

Cardiovascular responses in the seated posture of the Global Postural Reeducation (GPR) method

Respostas cardiovasculares durante a postura sentada da Reeducação Postural Global (RPG)

Mota YL, Barreto SL, Bin PR, Simões HG, Campbell CSG

Abstract

Objective: To evaluate heart rate (HR), systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP) and double product (DP) responses in the seated posture of the Global Postural Reeducation (GPR) method. **Methods:** Nine healthy female volunteers (23 ± 2.1 years; 56.4 ± 7.8 kg; 1.61 ± 0.05 m, 21.6 ± 2.4 kg/m²), without experience of the GPR, method underwent a treatment session in the seated posture. It was a three-step experiment: pre-posture resting, posture maintenance and post-posture recovery. In both the resting and the recovery step, the volunteers remained seated for 20 minutes and arterial pressure and HR were measured every five minutes. The posture maintenance step lasted for three minutes and was implemented three times with one-minute intervals between implementations. Arterial pressure and HR were measured every 1.5 minutes, while the posture was being maintained. **Results:** The SAP, DAP, MAP and DP values were significantly greater ($p < 0.05$) from the third to the ninth minute of maintaining the posture (154 ± 14 , 107 ± 11 , 122 ± 9 mmHg and $16,478 \pm 2,802$ mmHg/min) in comparison with the pre-posture resting values (109 ± 10 , 74 ± 7 , 85 ± 8 mmHg and $9,374 \pm 1,687$ mmHg/min) and the post-posture recovery values. However, these values returned to the resting values within the first five minutes of post-posture recovery. The HR while maintaining the posture was not statistically different from the pre-posture resting HR. **Conclusions:** Significant increases in SAP, DAP, MAP and DP were observed while maintaining the seated posture of the GPR method that was used in this study, but these values returned to the resting values within the first five minutes of post-posture recovery.

Key words: arterial pressure; double product; heart rate; isometric exercise; global postural reeducation.

Resumo

Objetivo: Avaliar as respostas da frequência cardíaca (FC), pressão arterial sistólica (PAS), diastólica (PAD), média (PAM) e duplo produto (DPr), durante a postura sentada do método de Reeducação Postural Global (RPG). **Materiais e métodos:** Nove voluntárias saudáveis ($23 \pm 2,1$ anos, $56,4 \pm 7,8$ kg, $1,61 \pm 0,05$ m, $21,6 \pm 2,4$ kg.m⁻²), inexperientes na prática do método RPG, foram submetidas a uma sessão de RPG na postura sentada, realizada em três fases: repouso pré-postura, execução da postura e recuperação pós-postura. No repouso e na recuperação, as voluntárias permaneceram sentadas por 20 minutos, sendo PA e FC verificadas a cada cinco minutos. A fase de execução da postura foi realizada em três séries e mantida por três minutos cada, com intervalo de um minuto entre elas. A verificação da PA e da FC foi realizada a cada um minuto e 30 segundos de execução da postura. **Resultados:** Os valores de PAS, PAD, PAM e DPr foram significativamente maiores ($p < 0,05$) do terceiro ao nono minuto da execução da postura (154 ± 14 , 107 ± 11 , 122 ± 9 mmHg e 16.478 ± 2.802 mmHg.min⁻¹) quando comparados aos valores de repouso pré-postura (109 ± 10 , 74 ± 7 , 85 ± 8 mmHg e 9.374 ± 1.687 mmHg.min⁻¹) e aos valores de recuperação pós-postura. Porém, estes valores retornaram aos valores de repouso nos primeiros cinco minutos de recuperação pós-postura. Durante a execução da postura, a FC não foi estatisticamente diferente da FC de repouso pré-postura. **Conclusões:** Elevações significativas da PAS, PAD, PAM e DPr foram observadas durante a execução da postura sentada da RPG empregada nesse estudo, mas retornaram aos valores de repouso nos primeiros cinco minutos de recuperação pós-postura.

Palavras-chave: pressão arterial; duplo produto; frequência cardíaca; exercício isométrico, reeducação postural global.

Received: 11/09/2006 – Revised: 12/12/2006 – Accepted: 08/04/2008

Introduction

The rehabilitation of patients with postural misalignment and pain involves the use of methods that include different types of exercise. Global Postural Reeducation (GPR) is one of the methods that include exercises involving isometric muscular contraction¹. The GPR method was originally developed by Phillippe Emmanuel Souchart in 1987, based on the theory of muscular chains², which are formed by the organization of static muscles that occurs through muscle overlaps and connections by means of aponeuroses. Thus, the tension of a given muscle group is transmitted to the entire chain³. The GPR method includes five muscular chains: dorsal chain, brachial chain, anterior chain of the neck, antero-lumbar chain and respiratory chain⁴. The use of these postures aims to correct the existing retractions in the different muscular chains².

The GPR postures were described as follows: “frog on the floor with open and folded arms; frog in the air with open and folded arms, standing against the wall, standing in the middle, seated and standing postures with anterior incline”⁴. The purpose of the seated position is to strengthen the paravertebral muscles, and to stretch the muscles of the dorsal chain, such as the gastrocnemius, soleus, flexor digitorum longus, flexor digitorum brevis and hamstring muscles¹.

Prior physical evaluation of the morphological alterations makes it possible to decide which postures are most suitable to correct the patient’s postural misalignments during treatment. Two different postures can be used in the same session, taking into consideration the patient’s ability to sustain that posture. A GPR session lasts one hour on average and usually takes place once a week⁵.

GPR uses active muscle stretching postures in which the stretching is made possible by the patients’ participation in their own corrections and isometric contractions in the increasingly eccentric positions of the shortened muscles⁵. The isometric contractions cause a progressive rise in blood pressure (BP) and heart rate (HR), and the rise in BP during isometric contraction varies according to the muscular tension that occurs during the exercise⁶⁻⁸.

BP is the product of cardiac output (CO) times peripheral vascular resistance (PVR). In isometric exercise, there is a minor increase in CO, particularly due to HR increase and to expressive PVR elevation, which contributes to a substantial increase in systolic blood pressure (SBP) and diastolic blood pressure (DBP)⁶⁻⁸. The boost in CO is primarily due to the HR increase. The rise in PVR may be influenced by the accumulation of local metabolites that stimulate muscular chemical receptors, by afferent discharges from muscular nerve endings to the cardiovascular center, and by an increase in

intrathoracic pressure caused by Valsalva’s maneuver, which often accompanies the isometric exercises⁹.

The sustained contraction of isometric exercise lowers blood and oxygen supply to the muscular tissue, thus HR rises linearly with the increase in the need for oxygen uptake⁹. Double product (DP) is one of the indicators of myocardial oxygen uptake. It can be obtained indirectly by multiplying the HR by the SBP and has been regarded as an important indicator of cardiac work load¹⁰. Isometric exercises cause significant modifications in HR and BP⁶⁻⁸, and these variations depend on the percentage of maximal voluntary contraction, on the time of contraction and on the muscle group involved. However, there are no scientific reports on the cardiovascular responses triggered by the GPR. Thus, because GPR involves the isometric contraction of large muscle groups for a long period of time, there is the concern that this method might cause the patient’s BP, HR, and DP to soar. The purpose of this study was to analyze the HR, BP, and DP responses during the “seated” posture of the GPR method in young, healthy individuals.

Materials and methods

Subjects

This was a cross-sectional investigation involving nine female subjects enrolled in the Physical Therapy undergraduate course (23±2.1 years old; 56.4±7.8kg; 1.61±0.05m; 21.6±2.4kg.m⁻²). The procedures of the present study were approved by the Ethics Committee in Human Research of Universidade Católica de Brasília (UCB), under protocol nº 082/2005. After undergoing a clinical evaluation and filling out a questionnaire, subjects were selected to take part in the study. Selection criteria were: no high BP (SBP<140mmHg and PAD<90mmHg)^{11,12}, no smoking habit, obesity, or cardiorespiratory disease, and no regular exercise regime or previous experience with the GPR method.

Subjects were advised to have a good night’s rest and avoid coffee, alcohol, foods with high-sodium content and physical exercise in the 48 hours prior to the tests. Before executing the posture, subjects were informed about the experimental protocol and the purpose of the study by means of a consent form, and then had their height and total body mass measured.

Procedures

BP was measured using the auscultatory method with the aid of a stethoscope (Duo Sonic, BD, Juiz de Fora, MG, Brazil)

and of a sphygmomanometer (Missouri São Paulo, SP, Brazil), which consists of an inflatable cuff connected to a calibrated mercury manometer. The BP measurement was obtained through arterial occlusion by inflating the cuff and correlating the auscultation of the heart beats to the values being displayed in the mercury column. The sounds perceived during the BP measurement are called Korotkoff sounds, and are classified into five phases, in which phase 1 (first sound) corresponds to the SBP value, and phase 5 (sound muffling or disappearing) corresponds to the DBP value¹³. A HR monitor (Polar Coded, Finland) was used, and the weight and height were measured using a scale (Filizola Personal Line, Campo Grande, MS, Brazil) with an attached stadiometer. The posture was performed on a stretcher (ISP, Instituto São Paulo, Cascavel, PR, Brazil). Data collection took place at the Cardiopulmonary Rehabilitation Laboratory of UCB.

Experimental protocol

The subjects had no previous experience performing the postures of the GPR method, therefore they attended a practice session to learn about monitoring techniques, evolution of seated posture, correct breathing, and adaptation to the laboratory environment. The subjects returned to the laboratory for data collection on a different day.

The cuff was placed firmly about 2 to 3cm from the antecubital fossa, and the rubber bulb was centralized on the left brachial artery. The watch containing the heart monitor screen was put on the right wrist, and the sensor on the subject's thorax.

The experiment was carried out in three stages: pre-posture rest, posture performance, and post-posture recovery. In the pre-posture rest, subjects remained seated on the stretcher for 20 minutes, in a comfortable position, with no support on the trunk and with their knees in semi-flexion, with a posture and position similar to the GPR posture used in the study. BP and HR were measured every five minutes for 20 minutes, and the mean was used to compare the values during and after the posture.

The performance of the seated posture began with the subject in the correct posture: hip flexion with the spine following the physiological kypholordotic curves when viewed in the sagittal plane (Figure 1). In the frontal plane, no lateral or rotational misalignment should be detected. The weight of the body was evenly distributed on each ischium, with the knees starting in semi-flexion facing outward and feet together⁵.

Each curve of the spine was corrected by axial manual traction in all necessary planes starting with lumbar traction, then the thoracic traction, until it offered a support to the

occipital bone⁷. The corrections were maintained manually by the therapist and by the abdominal and paravertebral muscle activity of the individual. The progression of posture was performed by maintaining the trunk position with an axial traction and extending with internal knee rotation and plantar dorsiflexion.

The posture was carried out in three series of three minutes each with one-minute intervals during which the subject remained in the same posture, though relaxed, totaling nine minutes of posture performance. BP and HR were checked every one minute and 30 seconds, *id est* at one minute and 30 seconds and three minutes after the beginning of each series, known as posture moment: 1min30s, 3min, 4min30s, 6min, 7min30s, and 9min, as detailed in Figure 2. During posture performance, the therapist made use of verbal commands and manual contact, requesting the maintenance of the alignment and the necessary postural corrections, in order to optimize stretching and avoid compensations. The subject inhaled softly, and let out prolonged, maximal exhalations, lowering the ribs and contracting the abdomen as much as possible to stretch the respiratory muscular chain, while the therapist helped to maintain the axial elongated position. In post-postural recovery, the individual remained in the same posture as the pre-posture rest for 20 minutes, and HR and BP were measured every five minutes. As a criterion for post-posture hypotension, we considered the significant BP reduction in the recovery values when compared to the mean of the four measurements taken during the pre-posture rest.

The measurements of both BP and HR were taken by a single researcher, and the performance of the GPR method was conducted by a physical therapist certified by the GPR course taught by Phillippe Emmanuel Souchard.



Figure 1. Representation of the Global Postural Reeducation (GPR) method execution in a seated posture as applied in the study.

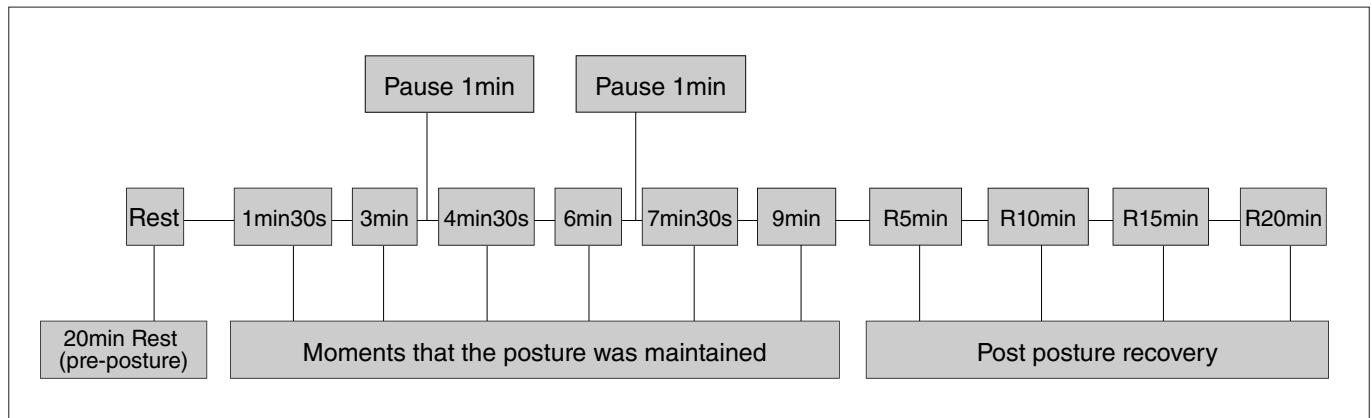


Figure 2. Schematic representation of the periods when the blood pressure and the heart rate were measured (Rest – Pre-posture resting; periods of posture execution from 1min30s to 9min; Post-posture recovery – R5min to R20min).

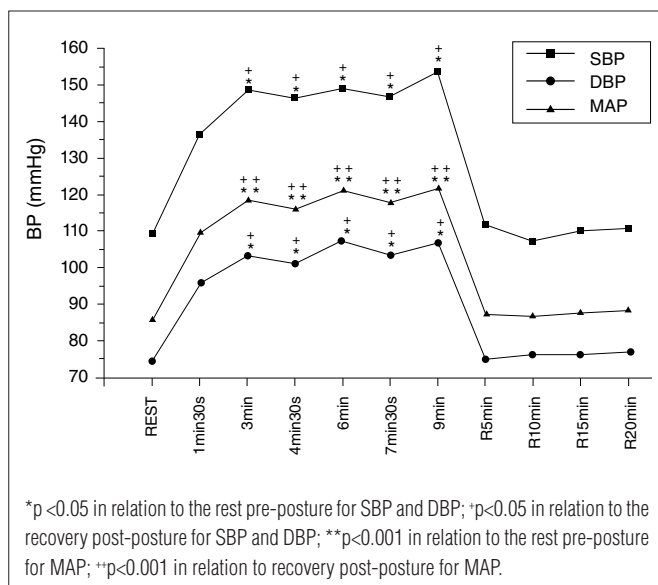


Figure 3. Mean results of the systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP), in the moments of pre-posture resting (Rest), execution of the posture (1min30s to 9min) and of post-posture recovery (R5min to R20min).

Statistical analysis

The results are presented with their mean values and respective standard deviations. In order to test the normality of the data, we used Kolmogorov Smirnov's method. We also compared the HR, SBP, DBP, MBP, and DP values taken for pre-posture rest, posture performance and post-posture recovery. Because the DP and MBP values had normal distribution, the variance analysis (ANOVA) with Tukey's *post hoc* was applied. To compare the results for HR, SBP, and DBP for pre-posture rest, posture performance and post-posture recovery, we applied Friedman's non-parametric test for repeated measures, followed by Dunn's multiple-comparison techniques. The level of significance was $p < 0.05$.

Results

The SBP, DBP, MBP, and DP values (Table 1 and Figure 3) during posture performance were significantly higher ($p < 0.05$) between the third and ninth minute of the task, reaching values of up to 154 ± 14 ; 107 ± 11 ; 122 ± 9 mmHg and $16,478 \pm 2,802$ mmHg.min⁻¹ when compared to the pre-posture rest values (109 ± 10 ; 74 ± 7 ; 85 ± 8 mmHg and $9,374 \pm 1,687$ mmHg.min⁻¹) for SBP, DBP, MBP and DP, respectively. At these moments, there was a mean increase of up to 45.0 ± 9 ; 33.0 ± 15 ; 37.0 ± 10 mmHg; and even $7,104.0$ mmHg.min⁻¹ above the pre-posture rest values for SBP, DBP, MBP and DP, respectively (Table 1).

As for the SBP and DBP values for the post-posture recovery (R5min to R20 min, Table 1 and Figure 3), they did not statistically differ from those obtained in the pre-posture rest.

With regard to the HR values, in spite of the mean increase between 20 ± 11 and 23 ± 13 bpm from one minute and 30 seconds to nine minutes of posture (Table 1), the differences did not reach statistical significance when compared to the pre-posture rest values.

Discussion

The significant increase of the variables studied from the third minute of posture performance is a common physiological response to isometric exercise. As the posture is carried out, the patient performs the stretch determined by the therapist, maintaining isometric contractions particularly in the paravertebral muscles, which is the probable cause of the cardiovascular alterations found in this study. In this kind of exercise, there is a mechanical compression of the arterial system, which brings about a persistent reduction in muscular perfusion and subsequent increase of the total PVR. In this case, sympathetic

Table 1. Mean±sd results of systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), double product (DP) and delta variation (Δ) of the SBP, DBP and HR during the pre-posture resting (Rest), moments of posture execution (1min30s; 3min; 4min30s; 6min; 7min30s and 9min) and during the 5th, 10th, 15th, and 20th min of post-posture recovery (R5min, R10min, R15min and R20min) from the seated posture of the GPR technique.

	SBP (mmHg)	DBP (mmHg)	MAP (mmHg)	HR (bpm)	DP (mmHg.min-1)	Δ SBP (mmHg)	Δ DBP (mmHg)	Δ HR (bpm)
Rest	109±10	74±7	85±8	86±7	9.374±1.687			
1min30s	136±10	96±4	109±6	106±14	14.416±2.836	27±11	22±12	20±12
3min	148±10**	103±12**	118±9****	107±15*	15.836±2.517****	39±14	29±21	21±14
4min30s	146±10**	101±9**	116±9****	106±12*	15.476±2.997****	37±10	27±11	20±11
6min	149±13**	107±11**	121±11****	109±14*	16.241±2.609****	40±13	33±15	23±13
7min30s	146±8**	103±12**	117±10****	107±12*	15.622±2.403****	37±13	29±15	21±11
9min	154±14**	106±8**	122±9****	107±13*	16.478±2.802****	45±9	32±13	21±13
R5min	111±7	75±7	87±6	80±10	8.880±1.228	2±8	1±6	-6±11
R10min	107±7	76±7	86±7	79±5	8.453±1.087	-2±7	2±5	-7±7
R15min	110±11	76±8	87±8	79±6	8.690±1.168	1±12	2±13	-7±5
R20min	110±12	76±7	87±8	80±6	8.800±1.424	1±9	2±5	-6±8

* $p < 0.05$ and ** $p < 0.001$ in relation to the pre-posture resting; * $p < 0.05$ and ** $p < 0.001$ in relation to the post-posture recovery.

nervous system (SNS) activity is boosted, thus increasing CO and mean BP in an attempt to reestablish and/or increase muscular blood flow¹⁴⁻¹⁶. Also, in the beginning of the isometric exercise, there is an inhibition of cardiac vagal activity (reduction of parasympathetic modulation) followed by an activation of the sympathetic response^{6,7,17-19}, as well as an interaction between the central command and the mechanoreceptors found in the muscles. This potencializes the SNS responses, causing the BP to rise^{7,19-21}.

The study revealed that between the third and ninth minute of posture performance there were significant increments in the SBP, DBP, MBP, and DP values. The magnitude of these responses may be directly related to the duration of the effort combined with the difficulty maintaining the muscle contraction and the size of the muscle mass involved in this type of isometric exercise^{14,15,22}. In the study developed by Polito and Farinatti²², BP responses increased in proportion to the number of repetitions (time of performance of the movements) in a resisted dynamic exercise. The present study used three series of isometric contractions lasting three minutes each and found that, as the posture performance time and the interval distance progressed (three, six, and nine minutes), the values for SBP, DBP, MBP, and DP also increased. Gandevia and Hobbs⁸ studied individuals performing intense isometric contractions (handgrip) to the point of fatigue and suggested that the chemoreceptors of the muscles were activated in direct proportion to the duration of isometric contractions, thus contributing to BP increase during contractions.

In the final moments of the test, the subjects reported the inability to maintain posture due to muscle fatigue. Polito and Farinatti²² observed that the repetitions to the point of fatigue (muscle failure to sustain a certain force) caused greater elevations in BP.

The DBP during isometric exercise, caused by the maintenance of the posture, had a different response from that observed by other authors. As the physical exercise is performed, the DBP remains constant or oscillates slightly, about 10mmHg, in relation to the values at rest²³. In the present study, there was an elevation in the DBP between 22 and 33mmHg during posture performance when compared to pre-posture rest, and this significant increase was observed from the third minute of posture maintenance onwards, as with the SBP. This provides us with an important practical application, *id est* that this GPR posture should not be sustained for more than three minutes by high-risk patients, such as those who suffer from symptomatic and asymptomatic cardiovascular diseases, especially high BP. However, further research is needed to confirm this claim. In addition, there was a tendency for the SBP, DBP, and MBP to fall in relation to the previous value in the stages of the posture performance that followed the one-minute intervals (4min30s and 7min30s), which suggests that the use of longer pauses may be helpful for this type of patient (Figure 3), or even for patients of other age groups whose BP tends to be higher.

In a study by Williams⁶, the researcher detected a SBP/DBP rise from 138/82 at rest to 224/156mmHg (+86/74mmHg) during a sustained contraction of the lower limb at 70% of the maximal voluntary contraction. At that point, the patient was overcome by fatigue and could no longer sustain the muscular contraction. In our study, we perceived an elevation from 109/74 at rest to 154/106mmHg (+45/32mmHg) in nine minutes of posture. It is important to consider that the intensity and duration of the effort to the point of fatigue in the aforementioned study were different from those employed in the present study, as was the method of BP measurement. The intra-arterial method, though invasive, produces the most realistic BP values. The BP values obtained in these studies show that isometric

exercise causes excessive BP increase, which varies according to the intensity and duration of the muscle contraction.

This significant increase both in SBP and DBP in the present study may also be caused by the increase in the intrathoracic pressure due to the additional contraction of the exhalation muscles as a consequence of Valsalva's maneuver^{16,24}. In this maneuver, the person tries to exhale while the glottis is closed, thus the increase in intrathoracic pressure causes a decrease in venous return due to the collapse in the veins that cross the thorax, elevating BP¹⁶. Narloch and Brandstater²⁵ investigated the influence of this breathing technique on the BP of young athletes during weight-bearing exercise and found an increase in the SBP/DBP at rest with and without Valsalva's maneuver, from 127/82 to 180/155mmHg, during the performance of five repetitions of the exercises at 85% of maximal repetitions from 178/156 to 267/239mmHg using the intra-arterial technique of BP measurement. This study allows us to assert that Valsalva's maneuver contributes to an even greater BP rise than that induced by the physical exercise, including excessive BP elevation even when the maneuver is performed at rest. Stretching during GPR is carried out in association with deep and prolonged exhalation⁵ and the patient may, despite advice to the contrary, perform Valsalva's maneuver at given moments in which the maintenance of the posture becomes uncomfortable, thus increasing BP. In addition to Valsalva's maneuver, the seated position of the GPR posture itself may have contributed to the reduction in venous return and therefore to the elevation of BP.

Post-exercise hypotension (PEH) is characterized by a reduction in BP during the post-exercise recovery phase, when the pressure values are significantly lower than those obtained in the pre-exercise stage. In this study, no statistical difference was found between BP at rest and post-posture recovery BP in the course of the 20 minutes during which it was taken, and the BP returned to its rest values in the first five and ten minutes of recovery. According to Brum et al.²⁶ the characteristic, type, intensity, and duration of the exercise determine the magnitude of PEH. Thus, the model put forward in this study in terms of duration, posture, pause, and type of muscular contraction did not result in post-posture hypotension in the course of the 20 minutes during which BP was measured. The effects of other variations, such as duration of posture performance and of post-posture recovery, as well as the posture used on recovery BP must be investigated. In a study developed by Simões²⁷, the PEH of SBP was only observed after 30 minutes of recovery following resisted exercise performed in a 20-minute circuit, whereas the PEH of DBP was not observed. It is possible that after the 20 minutes of post-posture recovery there was PEH induced by the nine minutes of performance of the seated posture of the GPR method, though this was not investigated in the present study.

The DP is a parameter obtained by multiplying HR by SBP and represents cardiovascular stress with a high correlation ($r=0.88$) to myocardial O₂ consumption and is an important indicator of cardiac workload during the physical exertion¹⁰. The present study found a significant increase in DP (75.8%), which went from 9,374 at rest to 16,478mmHg.min⁻¹ at nine minutes of posture, showing that the GPR method employed in the study caused a considerable cardiovascular overload. Therefore, the risk/benefit must be taken into account when using this method on patients with high BP and heart disease.

In the study by Andrade, Barbosa Júnior and Pulcenelli²⁸, the DP increase was a result of the significant elevation of SBP and HR in response to the number, intensity, and length of repetitions performed in resistance exercise. The DP can vary from around 6,000 at rest to 4,000mmHg.min⁻¹ (an increase of approximately 567%) or more, depending on the intensity and mode of exercise¹⁷.

We observed that the increase in DP during posture performance was below the value of the cutoff point for angina pectoris (from 30,000mmHg.min⁻¹). The young, healthy subjects of this study achieved approximately 55% (16,478mmHg.min⁻¹) of this threshold. Nevertheless, it is necessary to investigate the hemodynamic responses during the application of this method in high-risk populations. It is important to know the cardiac overload imposed by different exercises and therapies, as it helps in the selection of therapies that offer the least impact, especially when dealing with populations at risk.

With regard to MBP, we observed a significant increase between the third and ninth minute of posture performance when compared to the pre-posture rest values. MBP represents the mean force exerted by the blood against the arterial walls during the entire cardiac cycle. For this calculation, the duration of the diastole is considered 1/3 greater than that of the systole²⁴. The increase in MBP while posture is sustained may be related to the significant DBP increase¹⁶ in the present study. According to Polito and Farinatti¹⁶, the DBP response during the exercise, not exceeding the normal response, is considered the facilitator of myocardial perfusion. Therefore DBP and the MBP values should be monitored during posture performance to reduce ischemic risk.

HR is the variable that most contributes to the increase in CO during exercise, thus blood flow to the muscles during activity is enhanced¹⁴. In the present study, HR elevation during the posture in relation to the pre-posture rest was not statistically significant, whereas SBP elevation was. This suggests that the increase in SBP may be due primarily to the increase in the PVR, rather than to CO. In a study by Marin-Neto et al.²⁹, the pressure response during isometric exercise (handgrip) in patients with Chagas' disease was predominantly mediated by an increase in the systemic vascular resistance rather than by an

increase in CO. However, a limitation that might have contributed to results in the present study was the fact that HR was not continually recorded, but only when the other variables were registered (1min30s; 3min; 4min30s; 6min; 7min30s and 9min of posture). For this reason, future studies should monitor HR on a beat-by-beat basis.

A few limitations of the study must be highlighted. BP was measured using the auscultatory method. It is known that the use of invasive methods such as the intra-arterial catheterization would yield more precise, reliable, and valid results, despite being invasive and onerous. However, it was not possible to employ these procedures in the present study. In addition, all the hemodynamic variables investigated in the present study were elevated during the posture performance stage of the GPR posture in relation to the pre-posture rest values. However, all of them returned to values close to those observed in the pre-posture rest in the first five minutes of post-posture recovery. In spite of these limitations, the present study intended to encourage physical therapists to monitor the cardiovascular responses of patients who have been recommended

GPR treatment, particularly those at risk, such as individuals with symptomatic and asymptomatic cardiovascular disease, especially high BP. It is evident that the clinical practice of GPR has had beneficial results in terms of improving flexibility, but before it can be offered to patients as an alternative, risk-free treatment, it must be scientifically validated.

Conclusions : : : .

Significant increases in SBP, DBP, MBP, and DP were recorded during the performance of the GPR seated posture, however they returned to the rest values in the first five minutes of post-posture rest. We suggest that the responses of these variables in comparison with other GPR postures, with different periods of exertion and pause, be examined both in healthy individuals and those at risk of cardiovascular disease. The investigation of these parameters during and after the various types of GPR posture, as well as duration and pause, is necessary for both types of patients.

References

- Souchard PE. Reeducação postural global: método do campo fechado. 4ª ed. São Paulo: Ícone; 2001.
- Teodori RM, Moreno MA, Fiore Júnior JF, Oliveira ACS. Alongamento da musculatura inspiratória por intermédio da reeducação postural global (RPG). *Rev Bras Fisioter.* 2003;7(1):25-30.
- Yokohama TV. A prática do Iso-stretching na melhora da expansibilidade toracopulmonar, verificada através da Espirometria e da Cirtometria [Monografias do curso de Fisioterapia]. Cascavel (PR): Unioeste; 2004.
- Souchard PE. O stretching global ativo: a reeducação postural global a serviço do esporte. 2ª ed. São Paulo: Manole; 1996.
- Souchard PE, Ollier M. As escolioses: seu tratamento fisioterapêutico e ortopédico. São Paulo: Realizações; 2001.
- Williams CA. Effect of muscle mass on the pressor response in man during isometric contractions. *J Physiol.* 1991;435:573-84.
- Friedman DB, Peel C, Mitchell JH. Cardiovascular responses to voluntary and nonvoluntary static exercise in humans. *J Appl Physiol.* 1992;73(5):1982-5.
- Gandevia SC, Hobbs SF. Cardiovascular responses to static exercise in man: central and reflex contributions. *J Physiol.* 1990;430:105-17.
- Ghorayeb N, Barros Neto TL. O exercício: preparação fisiológica, avaliação médica, aspectos especiais e preventivos. São Paulo: Atheneu; 1999.
- Leite TC, Farinatti PTV. Estudo da frequência cardíaca, pressão arterial e duplo produto em exercícios diversos para grupamentos musculares semelhantes. *Rev Bras de Físio do Exercício.* 2003;2(1):29-49.
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA.* 2003;289:2560-72.
- Sociedade Brasileira de Hipertensão, Sociedade Brasileira de Cardiologia, Sociedade Brasileira de Nefrologia. V Diretrizes Brasileiras de Hipertensão Arterial. São Paulo; 2006, 1-50.
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension.* 2003;42(6):1206-52.
- McArdle WD, Katch FI, Katch VL. Fisiologia do exercício: Energia, nutrição e desempenho humano. 4ª ed. Rio de Janeiro: Guanabara Koogan; 1998.
- Nóbrega ACL. Fisiologia do exercício. *Revista SOCERJ.* 2000; XIII(4):19-23.
- Polito MD, Farinatti PTV. Respostas de frequência cardíaca, pressão arterial e duplo-produto ao exercício contra-resistência: uma revisão da literatura. *Rev Port Ciências Desp.* 2003b;3(1):79-91.
- Power S, Howley E. Fisiologia do exercício – Teoria e aplicação ao condicionamento e ao desempenho. 3ª ed. São Paulo: Manole; 2000.
- González-Camarena R, Carrasco-Sosa S, Román-Ramos R, Gaitán-González MJ, Medina-Bañuelos V, Azpiroz-Leehan J. Effect of static and dynamic exercise on heart rate and blood pressure variabilities. *Med Sci Sports Exerc.* 2000;32(10):1719-28.
- Ray CA, Rea RF, Clary MP, Mark AL. Muscle sympathetic nerve responses to static leg exercise. *J Appl Physiol.* 1992;73(4):1523-9.
- Iellano F, Massaro M, Raimond G, Peruzzi G, Legramante JM. Role of muscular factors in cardiorespiratory responses to static exercise: contribution of reflex mechanisms. *J Appl Physiol.* 1999;86(1):174-80.
- Smolander J, Aminoff T, Korhonen I, Tervo M, Shen N, Korhonen O, et al. Heart rate and blood pressure responses to isometric exercise in young and older men. *Eur J Appl Physiol Occup Physiol.* 1998;77(5):439-44.
- Polito MD, Farinatti PTV. Considerações sobre a medida da pressão arterial em exercícios contra-resistência. *Rev Bras Med Esporte.* 2003a;9(1):25-31.
- Conselho Nacional de Ergometria. Indicações e contra-indicações dos testes ergométricos. *Arq Bras Cardiol.* 1995;65(2):191-211.
- Robergs RA, Roberts SO, Silva AC. Princípios fundamentais de fisiologia do exercício para aptidão, desempenho e saúde. São Paulo: Phorte; 2002.
- Narloch JA, Brandstater ME. Influence of breathing technique on arterial blood pressure during heavy weight lifting. *Arch Phys Med Rehabil.* 1995;76(5):457-62.
- Brum P, Forjaz C, Tinucci T, Negrão CE. Adaptações agudas e crônicas do exercício físico no sistema cardiovascular. *Revista Paulista Educ Física.* 2004;18:21-31.
- Simões GC. Efeitos de diferentes intensidades de exercício resistido sobre as respostas hemodinâmicas em indivíduos diabéticos tipo 2 e não diabéticos [dissertação de mestrado em Educação Física e Saúde]. Brasília: UCB, 2006.
- Andrade FM, Barbosa Júnior OA, Pulcenelli AJ. Estudo comparativo do duplo produto no treinamento de força em séries piramidais crescente e decrescente. *Revista Digital Vida & Saúde.* 2002;1(3).
- Marin-Neto JA, Maciel BC, Gallo Júnior L, Junqueira Junior LF, Amorim DS. Effect of parasympathetic impairment on the haemodynamic response to handgrip in Chagas's heart disease. *Brazilian Heart Journal.* 1986;55(2):204-10.