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Prevalence of peripheral arterial occlusive disease in patients referred to a tertiary care hospital in Salvador, Bahia, Brazil, for coronary angiography

J.L.B. Nunes[1], A. Silvany-Neto[2], G.B.B. Pitta[3], L.F.P. Figueiredo[4], I. Oliveira[6], R. Quadros[7] and F. Miranda-Junior[5]

[1]Serviço de Cirurgia Vascular, Hospital Agenor Paiva, Salvador, BA, Brasil
[2]Departamento de Medicina Preventiva, Faculdade de Medicina, Universidade Federal da Bahia, Salvador, BA, Brasil
[3]Disciplina de Cirurgia Vascular, Departamento de Cirurgia, Universidade Estadual de Ciências da Saúde de Alagoas, Maceió, AL, Brasil
[4]Disciplina de Técnica Operatória e Cirurgia Experimental, [5]Disciplina de Cirurgia Vascular, Departamento de Cirurgia, Escola Paulista de Medicina, Universidade Federal de São Paulo, São Paulo, SP, Brasil
[6]Departamento de Acessos para Hemodiálise, Serviço de Cirurgia Vascular, Hospital Ana Nery, Salvador, BA, Brasil
[7]Escola Baiana de Medicina e Saúde Pública, Salvador, BA, Brasil

Correspondence to: J.L.B. Nunes, Av. Paulo VI, Qd-A, Rua B, 34, Pituba, 41810-001 Salvador, BA, Brasil
E-mail: jafascionunes@terra.com.br

The presence of peripheral arterial occlusive disease increases the morbidity and mortality of patients with coronary artery disease. The objective of the present study was to calculate the prevalence of peripheral arterial occlusive disease in patients referred for coronary angiography. This prevalence study was carried out at the Hemodynamics Unit of Hospital Santa Isabel, Salvador, Brazil, from December 2004 to April 2005. After approval by the Ethics Committee of the hospital, 397 patients with angiographic signs of coronary artery disease were enrolled. Diagnosis of peripheral arterial occlusive disease was made using the ankle-brachial blood pressure index ($\leq$0.90). Statistical analyses were performed using the *z* test and a level of significance of α = 5%, 95%CI, the chi-square test and *t*-test, and multiple logistic regression analysis. The prevalence of peripheral arterial occlusive disease was 34.3% (95%CI: 29.4-38.9). Mean age was 65.7 ± 9.4 years for patients with peripheral arterial occlusive disease, and 60.3 ± 9.8 years for patients without peripheral arterial occlusive disease (P = 0.0000003). The prevalence of peripheral arterial occlusive disease was 1.57 times greater in patients with hypertension (P = 0.007) and 2.91 times greater in patients with coronary stenosis $\geq$50% (P = 0.002). Illiterate patients and those with little education had a 44% higher chance of presenting peripheral arterial occlusive disease probably as a result of public health prevention policies of limited effectiveness. The prevalence of peripheral arterial occlusive disease in patients referred to a tertiary care hospital in Salvador, Bahia, for coronary angiography, was 34.3%.

Key words: Peripheral vascular diseases; Coronary atherosclerosis; Prevalence; Epidemiology; Ultrasound; Coronary angiography

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Introduction

Peripheral arterial occlusive disease (PAOD) in patients with coronary artery disease (CAD) compromises the recovery and postoperative quality of life of patients who undergo myocardial revascularization (1,2).

Early identification of PAOD by vascular surgeons in patients with CAD is fundamental to reduce morbidity and mortality in this group of patients (1,3-7).

Studies involving patients with CAD and PAOD have detected greater morbidity and mortality than among patients with only CAD. Patients with CAD and PAOD had a greater risk of cerebral vascular accidents after myocardial revascularization and a 25% increase in mortality (4,6,8,9).

Although several investigators have reported the effects of PAOD on the survival of patients with CAD, few studies in the literature have estimated the prevalence of PAOD in patients with CAD using the ankle-brachial blood pressure index (ABPI) (10). The ethnic diversity and miscegenation of the Brazilian population require that epidemiological studies use high-quality diagnostic methods and include representative samples of the population to define the rate of high-risk patients and to promote early follow-up by vascular surgeons to prevent complications.

The objective of the present study was to estimate the prevalence of PAOD in patients referred for coronary angiography and presenting CAD. The prevalence of PAOD was also evaluated according to the severity of CAD, and the clinical, epidemiological and demographic characteristics of the sample were described.

Material and Methods

This prevalence study was conducted at the Hemodynamics Unit of Hospital Santa Izabel, Salvador, BA, Brazil. After approval by the Ethics Committee of the hospital, patients consecutively seen in this unit were enrolled from December 2004 to April 2005 during the three weekly material collection shifts. Patients were referred for angiography by the assistant physician based on clinical criteria, effort test or myocardial scintigraphy results. The authors of the study did not participate in angiography. The sample was selected sequentially at the Hemodynamics Unit. All patients included in the study signed an informed consent form.

A vascular surgeon on the study team conducted physical vascular examinations before coronary angiography during routine medical examination at the Hemodynamics Unit. PAOD was diagnosed by measurement of ABPI using a Medmega DV610 unit (Medmega Indústria de Equipamentos Médicos Ltda., Franca, SP, Brazil) for Doppler sonography. Patients were examined while lying down in a room at 25°C after resting for 30 min. Systolic blood pressure was measured with a mercury sphygmomanometer placed at the level of the patient; the cuff was inflated to 10 mmHg above the patient's systolic pressure and deflated at 2 mmHg/s. Systolic pressure was measured in both arms and in the dorsal arteries of the foot and posterior tibial arteries of each lower extremity. To determine ABPI, the greatest pressures found in the dorsal artery of the foot or posterior tibial artery of the right and left lower extremities were divided by the greatest pressure found for the right or left arm (11,12). When this index was lower than or equal to 0.90, the patient was diagnosed as having PAOD (13,14). The values obtained by the two examiners for the first 30 measurements had good reproducibility, with a general agreement coefficient of 96% and kappa of 0.78 (15).

After coronary angiography was performed, only the patients with a diagnosis of CAD provided by the Hemodynamics Unit were included in the study. Severity of CAD was established by the hemodynamics specialist of the Unit. Stenosis that affected less than 50% of the coronary artery lumen was classified as wall abnormalities, and stenosis that affected 50% or more of the lumen was classified as one-, two- or three-vessel disease according to the number of coronary arteries compromised (16). Patients without atherosclerotic coronary artery alterations were excluded from the study.

Sample size was calculated to obtain the minimum number of individuals necessary to estimate prevalence (17), assuming a PAOD prevalence of 30%, a 95% confidence level, precision of 5%, and a design effect of 1.1, and the result was a sample size of about 387 patients.

The *z* test was used for statistical analysis at a 95% confidence interval (95%CI) and a level of significance of α = 5%. The chi-square test was used to analyze the independence between variables, and the *t*-test to compare means. Multiple logistic regression analysis was used in multivariate analysis (18). Patients were described according to usual descriptive statistics (17,19).

Hypertension, dyslipidemia, smoking, and diabetes mellitus were defined as clinical and epidemiological variables and classified as follows: hypertension: mild - controlled with 1 drug; moderate - controlled with 2 drugs; severe - controlled with ≥3 drugs or not controlled; diabetes mellitus: mild - type II, controlled with diet or an oral hypoglycemic agent; moderate - type II controlled with insulin; severe - type I, juvenile diabetes; smoking: mild - smoked in the last 10 years; moderate - smoked <1 pack/day or quit <1 year before; severe - smoked ≥1 pack/day; dyslipidemia: mild - easily controlled with diet; moderate -

controlled with a strict diet; severe - controlled with diet and medication (20). Origin, sex, education, occupation, and marital status were defined as demographic variables. Education was classified as illiterate, primary (up to 4 years of primary education), secondary (up to third year of secondary education) or tertiary (higher education with or without graduate degrees).

Results

A total of 397 patients were examined. Mean age was 62 ± 10 years (range: 43 to 87 years). The prevalence of PAOD in patients referred for coronary angiography and presenting CAD was 34.3% (136/397; 95%CI: 29.4-38.9). Mean age was 65.8 ± 9.4 years for patients with PAOD and 60.3 ± 10 years for patients without PAOD. The difference between mean ages was statistically significant (P = 0.0000002; *t*-test).

Table 1 shows the demographic characteristics of the sample: 54.9% (218/397) of the patients were from Salvador, the state capital city; 59.4% (236/397) were illiterate or had primary education; 63.2% (251/397) were not retired, and 69.8% (277/397) were married. Of the patients with PAOD, 72.1% (98/136) were illiterate or had primary education, and 54.4% (74/136) were not retired.

The clinical and epidemiological characteristics of the sample are shown in Table 2: 34.3% (136/397) had smoked in the past 10 years; 26.2% (104/397) had diabetes; 70.0% (278/397) had hypertension, and 60.3% (239/397) had dyslipidemia. Of the patients with PAOD, 14.7% were heavy smokers and 40.4% had severe dyslipidemia.

The analysis of the association of clinical and epidemiological variables with PAOD showed that patients with hypertension had a statistically greater prevalence of the disease than patients without hypertension. The prevalence ratio for this association was 1.57 (95%CI: 1.11-2.24; P = 0.007; chi-square test), which indicates that the prevalence of PAOD was 1.57 times greater in patients with hypertension. The associations with the other variables were not statistically significant (Table 3).

Table 4 shows the frequency of each type of coronary lesion. Of the 397 patients in the sample, 88.2% (350) had ≥50% stenosis in at least one coronary artery, and 40.2% of patients with PAOD had two-vessel disease.

Table 5 shows the separate comparisons between each type of coronary lesion and other lesions. Patients with one-, two- or three-vessel disease had a statistically greater prevalence of PAOD than patients with wall abnormalities. Similarly, when patients with one-, two- or three-vessel disease were compared as a single group, their prevalence of PAOD was statistically greater than among

Table 1. Distribution of demographic variables in the overall sample and in patients with peripheral arterial occlusive disease (PAOD).

Variable	Overall sample	With PAOD
Sex		
Male	249 (62.7%)	77 (56.6%)
Female	148 (37.3%)	59 (43.4%)
Origin		
Capital city	218 (54.9%)	77 (56.6%)
Other cities	179 (45.1%)	59 (43.4%)
Education		
Illiterate	37 (9.3%)	16 (11.8%)
Primary	199 (50.1%)	82 (60.3%)
Secondary	110 (27.7%)	27 (19.8%)
Tertiary	51 (12.9%)	11 (8.0%)
Occupation		
Not retired	251 (63.2%)	74 (54.4%)
Retired	146 (36.8%)	62 (45.6%)
Marital status		
Married	277 (69.8%)	91 (66.9%)
Widowed	58 (14.6%)	26 (19.1%)
Single	44 (11.1%)	13 (9.6%)
Separated/divorced	18 (4.5%)	6 (4.4%)

Data are reported as number with percent in parentheses.

Table 2. Distribution of clinical and epidemiologic variables in the overall sample and in patients with peripheral arterial occlusive disease (PAOD).

Variable	Overall sample	With PAOD
Smoking		
Severe	46 (11.6%)	20 (14.7%)
Moderate	28 (7.1%)	9 (6.6%)
Mild	62 (15.6%)	20 (14.7%)
No smoking	261 (65.7%)	87 (64.0%)
Diabetes mellitus		
Severe	0 (0%)	0 (0%)
Moderate	23 (5.8%)	12 (8.8%)
Mild	81 (20.4%)	29 (21.3%)
No diabetes	293 (73.8%)	95 (69.9%)
Hypertension		
Severe	56 (14.1%)	15 (11.1%)
Moderate	104 (26.2%)	49 (36.0%)
Mild	118 (29.7%)	43 (31.6%)
No hypertension	119 (30.0%)	29 (21.3%)
Dyslipidemia		
Severe	152 (38.3%)	55 (40.4%)
Moderate	30 (7.6%)	8 (5.9%)
Mild	57 (14.4%)	25 (18.4%)
No dyslipidemia	158 (39.8%)	48 (35.3%)

Data are reported as number with percent in parentheses.

Table 3. Association of clinical and epidemiologic variables with peripheral arterial occlusive disease (PAOD) in 397 patients.

Variable	PAOD		Prevalence ratio	95%CI
	Yes	No		
Smoking				
Yes	49 (36.0%)	87 (64.0%)	1.08	0.82–1.43
No	87 (33.3%)	174 (66.7%)		
Diabetes mellitus				
Yes	41 (39.4%)	63 (60.6%)	1.22	0.91–1.62
No	95 (32.4%)	198 (67.6%)		
Hypertension				
Yes	107 (38.5%)	171 (61.5%)	1.57	1.11–2.24*
No	29 (24.4%)	90 (75.6%)		
Dyslipidemia				
Yes	88 (36.8%)	151 (63.2%)	1.21	0.91–1.62
No	48 (30.4%)	110 (69.6%)		

Data are reported as number with percent in parentheses, prevalence ratio or 95%CI (95% confidence interval).
*Statistically significant (Taylor series method).

Table 4. Severity of coronary artery disease (CAD) in the overall sample and in patients with peripheral arterial occlusive disease (PAOD).

Severity	Overall sample	With PAOD
Three-vessel CAD	139 (35.0%)	52 (37.4%)
Two-vessel CAD	102 (25.7%)	41 (40.2%)
One-vessel CAD	109 (27.5%)	37 (33.9%)
Wall abnormalities	47 (11.8%)	6 (12.8%)

Data are reported as number with percent in parentheses.

Table 5. Association between severity of coronary artery disease and peripheral arterial occlusive disease.

Comparisons	PR	95%CI	χ^2	P
3V x WA	2.93	1.35-6.38	8.83	0.003*
3V x 1V	1.10	0.79-1.55	0.19	0.666
3V x 2V	0.93	0.68-1.28	0.09	0.760
2V x WA	3.15	1.40-6.90	9.98	0.002*
2V x 1V	1.18	0.83-1.69	0.64	0.425
1V x WA	2.66	1.20-5.78	6.35	0.012*
3V, 2V, and 1V x WA	2.91	1.36-6.22	9.88	0.002*

1V = one-vessel disease; 2V = two-vessel disease; 3V = three-vessel disease; WA = wall abnormalities; PR = prevalence ratio; 95%CI = 95% confidence interval; χ^2 = chi-square test.
*$P < 0.05$ (Taylor series method and chi-square test).

patients with wall abnormalities.

Mean ABPI was 0.94 ± 0.21. Mean ABPI for patients with diabetes was 0.93 ± 0.22, but the difference was not statistically significant when compared with the mean value of 0.94 ± 0.19 for patients without diabetes.

Table 6 presents the results of multivariate analysis. The clinical/epidemiological and social/demographic variables considered in the study were as follows: angiography result (one-, two-, or three-vessel disease versus parietal irregularities), interaction term between hypertension and angiography result, education (illiterate and little schooling versus others), age (years), interaction term between age and dyslipidemia, dyslipidemia (yes versus no), and hypertension (yes versus no). This analysis obtained an adequate power (97%) to investigate the variable education level only. Illiterate patients and those with little education showed a 44% higher chance of presenting PAOD.

Patients also underwent a physical vascular examination. Results showed that 4.5% (18/397) had carotid bruit, 1.7% (7/397) had decreased pulse and blood pressure in the upper extremities, and 43.8% (174/397) had reduced or no pulse in at least one of the posterior tibial arteries or dorsal arteries of the foot in the lower extremities. No abnormalities were found in thorax or abdomen.

Discussion

The prevalence of PAOD in patients with CAD ranges from 5 to 40% (5,10,21-26). Such broad range may be justified by the fact that prevalence studies enroll different populations, are not randomized, investigate few clinical presentations of coronary disease, and use different diagnostic methods. Most studies that used ABPI enrolled small samples, sometimes only hospitalized patients who probably had more severe CAD. Therefore, comparisons with results of studies that selected large and diversified samples of patients with CAD are difficult (10,19).

The measurement of ABPI is a widely accepted method for epidemiological studies (13,14). However, results vary according to the time when patients are examined and who performs the measurements (27). This index also shows a greater number of false-negative results among patients with diabetes because of the calcification of artery walls. It is estimated that 5 to 10% of patients with diabetes have an artificial elevation of blood pressure due to the incompressibility of vessels, and that blood pressure differences between patients with and without diabetes is about 25 mmHg (28). One alternative to reduce the number of false-negative results is to use toe blood pressure measurements (13,14), but this method is not widely accepted because of its low sensitivity (29). False-negative results in patients with diabetes may not have significantly affected the results of the present study because the difference in mean ABPI between patients with and without diabetes was not statistically significant. Studies that use color Doppler sonography to investigate PAOD in patients with CAD are not easily compared with our study because their measurement criteria are the visualization of an atherosclerotic plaque and the measurement of stenosis (1,3,30-33). The ABPI has been shown to correlate with clinical involvement and hemodynamic repercussions of stenosis in the peripheral artery system of the lower extremities (34).

In our study, PAOD was more prevalent among patients with two-vessel disease and was associated with ≥50% stenosis. Other studies also found a higher frequency of PAOD in patients with more severe CAD (21.3 to 25%), but did not evaluate the statistical significance of their results (5,10). This information provides scientific evidence to support early vascular screening of patients with CAD who are at a greater risk of having PAOD.

The description of the demographic characteristics of patients in this prevalence study is important because little education and a low socioeconomic status have been described as important risk factors for cardiovascular diseases (35,36). Moreover, PAOD has been found to be associated with geographical location and population under study (13,14). Most studies about the prevalence of PAOD in patients with CAD were conducted in developed countries, whose population profiles and public health policies reflect their socioeconomic reality. The description of demographic characteristics of patients with PAOD in our study showed that most patients worked, had a family, and had little education. Therefore, the poor control of this disease and the lack of specialized follow-up of these patients may represent a high socioeconomic cost for developing countries (37,38). Moreover, many patients in our study came from other cities in the State of Bahia, which may suggest little decentralization of the health system. The great patient demand that results from such centralization may impair the provision of adequate health care (37).

In the present study, the frequency of risk factors for atherosclerotic disease was high and similar to that found in other studies (31,39,40). Possible explanations for the broad variation in the prevalence of these risk factors among different ethnic groups are economic and sociocultural factors, which may be responsible for the high frequency of cardiovascular disease in developing countries (35). The cardiovascular risk profile of the population was critical in the city where this study was conducted, which has more than 2,500,000 inhabitants, 70% of whom have mixed ethnic backgrounds, and most have little education and a low income. Improvements in educational levels and socioeconomic status may decrease the high frequency of risk factors (39).

This study was designed to estimate the prevalence of PAOD in the lower extremities of patients referred for coronary angiography and presenting CAD, and, therefore, the results of the physical examination of other segments cannot be statistically interpreted. However, abnormalities found in the upper extremities and carotid arteries support the findings of studies that have emphasized the importance of broad diagnostic screening examinations in patients with atherosclerotic disease because of the possible simultaneous involvement of several organs (7).

To sum up, the prevalence of PAOD in patients referred for coronary angiography and presenting CAD in the present study was 34.3%, and was associated with illiteracy or little education, older age, hypertension, and coronary stenosis ≥50%. Such a high prevalence rate stresses the need for early and routine evaluation of patients with CAD by vascular surgeons to prevent the severe complications of associated PAOD.

Table 6. Association between prevalence of peripheral arterial occlusive disease and clinical/epidemiological and social/demographic variables: results of the logistic regression model.

Variable	ß	$SE_ß$	P	Odds ratio	95%CI
Coronary angiography result	0.61	0.24	0.005	1.83	1.32–2.54
Interaction term between hypertension and coronary angiography result	0.39	0.24	0.112	1.47	1.06–2.04
Education	0.37	0.12	0.002	1.44	1.22–1.70
Age	0.05	0.01	0.000	1.05	1.03–1.07
Interaction term between age and dyslipidemia	0.02	0.01	0.079	1.02	1.01–1.04
Dyslipidemia	-1.24	0.82	0.134	0.29	0.09–0.90
Hypertension	-0.07	0.20	0.766	0.93	0.67–1.29

$SE_ß$ = standard error of beta; 95%CI = 95% confidence interval.

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