. Disponível em URL: <http://www.sbh.gov.br>
  24. Nami R, Mondillo S, Agricola E, Lenti S, Ferro G, Nami N, Tarantino M, Glauco G, Spanò E, Gennari C. Aerobic exercise training fails to reduce blood pressure in nondipper-type hypertension. Am J Hypertens 2000; 13: 593-600.
  25. Legramante JM, Galante A, Massaro M, Attanasio A, Raimondi G, Pigozzi F, Iellamo F. A hemodynamic and autonomic correlates of post exercise hypotension in patients with mild hypertension. Am J Physiol Regul Integr Comp Physiol 2002; 282: 1037-43.
  26. Teixeira JAC. Hipertensão arterial sistêmica e atividade física. Rev Socerj 2000; 13: 25-
  27. Negrão CE, Rondon MUPB. Exercício físico, hipertensão e controle barorreflexo da pressão arterial. Rev Bras Hipertens 2001; 8: 89-95.
  28. IV Diretrizes Brasileiras de Hipertensão 2002; cap. 5: 13-14 - SBC.
  29. ACC/AHA Guidelines for exercise testing: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). J Am Coll Cardiol 30: 260-315.
  30. McCartney N. Acute responses to resistance training and safety. Med Sci Sports Exerc 1999; 31: 31-7.