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ORIGINAL ARTICLE

USE OF BATH PARAFFIN AND EXERCISE FOR INDIVIDUALS WITH INTERMITTENT CLAUDICATION- A PILOT STUDY

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Background: Peripheral arterial obstructive disease's (PAOD) most common symptom is the Intermittent Claudication. The hot paraffin associated with physical exercise could be a possible support in the treatment of PAOD patients, since the amount of heat delivered to the tissues may potentially increase blood flow. **Objectives:** compare the indicators of functional capacity between a group of individuals with PAOD who underwent a combination of thermal stress and physical exercise, and another group of similar individuals treated only with physical exercise. **Methods:** Paraffin Group (PG) comprised of 10 individuals received thermal stress (hot compresses of paraffin) before physical activity. The control group (CG) of 9 participants was treated with physical activity alone. Shuttle-walking test (SWT), six-minutes walking test (6MWT) and ankle-brachial index (ABI) before interventions and after six weeks of training were assessed. **Results:** The mean age of the PG and for CG was 59.1 ± 10.41 and 68.89 ± 4.91 years (p = 0,019), BMI 27.54 ± 3,52 and 27.51 ± 2,07 (p=0,98) respectively. There was no statistically significant difference in the mean values of distance, time, speed or walking economy, both at symptom onset and at limiting symptom between groups during the SWT (p > 0,05). The change in distance measured during the 6MWT, both at symptom onset and at limiting symptom were not different between groups (p > 0,05).
Conclusion: There was no statistically significantly difference in the indicators of functional capacity between PG and CG.

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INTRODUCTION

The most common symptom of peripheral arterial obstructive disease (PAOD) is the intermittent claudication (IC) that can be defined as pain, cramp, stiffening or paresthesia of the muscle mass involved[1-3]. IC is caused by progressive limitation of the blood flow during walking[1-3], which may lead a progressive sedentary lifestyle[4].

Literature describes many interventions[5] for the individuals with PAOD, like the programmed physical exercise that has been progressively considered as a coadjutant in the treatment of IC [6,7].

Because of the inability to increase blood flow of the individuals with PAOD different ways to enhance blood supply have been tried out, including thermal stress[8,9,10]. The use of the latter to relief symptoms, to improve vascular function and functional capacity in individuals with PAOD can be managed in different ways[11,12]. A study which evaluated 14 patients receiving alternate hot and cold water for three weeks found a reduction in the claudicating pain, an increase in walking distance and an improvement in the hemodynamic function[13].

Paraffin bath is a technique, which is quite efficient in transferring heat to a given area of the body[12] .So, hot paraffin could be a possible support in the treatment of PAOD patients, since the amount of heat delivered to the tissues may potentially increase blood flow secondary to the vasodilation effect induced by the heat. Notwithstanding, the use of this technique for patients with PAOD has not yet been reported.

In spite of the benefits of physical exercise and thermotherapy in PAOD individuals, more extensive investigation on the effects of the use of thermal stress associated with physical exercises in this population has not been carried out yet. Therefore, the objective of this pilot study was to compare the indicators of functional capacity between a group of individuals with PAOD who underwent a combination of thermal stress (paraffin bath) and physical exercise, and another group of similar individuals treated only with physical exercise.

METHODS

Participants

Individuals with PAOD who voluntarily participated in this study were those who were on the waiting list for physical therapy treatment at The Vascular Disease Treatment Center at Belo Horizonte University Center, and volunteers referred by the department of angiology form other medical institutions. Their PAOD was diagnosed by arterial dupplex-scan of the lower limbs and by the presence of intermittent claudication (IC).

The study was approved by the Ethics Committee of Socor Hospital, on 07/03/2007 and each participant was accepted into the program after signing an informed consent.

Subjects who participated in this study were adult individuals with PAOD who presented an ankle-brachial index (ABI) between 0.4 - 0.9 without lower limb pain at rest. Individuals who suffered from any illnesses or complications precluding physical activity such as arrhythmia, unstable angina or signs of haemodynamic instability were excluded. Patients with inaudible blood pressure or non-measurable ABI, lower sensorial limb, stroke sequel affecting walking, and patients who had undergone supervised physical exercising during the previous six months could not join the study either. If the patient fulfilled the inclusion criteria but were on vasodilation drugs they were referred back to their primary physician to evaluate the possibility of suspension or substitution of the drug. Whenever necessary, the patient had to wait up to 48 hours before joining the study[5].

Measures

Evaluations were conducted once before beginning treatment and then at six weeks after interventions. Measurements included the ankle-brachial index (ABI), shuttle walking test (SWT) and six-minute walk test (6MWT). Every participant was evaluated and re-evaluated by the same investigators.

The ABI were recorded by a portable doppler (MEDPED DV-2001). Both limbs were measured separately, and the reliability of this procedure was tested among the researchers in a pilot study with claudicating and normal individuals. The reliability index (intra- and inter-investigators) rendered an intraclass correlation coefficient above (ICC) 0.90[17].

Following the determination of the ABI, patients were asked to perform the walking tests: SWT and 6MWT[18,19]. The outcome variables analyzed were distance in meters, speed in meters per minute, time in seconds, and walking

economy (distance walked divided by heart rate, recorded as meters per beats per second) at the moment of claudicating symptom onset (SO) and of claudicating limiting symptom (LS). Walking economy is a variable which allows to infer possible changes in physical conditioning. If after the interventions the patient is able to walk a similar distance with lower heart rate, it is suggestive that, in principle, some positive changes in the utilization of oxygen uptaking might have occurred[4].

The reliability of SWT in evaluating distance and time at symptom onset as well as at the limiting symptom during the walk was investigated. CCI test-retest varied between 0.72 and 0.95, while coefficients of variation were between 9,1% and 26,8%[20]. The reliability of the 6MWT to evaluate the distance claudicating pain onset and symptom-limited distance walked was examined. The test-retest CCI scores were between 0.81 and 0.87[17].

Study design

Participants were randomly assigned to a control group (CG) which consisted of physical training alone, or to the paraffin group (PG) which included also a previous warming of the lower limbs by means of hot compresses of paraffin. In both groups, training was conducted for six weeks, three times a week, totaling eighteen sessions.

Before treatment, a screening on thermal sensorial integrity was also carried out in patients of the PG. The integrity in thermal perception capacity was screened by touching several spots in the lower limbs of patients of the paraffin group with two tubes containing hot and cold water. The patients were asked to describe their perception. Those who retained the capacity to perceive and discriminate the temperature in the tubes were considered able to submit to the paraffin treatment[21].

In the PG, hot paraffin compresses were applied only to the affected limb (one or both legs) for a period of twenty minutes prior to the exercise program. The hot pack compresses were prepared by soaking cotton bandages into a tank containing a mixture of one part of mineral oil to seven parts of paraffin at a temperature of 60°C. These cotton bandages were enveloped in plastic bags before they were applied to all the patient's limb. In order to prevent heat loss and enhance the contact between the hot packs and skin, the compresses were secured by wrapping the limbs with a dry layer of cotton bandages. Following the application of the thermal stress, the patient was taken to the programmed session of exercises.

The training session consisted of instructing the patient to walk along the floor surface, aiming to induce the limiting symptom[4]. The limiting symptom was defined as the moment in time during the walk when the participant could no longer continue walking because of IC. At the onset of the limiting symptom the walk was interrupted, and the participant was allowed to rest until he/she could resume the task. The walking time for each session was always at least 30 minutes, excluding the resting periods. If the patient could walk for a minimum of 15 minutes at a higher speed without reporting the claudicating symptom, sand-bag weights (ranged from 0.5 to 2.0kg) were wrapped around his/her ankles to add an extra effort to provoke the limiting pain. When this resource failed to induce the symptom, the patient was taken to walk on a treadmill using inclination and/or addition of sand-bag weights to the ankles in order to bring about the limiting symptom desired.

The individuals in CG performed the same exercising protocols as in PG.

Statistical Analysis

Data was reported as average ± standard deviation. The independent T-test was used to compare age and Body Mass Index (BMI) between groups. A two-way analysis of variance (ANOVA) was used to investigate the differences between and within groups. Since this was an intention-to-treat design, all participants who initiated the program, regardless of the eventual drop outs, were included in the statistical analysis. An alpha value of 5% or less was utilized for statistical significance.

RESULTS

Out of the 28 individuals contacted to take part in the study, nine were excluded because of hemodynamic instability or walking impairment due to motor sequels secondary to cerebral vascular accident. Of the remaining 19 individuals, 10 were allocated in the PG (10 men) and nine in the CG (7 men and 2 women). Three participants in the PG were smokers. The average age of the PG and for CG was 59.1±10.41 and 68.89±4.91 years (p=0,019), BMI 27.54±3,52 and 27.51±2,07 (p=0,98) respectively. One participant in the CG and two from the PG could not complete the 18 sessions of the study protocol due to

anemia, glycemic instability, and decision to withdraw from the study. Out of 19 participants, five in PG and two in CG continued on calcium channel-blocker medication (table 1).

Table 1. List of drugs in used by participants

Class	Control Group (n = 10)	Paraffin Group (n = 9)
Anti-aggregating agent	8	6
Diuretic	7	6
Hypolipemiant	5	5
ACE inhibitors	6	3
Calcium channel-blocker	2	5
Hypoglycemic	1	2
Insulin	1	-

The ABI values pre-interventions and post-interventions indicated that the patients had artery obstruction degrees ranging from slight to moderate, in both groups (table 2).

Table 2. Ankle-brachial indexes of right and left lower limbs, pre- and post-interventions in control and paraffin groups

Arteries		Control Group (n = 10)		Paraffin Group (n = 9)		F	*p*
		Pre	Post	Pre	Post		
Dorsalis Pedis	RLL	0.67±0.24	0.58 ± 0.18	0.84 ± 0.19	0.88 ± 0.22*	2.825	0.111
	LLL	0.62 ± 0.16	0.62 ± 0.2	0.59 ± 0.34	0.59 ± 0.39	0.049	0.828
Posterior Tibial	RLL	0.66 ± 0.18	0.65 ± 0.17	0.89 ± 0.2*	0.93 ± 0.20*	6.127	0.025
	LLL	0.69 ± 0.17	0.72 ± 0.21	0.63 ± 0.31	0.61 ± 0.28	0.304	0.589

RLL: right lower limb; LLL: left lower limb; F: F of interaction of two-way analysis of variance; P: significance level of two-way analysis of variance;* $p<0.05$ (between groups)

There was no statistically significant difference in ABI pre-intervention and post-intervention within groups.
But the between groups comparison revealed that the ABI obtained with the right posterior tibial artery either before or after intervention was significant higher in PG. The ABI found for the right dorsalis pedis artery was also significant after interventions in PG.

There was no statistically significant difference in the mean values of distance, time, speed or walking economy, both at symptom onset and at limiting symptom between groups during the SWT. But within groups there was a significant improvement in distance, time and speed measured at limiting symptoms after both interventions (table 3).

Table 3. Shuttle walking test data pre- and post-interventions in control and paraffin groups

Variables		Control Group (n = 10)		Paraffin Group (n = 9)		F	P
		Pre	Post	Pre	Post		
Distance (m)	SO	184.4 ± 104.7	181.1 ± 107.3	175 ± 108.4	199. ± 121.4	0.037	0.850
	LS	340 ± 61.8	410 ± 68.4*	370.3 ± 158.4	432.7 ± 187.3*	0.288	0.598
Time (s)	SO	234.7 ± 99.4	235.2 ± 99.9	231.1 ± 117.6	242.9 ± 121.9	0.005	0.943
	LS	370.2 ± 50	411.6 ± 64.2*	371.2 ± 113.4	410.4 ± 128.2*	0,001	0.981
Velocity (m/s)	SO	1.1 ± 0.27	1.07 ± 0.29	1.05 ± 0.30	1.10 ± 0.34	0,002	0.967
	LS	1.46 ± 0.11	1.56 ± 0.14*	1.52 ± 0.30	1.63 ± 0.32*	0.258	0.618
Walking economy (m/bpm)	SO	1.59 ± 0.92	1.79 ± 0.97	1.79 ±0.96	1.8 ± 1	0.008	0.938
	LS	3.03 ± 0.99	3.45 ± 1.24	3.07 ± 0.60	3.46 ± 0.57	0.001	0.973

SO: symptom onset; LS: limiting symptom; bpm: beats per minute; m: meters; s: seconds, m/s: meters/seconds; F: F of interaction of two-way analysis of variance; P: significance level of two-way analysis of variance; * p<0.05 (pre to post-intervention within group)

The change in distance measured during the 6MWT, both at symptom onset and at limiting symptoms were not different between groups. But the 21% increase (106 meters) in distance pre-intervention to post-intervention with the CG was statistically significant at limiting symptom (table 4).

Table 4. 6-Minute walking data pre- and post-interventions in control and paraffin groups

		Control Group (n = 10)		Paraffin Group (n = 9)		F	P
		Pre	Post	Pre	Post		
Distance (m)	**SO**	147.4 ± 91.6	176.8 ± 124.9	109.5 ± 40.3	116.3 ± 54.4	1.166	0.297
	LS	495.8 ± 165.2	601.2 ± 78.6*	453.2 ± 235.6	515.5 ± 202.7	1.592	0.226

SO: symptom onset; LS: limiting symptom; m: meters; F: F of interaction of two-way analysis of variance; P: significance level of two-way analysis of variance;* p<0.05 (pre to post-intervention within group)

DISCUSSION

Treatment with heat stress associated with physical training showed no statistically significant difference when compared to physical activity alone in patients with PAOD. The study showed, though, a trend towards higher performance values in both the distance and time at symptom onset in the PG, during the SWT.

The rationale to use thermal stress by means of hot compresses of paraffin associated with physical activity was based on the principle that it is a common clinical procedure to prescribe vasodilating drugs alone for patients with PAOD, or in conjunction with exercise. In principle, the prescription of drugs to increase arterial diameter appears to be not fully tenable since the obstruction in the blood vessel observed with this disease is caused by atherosclerotic plaques, that is, the problem explained by the restoration or even augmentation in dilation capacity of non-obstructed arteries adjacent, whose capacity to change their diameter was secondarily affected by progressive loss of mobility. It is known that, due to a gradual decrease in physical activity, the production of nitric oxide in the vascular epithelium diminishes thus jeopardizing its dilating capacity[23]. The hypothesis is that the overall vessel dilating capacity of non-affected arteries in a given body segment is below optimum levels, mainly due to the progressive decrease in vasodilating capacity secondary to progressive loss of mobility. Therefore, the use of Paraffin compresses associated to programmed physical activity was tested considering that heat induces vasodilation in the adjacent areas and, consequently, may increase blood flow. It was observed that there was a difference between groups in relation to age. Physiologically, the paraffin group had better endothelial function and better vasodilator response to the warming of the lower limb. However, this age difference would not be considered a limitation of this study, because the paraffin group did not have better responses than the control group. The ABI average obtained with dorsalis pedis artery from both feet did not change or tended to worsen after intervention, while the ABI obtained with the posterior tibial artery tended to increase, in the CG is primarily anatomical, not functional. So, no vasodilating drugs would increase the vascular lumen at the site of the plaque. Actually, what is more often observed is that after the atherosclerotic obstruction, the artery tends to be more dilated to compensate for the decreased blood flow secondary to the narrowing of the vessel. This suggests that functionally the artery may be compromised from that point forward. However, there are reports in scientific literature of increase in physical performance after the administration of vasodilating drugs[9,22]. So it is possible that such an improvement in performance of patients with PAOD put on vasodilating drugs could be.

In the PG, whereas there was no change in these indexes after the intervention, the trend was towards an increase in the values, when both arteries were tested. Positive change in the ABI is suggestive that the blood flow to the affected limb has improved. The mechanisms possibly involved in this process are complex, but it has been shown that with healthy individuals, one single session of exercising may increase the growth factor expression of the endothelium in the messenger RNA in the calf. The magnitude of this increase is dependent on the degree of metabolic stress[4]. Significant improvement in both clinical and physical performance aspects have been associated with interventions lasting no less than six months with a frequency of three times per week[7]. Usually, protocols for treating individuals with PAOD have different periods of duration, ranging from 12 and 36 weeks[7,24-25]. The present study tested a rather short protocol lasting only 6 weeks, totaling 18 sessions of training for both groups. Due to its individualized and progressive character, it was still possible to observe clinical improvements in both groups when comparing performances of each one before and after the interventions. Within each group, there were statistically significant differences in the variables of distance, time and speed of limiting symptom. These results show that even on a short duration program, with progressive intensity tailored individually, patients with PAOD may improve physical performance. Such positive changes observed in the walking performance can also be traced by the 6MWT. In an exercise program, which lasts six months, three times a week, with a gradual increase in speed and time, the average distance in the test, at the end of the intervention, was 348 ± 80m, showing a significant gain of 20.9 meters[25]. This increase, in spite of the protocol duration, was smaller than the observed in the present study, once the CG and PG gain in walking distance was 106 and 60 meters, respectively. It is not possible to explain precisely what mechanisms were

primarily responsible for the improvements in each group separately regarding the performance in the walking tests, in the present study. Intervention protocols based on programmed physical activity usually report a mean time of 12 weeks before the effects of training can be observed [3,23] . But one of the problems with walking protocols is that, during the intervention, patients may eventually need to jog or to run, in order to achieve the claudicating symptom. This happens because of the training effect observed while still training. However, since patients with PAOD tend to be older and more fragile, jogging or running may not be a suitable approach to train them. Therefore, this present study made use of leg weights to increase the load while walking so that the participants were always able to walk up to the limiting symptom. Thus, this approach allowed us to provide a considerable intensity to training. One of the haemodynamic variables more easily accessible to infer physical conditioning is heart rate, which tends to reduce at a given work load, after conditioning. After the intervention in the PG, the patients walked 14% longer , without any change in the mean HR, at symptom onset whereas, at limiting symptom, they also walked 17% more with a slight increase of 3% in HR. These results may indicate that the use of thermal stress associated with exercise is clinically more relevant than exercise alone. Another aspect that must be considered in the present study was the effect size generated when the maximal distance walked was contrasted between the two groups during the SWT. The effect size of 0.15 units standard deviation is considered small and, with the number of participants included, it showed that the test had a power (beta value) of less than 20%. Some factors may help to understand why such a small effect size was observed. First, the "intention-to-treat" approach presupposes the inclusion of data of participants who did not complete the protocol, thus decreasing the power of the test. Data of two participants in PG and one in CG entered the analysis, and this may represent an important quantity considering the overall sample size of this pilot study. Second, three participants in PG continued to smoke throughout the protocol. The tobacco seems to accelerate the atherosclerotic process[25] thus harming the blood flow and preventing possible improvements brought by the intervention. So the "intention-to-treat" methodology, the non-interruption of smoking, may have limited possible positive outcomes. This pilot study confirms the importance of exercising, like walking, for cardiovascular physical therapy for individuals with intermittent claudication independently of using bath paraffin, because there was no additional gain in functional capacity with the use of this resource in a group of younger individuals who theoretically would present a better vasodilator response to warming of the lower limb. However, due to the trends observed with the result and the limitations listed, only like a small sample, compromises the external validity. Further studies with a larger and more homogeneous sample size, and longer intervention time are necessary.

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