Original Article

Functional Limitation and Intermittent Claudication: Impact of Blood Pressure Measurements

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Abstract

Background: **Arterial hypertension is an important risk factor for Lower-Limb Occlusive Arterial Disease (LLOAD). However, the correlation between blood pressure and pulse pressure (PP) with LLOAD severity and functional impairment resulting from this disease is not well established in the Brazilian population.**

Objective: **To verify whether there is a correlation between blood pressure, PP, LLOAD severity and functional capacity in patients with symptomatic LLOAD.**

Methods: **A total of 65 patients (62.2 + 8.1 years, 56.9% males) were evaluated. They were divided into two groups: normal (A) and high (B) blood pressure. LLOAD severity was assessed using the ankle-brachial index (ABI) and functional capacity by the total and pain-free walking distance at the 6-minute walking test (6MWT).**

Results: **Group A consisted of 17 (26.1%) patients. The systolic (SBP), diastolic blood pressure (DBP), and PP were, respectively, 125.4 ±11.7, 74.5 ± 9.1 and 50.9 ± 10.0 mmHg in group A and 160.7 ± 19.6, 90.0 ± 12.2 and 70.7 ± 20.2 mmHg in group B. The ABI was significantly lower in group B (0.66 ± 0.12 vs. 0.57 ± 0.13, p <0.05). SBP and PP correlated with LLOAD severity and the distances walked at the 6MWT. Patients with PP > 40 mmHg walked shorter distances.**

Conclusion: **SBP and PP significantly correlated with the distances walked in the 6MWT, suggesting they are clinical markers of functional capacity impairment in patients with symptomatic LLOAD. (Arq Bras Cardiol 2012;98(2):161-166)**

Keywords: **Intermittent claudication; blood pressure; hypertension; peripheral arterial disease; walking.**

Introduction

Lower-limb obstructive arterial disease (LLOAD) is an important manifestation of systemic atherosclerosis. LLOAD has high rates of morbidity and mortality and is associated with a higher incidence of cerebrovascular and cardiac events. Its most common clinical manifestation is intermittent claudication, characterized by the onset of pain in the lower limbs (LL) during walking, which rapidly disappears after cessation of the activity[1]. This symptom has significant impact on quality of life of individuals with LLOAD, as it is strongly associated with impaired functional capacity[2,3].

Arterial obstruction caused by the atherosclerotic plaque determines overall loss of pressure along the lower-limb arterial system. The calculation of ankle-brachial index (ABI) has been extensively used to evaluate the hemodynamic effects of LLOAD on lower limbs. The ABI is a noninvasive, reproducible and easy-to-perform method, which is useful in the detection of LLOAD with hemodynamic impact, as well as assessing patient functional capacity[4,5].

Several risk factors contribute to the onset and progression of LLOAD, among which arterial hypertension (AH) is one of the most important factors[1-7]. Elevated systolic blood pressure (SBP) and diastolic blood pressure (DBP) are accelerating atherosclerosis factors in the long-term[8].

Some epidemiological studies have shown a strong association between arterial hypertension (AH) and LLOAD. There is evidence that AH affects up to 90% of individuals with LLOAD [7], and BP levels > 150/90 mmHg were observed in about 25% of patients with intermittent claudication [8]. The Framingham study showed that hypertensive patients are up to four-fold more likely to develop intermittent claudication than normotensive individuals[9].

More recently, emphasis has been given to the prognostic value of pulse pressure (PP) regarding cardiovascular events[10]. In this sense, there is evidence that PP is associated with greater LLOAD severity in asymptomatic individuals[11]. However, the association between AH, PP, LLOAD severity and functional capacity remains little understood, particularly in the Brazilian population.

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The objective of this study was to prospectively determine whether there is an association between BP, PP, disease severity and functional capacity in patients with symptomatic LLOAD.

Methods

The study assessed a total of 65 patients (62.2 + 8.1 years, 56.9% males) with symptomatic LLOAD (Rutherford grade I), stable intermittent claudication for at least six months; ABI < 0.90, and age > 40 years, who agreed to participate and signed the free and informed consent form. This study was approved by the Ethics Committee of the institution.

Anthropometric measurements

Weight and height measurements were obtained with a properly calibrated electronic scale (Personal, Filizola, SP, Brazil) and a stadiometer attached to the scale. Body mass index (BMI) was calculated by dividing the weight by the squared height and analyzed according to the recommendations of the World Health Organization (WHO)[12].

Clinical and laboratory assessment

Medical history data were obtained from medical records, as well as laboratory test results.

The personal data were collected through interviews. Physical activity was defined as the practice of aerobic activity for at least three times a week for 30 minutes.

Blood pressure measurements

For blood pressure (BP) measurements, patients were placed in the supine position and remained at rest for 5 to 10 minutes in a quiet room with appropriate temperature and light. BP was measured through the oscillometric method, using validated and calibrated equipment (Omron HEM 741C, *Omron Healthcare Inc., China*). Two consecutive measurements were obtained with a one-minute interval between them. The second measurement obtained was always considered valid. SBP measurements were considered elevated when > 140 mmHg and DBP when > 90 mmHg [13]. PP was calculated as the difference between SBP and DBP.

Ankle-brachial index (ABI)

Blood pressure measurements to calculate the ABI were performed 5 minutes after the BP measurement described above. For this purpose, a portable vascular Doppler device (*DV 610*, Medmega, SP, Brazil) and a mercury sphygmomanometer with an appropriate cuff size for the patient's arm circumference were used. SBP measurements were carried out in the following order: left brachial artery, left dorsalis pedis artery, left posterior tibial artery, right dorsalis pedis artery, right posterior tibial artery and right brachial artery. The ABI was calculated for each lower limb, establishing the ratio between the highest ankle pressure (dorsalis pedis or posterior tibial) and highest pressure on the arm (right or left)[1]. The worst ABI value obtained was used for the analysis of results (right or left ABI).

Six-minute walking test (6MWT)

The test was performed according to previously published guidelines[14], in a 20-meter long corridor. All patients were instructed to report symptoms that occurred during the test. Phrases of encouragement were spoken every two minutes. For the analysis, we used the total and pain-free walking distance.

The patients were divided into two groups: group A comprised 17 patients (26%) with normal blood pressure levels, and group B, 48 patients (74%) with elevated SBP and/or DBP levels.

The data were analyzed using descriptive statistics and are presented as mean ± standard deviation and absolute and relative frequencies. Inferential analysis was performed using Student's *t* test for continuous variables, Chi-square test for categorical variables, and Pearson's correlation for associations. P values < 0.05 were considered statistically significant.

Results

Initially, the sociodemographic and clinical characteristics of patients in this study were analyzed (Table 1).

The mean age was 62.2 + 8.1 years and there was a predominance of male patients (56.9%). Although they were undergoing medical care, there was a persistence of cardiovascular risk factors, such as smoking and overweight. The mean ABI in group B was significantly lower than in group A (0.57 ± 0.13 *versus* 0.66 ± 0.12, p = 0.013), indicating greater LLOAD severity. However, mean serum levels of fasting glucose, total cholesterol and its fractions showed no significant difference between the groups.

The functional capacity assessment showed that groups A and B were similar (Table 2).

It can be observed that there was no difference between groups A and B regarding the total distance (275.8 ± 42.4 *vs*. 261.3 ± 86.5 meters, respectively, p > 0.05) and pain-free (200.0 ± 95.6 meters *versus* + 180.6 ± 100.5 meters, respectively, p > 0.05).

It is noteworthy the fact that patients with PP > 40 mmHg walked shorter distances at the 6MWT, both total (259.3 ± 77.2 *vs*. 334.7 ± 37.5 meters, p = 0.035) and pain-free (177.5 ± 95.4 *vs*. + 284.0 ± 95.3 meters, p = 0.019).

When analyzing the correlation between blood pressure, LLOAD severity and functional capacity, it was observed that SBP had a statistically significant correlation with the ABI (r = -0.36, p = 0.003) and with the total distance walked at 6MWT (r = -0.31, p = 0.006), as shown in Figure 1. However, there was no correlation between SBP and pain-free walking distance (r = -0.19, p = 0.07). Regarding PP, a statistically significant correlation was observed with ABI (r = -0.36, p = 0.003) and the distances walked test at the 6MWT, both total (r = -0.42, p <0.001) and pain-free (r = -0.31, p = 0.012). The DBP did not correlate with the ABI, or with the walked distances.

Discussion

The main contribution of this study is the demonstration that high levels of SBP and PP correlated to LLOAD severity and to the functional impairment of patients with intermittent claudication.

It is well established in the literature that hypertension is an important risk factor for the onset and progression of atherosclerosis and high BP has been linked to higher LLOAD prevalence[7,8,15,16]. The Framingham study showed that AH increased by 2.5-fold the risk of LLOAD for men, and four-fold for women[9].

The physiopathological mechanisms underlying the involvement of AH as a contributing factor to the development of vascular disease are complex. It should be emphasized that in spite of the existence of atherogenic cofactors interacting throughout the circulatory system, atherosclerosis develops in segments with high pressure status, highlighting the central role of AH in this process[17].

The relevance of other risk factors such as smoking, diabetes mellitus, obesity and hypercholesterolemia, however, has also been recognized and their association with a higher LLOAD prevalence has been demonstrated[18-20]. In the present study, although patients were undergoing clinical treatment, it was observed that they maintained the habit of smoking, were overweight, and most were sedentary. It is known that the presence of risk factors determines vascular alterations in other vascular territories such as the carotid, coronary and cerebral arteries, worsening the cardiovascular prognosis for patients with LLOAD[21-23].

Mehler et al[24] demonstrated that intensive BP control in diabetic patients with LLOAD results in marked reduction of cardiovascular events. Moreover, these authors showed that there is an inverse association between the ABI and the risk of cardiovascular events in these patients, which, however, was abolished in individuals who underwent intensive treatment to control BP. This protective effect conferred by BP control

Table 1 – **Sociodemographic and clinical characteristics of the patients with symptomatic LLOAD**

Variables	Group A (n = 17)	Group B (n = 48)	Total (n = 65)	p*
Age (years)	63.1 ± 6.9	61.9 ± 8.5	62.2 ± 8.1	NS
Male sex	35.3% (n = 6)	64.6% (n = 31)	56.9% (n = 37)	0.03
Smoker/ex-smoker	82.3% (n = 14)	81.2% (n = 39)	81.5% (n = 53)	NS
Alcohol consumer/ex-alcohol consumer	70.6% (n = 12)	72.9% (n = 35)	72.3% (n = 47)	NS
Physical activity practice	23.5% (n = 4)	18.5% (n = 12)	24.6% (n = 16)	NS
BMI (Kg/m²)	25.0 ± 2.2	27.1 ± 4.5	26.6 ± 4.1	NS
Systolic BP (mmHg)	125 ± 12	161 ± 20 *	151 ± 24	< 0.001
Diastolic BP (mmHg)	74 ± 13	90 ± 12*	86 ± 13	<0.001
Pulse pressure (mmHg)	51 ± 10	71 ± 20	65 ± 20	< 0.001
Heart rate (bpm)	67 ± 13	71 ± 11	70 ± 12	NS
Ankle-brachial index	0.66 ± 0.12	0.57 ± 0.13	0.59 ± 0.14	0.013
Glycemia (mg/dL)	115.1 ± 42.5	122.4 ± 46.4	120.4 ± 45.2	NS
Total Cholesterol (mg/dL)	161.8 ± 28.4	186.2 ± 48.8	180.1 ± 45.6	NS
LDL (mg/dL)	88.2 ± 23.2	105.8 ± 37.6	101.3 ± 35.2	NS
HDL (mg/dL)	49.3 ± 16.8	49.3 ± 12.8	49.3 ± 13.8	NS
Triglycerides (mg/dL)	120.8 ± 72.2	154.3 ± 98.6	145.9 ± 93.3	NS

NS - non-significant; LLOAD - Lower-Limb Occlusive Arterial Disease; BMI - Body Mass Index; BP - Blood Pressure(*)descriptive levels for comparison between groups A and B.

Table 2 – **Functional capacity of patients with symptomatic LLOAD, assessed by walking distances at the 6-minute walk test (6MWT)**

Variables	Group A (n = 17)	Group B (n = 48)	Total (n = 65)	p*
Total walking distance (meters)	275.8 ± 42.4	261.3 ± 86.5	265.1 ± 77.4	NS
Pain-free walking distance (meters)	200.0 ± 95.6	180.6 ± 100.5	185.7 ± 98.9	NS

NS - non-significant; LLOAD - Lower-Limb Occlusive Arterial Disease; (*) descriptive levels for comparison between groups A and B.

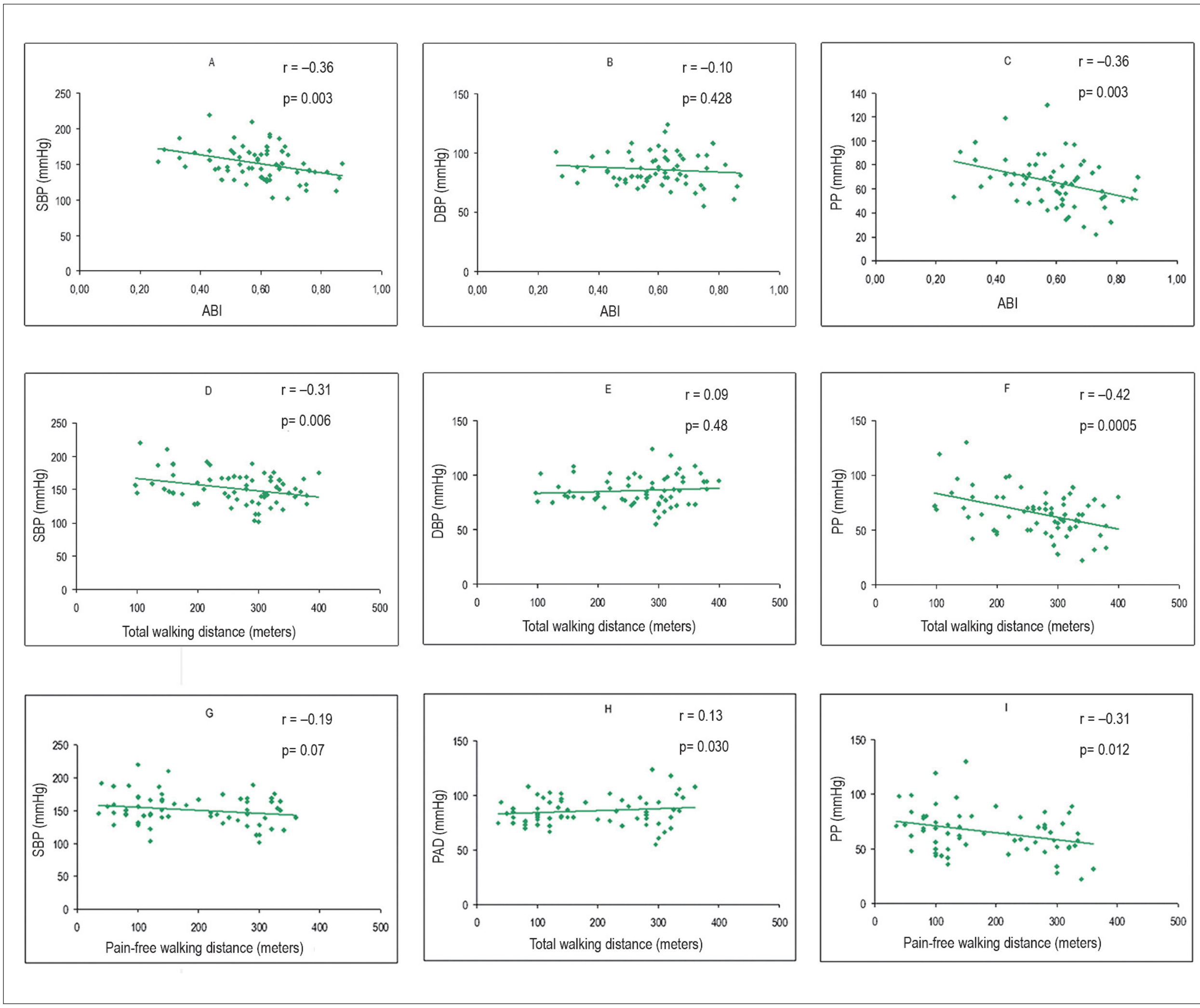

Figure 1 – *Correlation between blood pressure, pulse pressure, peripheral arterial disease severity and functional capacity (n = 65); A - Correlation between systolic blood pressure (SBP) and peripheral arterial disease severity, measured by ankle-brachial index (ABI); B - Correlation between diastolic blood pressure (DBP) and peripheral arterial disease severity, measured by ABI; C - correlation between Pulse Pressure (PP) and peripheral arterial disease severity, measured by ABI; D - correlation between SBP and functional capacity, measured by total walking distance at the 6-minute walk test; E - correlation between DBP and functional capacity, measured by total walking distance at the 6-minute walk test; F - Correlation between PP and functional capacity, measured by total walking distance at the 6-minute walk test; G - Correlation between SBP and functional capacity, measured by pain-free walking distance in the 6-minute walk test; H - Correlation between DBP and functional capacity, measured by pain-free walking distance in the 6-minute walk test, I - Correlation between PP and functional capacity, measured by pain-free walking distance in the 6-minute walk test.*

occurred independently from the classes of medications used in the treatment[24].

Upon recognizing the significant impact of hypertension on LLOAD progression in the present study, we chose to divide the patients into two groups, according to the pressure level.

It was observed that the risk factors were evenly distributed between the groups A (normal blood pressure) and B (high blood pressure), with arterial hypertension remaining as the only risk factor that differentiated them. Thus, we observed that SBP and PP showed an inversely proportional association with the ABI, demonstrating that patients with uncontrolled blood pressure and elevated PP had a higher LLOAD severity.

The increase in SBP is a process that accompanies aging. This increase is secondary to arterial wall stiffening and is also associated with an increase in cardiovascular event occurrence[17]. Possibly, the increased pressure load increases the wall stress, resulting in vascular injury, caused by endothelial dysfunction and vascular smooth muscle remodeling[17].

The SBP increase is not necessarily accompanied by a DBP increase of the same magnitude. This implies an increase in PP, of which prognostic value, regarding the occurrence of cardiovascular events, remains debatable[10,25]. The results of this study, however, showed that there was a statistically significant correlation between PP and LLOAD severity, verified by the ABI. Similar results have been reported in the literature. It has been shown that SBP and PP, but not DBP in patients with cardiovascular risk factors, but without clinically detected LLOAD, have an inversely proportional association with ABI[11]. Moreover, another study showed that PP has a positive and significant correlation ($r = 0.61$, $p < 0.01$) with blood flow in the calf, measured by pletismography[26].

It is known that patients with intermittent claudication have impaired functional capacity[27]. The present study showed that the pain-free walking distance accounted for 70% of the total walking distance, demonstrating that intermittent claudication was extremely limiting for these patients.

The total distance was significantly correlated with SBP and PP. On the other hand, the pain-free walking distance correlated only with PP. Thus, it is suggested that in patients with intermittent claudication, SBP and PP levels may be markers of functional limitation. These results corroborate the evidence already available in the literature. Selvin and Hirsch[28] showed that the AH determines a greater chance of walking limitation for individuals older than 60 years. In parallel, Safar et al[26] demonstrated that there is a strong correlation between the walked distance and the peripheral bed microvascular reserve in patients with LLOAD.

Notably, little is known about the associations between pressure variables (SBP, DBP and PP), severity of LLOAD (measured by the ABI) and functional capacity (measured by walking distances at the 6MWT) in the Brazilian population. Although the study sample is small, the results contribute to the understanding of the correlations between these variables. It must be emphasized that other risk factors in addition to blood pressure were present in the studied sample, but differently from what was demonstrated for the pressure variables, the prevalence of smoking, blood glucose and total cholesterol, LDL and HDL were similar between groups A and B. Therefore, it can be concluded that SBP and PP correlated with the severity of LLOAD, and PP seems to be a marker of greater functional capacity limitation in patients with intermittent claudication.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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