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Case Report

Screening for Peripheral Artery Disease by Measuring the Ankle-Brachial Index in Patients Hospitalised in a Cardiology Department in Dakar, Senegal

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Abstract

Introduction: Patients hospitalised in cardiology departments often have multiple cardiovascular conditions related to atherosclerosis. Peripheral artery disease (PAD), often diagnosed late, is one of the main manifestations of this. The objectives of this study were to determine the hospital frequency of PAD in a cardiology department and to analyse the factors associated with abnormalities in the ankle-brachial index (ABI).

Methodology: This was a cross-sectional, descriptive, and analytical study conducted over a 5-month period from 15 February to 15 July 2023. We included patients admitted to the cardiology department during this period who had at least one cardiovascular risk factor and had signed an informed consent form. Data were collected using a questionnaire with various parameters and recorded on an exploitation sheet. ABI measurement was performed using a handheld EDAN Doppler device with a 4 and 8 Hz bifrequency probe. PAD was defined as an ABI less than 0.9. A p-value <0.05 was considered significant.

Results: The study enrolled 450 patients, predominantly male, with a sex ratio of 1.08. The mean age was 58 ±13 years, with the majority of patients coming from the suburbs (78%). The cardiovascular risk level was considered high in 52.7% and very high in 32% of cases. Erectile dysfunction was observed in 30.7% of the male population. The frequency of PAD was 41.3%, with a predominance in the right lower extremity. It was asymptomatic in 59.6% of patients. Medial calcification was found in 2.66% of cases.

Abnormalities detected on ECG were dominated by subepicardial ischemia (36%) and 62% had a left ventricular ejection fraction below 50%. The majority of patients were admitted for coronary artery disease (30%).

PAD was associated with age over 60 years (p=0.04), obesity (p=0.018), erectile dysfunction (p=0.002), very high cardiovascular risk (p=0.012), and intermittent claudication (p=0.04).

Conclusion: PAD is very common in patients hospitalised in cardiology departments due to the high prevalence of cardiovascular risk factors. It was generally asymptomatic, justifying the widespread screening using ABI.

Keywords: peripheral artery disease; ankle-brachial index; cardiology; senegal

Introduction

Atherosclerosis is by far the leading human arterial disease today. Affecting large and medium-sized arteries, it is defined as an obstructive disease of the vessels in the lower limbs [1, 2]. It consists of an atheromatous obstruction of arteries located between the abdominal aorta and the digital arteries supplying the lower limbs. Peripheral artery disease is often asymptomatic, underdiagnosed, under-recognised, and undertreated. It is associated with significant cardiovascular and cerebrovascular morbidity and mortality [3]. After coronary and cerebral involvement, peripheral artery disease (PAD) is, by frequency, the third most common location of atherosclerosis [4]. It is estimated that over 200 million individuals worldwide are affected by lower extremity artery disease. This prevalence is thought to have increased by approximately 25% between 2000 and 2010, particularly in low/middle-income countries. One third of atherosclerotic patients are asymptomatic polyvascular patients who are at very high cardiovascular risk [1]. Most epidemiological studies use the measurement of the ankle-brachial index (ABI) [5, 6]. ABI measurement is recommended as a first-line non-invasive test for the screening and diagnosis of PAD (I, C). It is a simple,

non-invasive, and inexpensive clinical measurement. An arterial component is suspected with an ABI below 0.9 and confirmed with an ABI below 0.5. PAD is a marker of the severity of atherothrombotic disease, whether symptomatic or not [5]. The French National Authority for Health recommends measuring ABI in individuals exposed to risk factors, particularly smoking, diabetes, and those aged over 65 years [1]. Unfortunately, in our regions, this practice is not common, leading to underdiagnosis of lower limb arteritis.

Patients with generalised atherosclerosis, such as peripheral artery disease (PAD), are at high risk for cardiovascular and limb symptoms and complications, affecting their quality of life and longevity [3]. Therefore, it seems beneficial to screen for this condition, notably by measuring ABI, to identify a subgroup of patients with a higher risk level, in order to better tailor therapeutic management.

The objectives of the study were to determine the prevalence of peripheral artery disease by measuring ABI in patients hospitalised in the cardiology department, to establish the epidemiological and clinical profile of PAD, to correlate PAD with underlying cardiac pathology, and to identify associated cardiovascular risk factors.

Methodology

This was a cross-sectional, descriptive, analytical study conducted over a period of 5 months from February 15 to July 15, 2023. The study included patients aged 18 years and older, of all genders, who had at least one cardiovascular risk factor and were hospitalized in the cardiology department of Dalal Jamm Hospital in Guediawaye, Senegal. Patients who had undergone lower limb amputation or had significant lower limb edema that prevented ABI measurement were excluded from the study. Sociodemographic data, cardiovascular risk factors, clinical, and paraclinical data were collected using a structured questionnaire and recorded in an exploitation sheet.

ABI measurement was obtained by calculating the ratio of ankle systolic blood pressure (anterior tibial and posterior tibial) to brachial systolic blood pressure. A manual sphygmomanometer from Spengler and a handheld EDAN SD3 VASCULAR Doppler (Hamburg, Germany) were used for measurements.

This study was conducted in collaboration with the hospital administration after obtaining approval from the center and signing the confidentiality agreement of the cardiology department. An information sheet was provided to patients summarizing the study, including its title, objectives, target population, duration, number of participants, benefits and risks, and contact information for study coordinators. Written consent was obtained from each participant; those who declined participation were excluded, with no impact on their medical care and follow-up in the department. All patients were informed about the confidential nature of the study. Participants received explanations regarding PAD and ABI measurement techniques. The measurement process lasted between 5 to 10 minutes. Patients with abnormal ABI values underwent arterial Doppler ultrasound of the lower limbs and received medical treatment or were referred for cardiovascular surgery for further management. All patients underwent ABI measurement, ECG, and echocardiography. Data analysis, word processing, and graph creation were performed using Microsoft Word 2016, Excel 2013, and Sphinx version 5.1.0.2. Statistical analysis was conducted using SPSS (Statistical Package for the Social Sciences) version 24.0. Descriptive analysis included frequency and percentage for qualitative variables and mean with standard deviation, range, and median for quantitative variables. Bivariate analysis was conducted using binary logistic regression. Variables with a p-value $\leq$ 0.05 were included in the multivariate analysis to model poor prognosis. An ascending modeling approach was employed, and adjusted odds ratios (OR) with 95% confidence intervals were calculated for variables retained in the final model. Model fit was assessed using the Hosmer-Lemeshow test to ensure adequacy.

Results

Our study included 450 patients, with a male predominance (sex ratio 1.08). The mean age was 58 years +/- 13. The age group of 60 to 69 years was the most represented (27.3%) (Figure 1). The majority of patients came from the suburbs of Dakar, accounting for 78%. Socioeconomic status was considered low in more than half of the patients (65.4%) (Figure 2). The main cardiovascular risk factors found were sedentary lifestyle (98%), hypertension (60.7%), menopause (43.3%), diabetes (27.3%), and smoking (20.7%) (Figure 3). Additionally, 40% of patients had at least 4 cumulative cardiovascular risk factors (Figure 4). In this study, patients with very high cardiovascular risk were 2.2 times more likely to develop PAD.

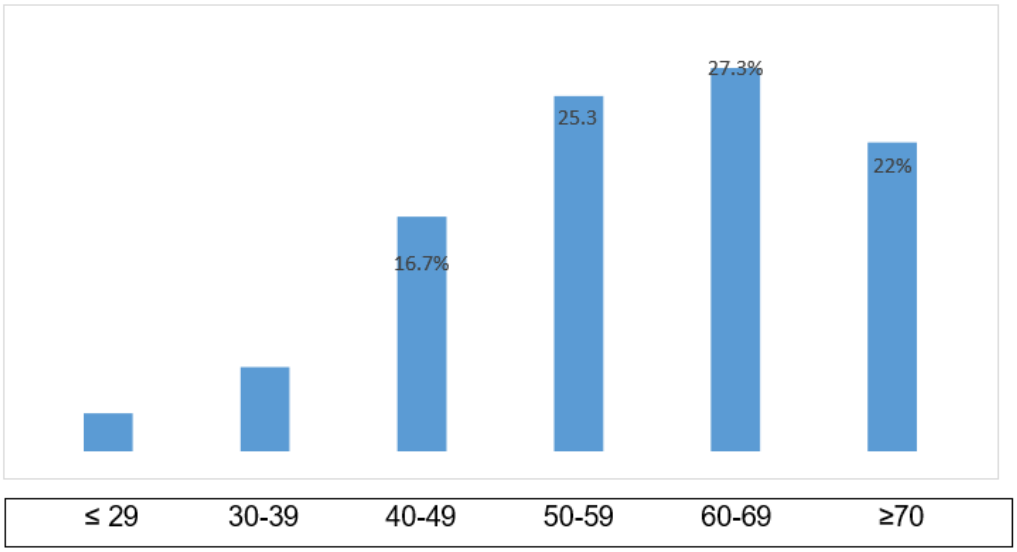

Figure 1: Distribution of patients according to age group (n=450)

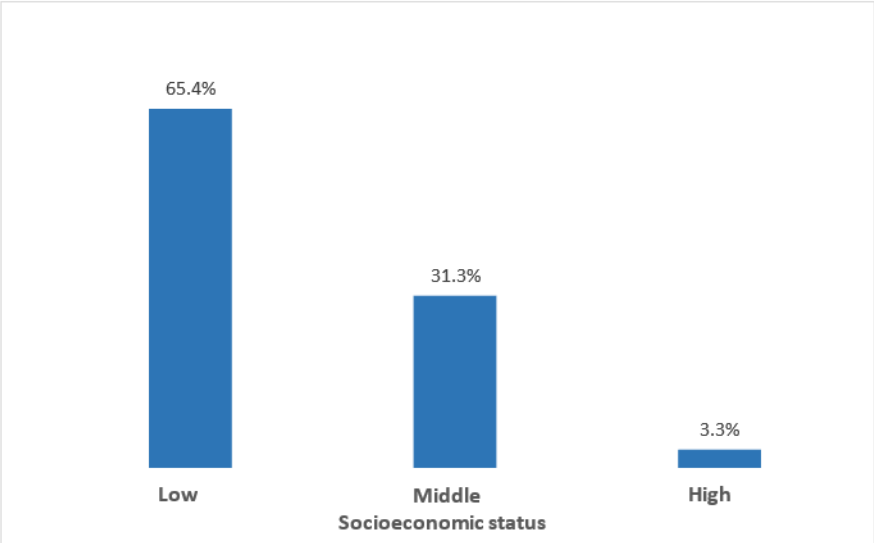

Figure 2: Distribution of patients according to socio-economic status (n = 450)

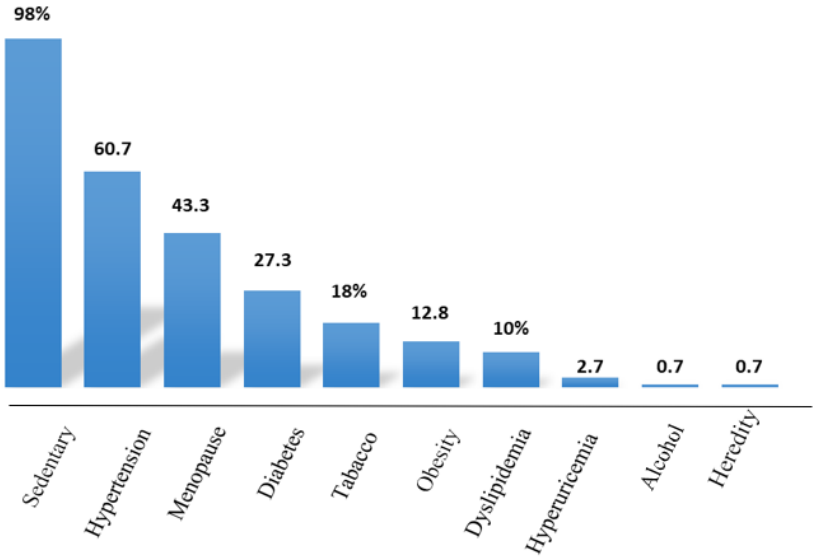

Figure 3: Distribution according to cardiovascular risk factors (n=450)

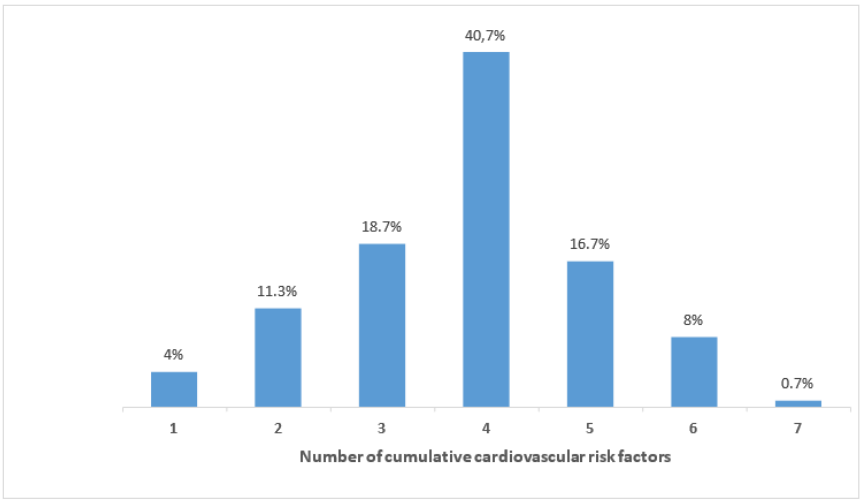

Figure 4: Evaluation of cumulative cardiovascular factors (n=450)

Risk Factors	OR	95% CI	p value
Advanced age 60 years	1.9	[1.1 – 3.3]	0.02
Obesity	2.0	[1.1 – 3.5]	0.018
Very high cardiovascularrisk	2.2	[1.2 – 4.1]	0.012
Erectile dysfunction	2.5	[1.4 – 4.5]	0.002
Intermittent claudication	1.8	[1.0 – 3.2]	0.04

Table I: Cardiovascular Risk Factors Associated with the Onset of PAD

Clinically, 24.2% of patients had intermittent claudication, 12.9% had rest pain, and 1.3% had foot ulcers. Intermittent claudication increased the risk of PAD by 1.8 times. Erectile dysfunction, evaluated using the IIEF score, was observed in 30.7% of male patients, mostly mild (16.7%) or severe (8.9%). Erectile dysfunction was associated with a 2.5 times increased risk of developing PAD (p-value=0.002). Physical examination revealed lower limb edema in 30% of patients, mostly bilateral and related to heart failure. Palpation of anterior and posterior tibial pulses was weakly palpable or absent, with rates ranging from 26.7% to 40% for weakly palpable pulses and from 0.7% to 3.3% for absent pulses. Patients showing signs of PAD were classified into subgroups according to the Leriche and Fontaine Classification, with 16.55% being symptomatic.

The main lipid profile disturbances included elevated levels of total cholesterol (14.6%), LDL cholesterol (14.3%), and triglycerides (23.8%). Electrocardiogram abnormalities consisted of subepicardial ischemia (36%), ST segment abnormalities (30%), supraventricular rhythm disturbances (15.9%), conduction abnormalities (35.3%), and electro-entrained rhythm (7.3%). Echocardiography showed impaired left ventricular (LV) kinetics in 69.9% of patients. Mean systolic pulmonary arterial pressure (PAP) was 39 mmHg ±16mmHg.

ABI measurement in our study population revealed a frequency of PAD (ABI < 0.9) of 41.3%, corresponding to a hospital prevalence of 15.2%. Among them, 64.7% had well-compensated PAD and 37.3% had poorly compensated PAD. PAD was more prevalent in the right lower limb

(30.6%) compared to the left (28%). Bilateral involvement was found in 17.3% of cases. Posterior tibial artery involvement was more frequent than anterior tibial artery involvement; specifically, the frequency of right posterior tibial artery involvement was 68.5% compared to 66.4% for the anterior tibial artery, and for the left side, posterior tibial artery involvement was 70.1% compared to 68.5% for the anterior tibial artery.

Our study demonstrated that patients over 60 years old were 1.9 times more likely to develop PAD compared to younger patients, and obesity nearly doubled the risk of PAD. Doppler ultrasound of the lower limbs showed diffuse bilateral infiltration (63.7%), and 33.33% had at least one significant stenosis in at least 2 of the 3 leg axes. In our study population, the etiology was dominated by atherosclerosis (30%) and non-atherosclerotic vascular diseases (29.33%). Furthermore, ABI measurement revealed medial calcification (ABI > 1.3) in 2.7% of cases.

These results highlight several significant factors associated with the occurrence of PAD in the studied patients, including advanced age > 60 years (p=0.02), obesity (p=0.018), very high cardiovascular risk (p=0.012), erectile dysfunction (p=0.002), and intermittent claudication (p=0.04) (Table I). These findings can help better target prevention and management strategies for at-risk patients.

Discussion

This study presents several limitations that should be considered when interpreting the results. One significant limitation was the relatively low number of included patients due to non-receptivity and cooperation issues among some interviewed patients. Additionally, many patients lacked information about their condition, with a substantial portion being unaware of their treatment plans.

Furthermore, being a monocentric study conducted in a public hospital located in the suburbs of the capital city, the study parameters may not fully represent broader demographic and socioeconomic groups. The hospital primarily serves patients from low to middle-income backgrounds. Moreover, the high cost of biological and radiological tests may have restricted access to comprehensive diagnostics for some participants. As a result, the study findings may not be generalizable to patients from higher socioeconomic backgrounds due to differences in psychosocial factors and living standards. These difficulties could have affected the quality of the collected data and consequently, the study conclusions. It would be pertinent to consider these limitations when interpreting the results and propose improvements for future studies.

Our study, conducted on 450 patients in the suburbs of Dakar, provides epidemiological and clinical insights into cardiovascular diseases that can be compared with recent studies in the literature. The male predominance (sex ratio of 1.08) and a mean age of 58 years are consistent with other studies such as those conducted by Kannel and Criqui, which also found a male predominance and similar age averages among patients with cardiovascular diseases. The most represented age group in our study was 60-69 years (27.3%), suggesting an increased prevalence of cardiovascular diseases among older individuals. Peripheral arterial disease (PAD) of the lower limbs is prevalent in individuals aged 50 and older. While population-based studies suggest a higher prevalence of asymptomatic disease and more severe, multi-visceral disease at the time of diagnosis among women, there is a lack of studies that have specifically examined sex differences in the diagnosis of PAD [9, 10, 11].

However, our study highlights a low socioeconomic status in 65.4% of patients, which is an important risk factor that could be targeted for public health interventions, as it is rarely addressed in studies from high- income countries. Economic factors appear to have a significant effect on PAD epidemiology. In the same country, low socioeconomic status is associated with PAD, both in the United States, Europe, and Africa [2, 12]. The major cardiovascular risk factors identified, such as hypertension (60.7%), menopause (43.3%), diabetes (27.3%), and smoking (20.7%), were comparable to those observed in other regions of Africa [2]. It is notable that 40% of patients had at least four cardiovascular risk factors, which accentuates their vulnerability. All studies agree that smoking is probably the most powerful contributor to PAD [8, 13]. According to a longitudinal study of men working in the United States, the attributable share of smoking to the presence of PAD in this population was estimated at 44% [14]. Diabetes is a powerful and independent factor in the occurrence of PAD [15, 16]. The risk of PAD is generally multiplied by 2 to 4, and this risk increases with the duration of diabetes. In its asymptomatic form, the study of the association between diabetes and a low ABI is made difficult by the potential presence of medial calcification, which could decrease the sensitivity of ABI in detecting PAD [17]. Diabetes being a less prevalent risk factor in the general population, its attributable share in the occurrence of PAD in the population is 14% [14]. Regarding hypertension, most studies agree that it is an independent risk factor for PAD, although the strength of the association is weaker, with an odds ratio ranging from 1.5 to 2 [8, 13].

The clinical manifestations of our population, such as intermittent claudication (24.2%) and rest pain (12.9%), as well as foot ulcers (1.3%), indicate advanced manifestations of PAD in these patients. However, according to the study of Bauersachs, Only 5%-10% of patients with PAD present with classical symptoms of intermittent claudication [18]. Other studies conducted in Europe and the United States, which used questionnaires, define the prevalence of intermittent claudication as less

than 1% before 50 years of age and up to 6% after 65 years [19]. A study conducted in Europe reported intermittent claudication rates of up to 25%, with a strong association between erectile dysfunction and PAD [20], similar to our observation (p=0.002).

Physical examination revealed lower limb edema in 30% of patients, primarily due to heart failure. Palpation of anterior and posterior tibial pulses was often weakly palpable or absent, with rates ranging from 26.7% to 40% for weakly palpable pulses and from 0.7% to 3.3% for absent pulses, suggesting significant peripheral arterial insufficiency.

The disturbances in the lipid profile in our study, with elevated total cholesterol, LDL cholesterol, and triglycerides, correspond to trends observed globally, where dyslipidemias are major contributors to cardiovascular diseases [21]. Electrocardiographic abnormalities such as subepicardial ischemia (36%) and ST segment abnormalities (30%) indicating underlying severe cardiac pathologies are also consistent with literature data on high-risk cardiovascular populations [22]. Cardiac ultrasound revealed impaired left ventricular kinetics in 69.9% of patients, with a mean systolic pulmonary arterial pressure (PAP) of 39 mmHg ±16 mmHg, indicating frequent cardiac dysfunction.

The prevalence of PAD in our population (41.3%) is higher than that reported in some studies conducted in developed countries, where it generally ranges between 20% and 30%. This difference can be attributed to factors such as limited access to care, socioeconomic differences, and a higher prevalence of uncontrolled risk factors. In high-income countries, prevalence is similar between women and men. This prevalence is around 5% at the age of 45–49 years and increases to nearly 18% after 85 years. It is estimated that nearly 40 million individuals are affected by any form of PAD across the entire European continent [23]. In France, it is estimated that nearly one million people have this disease. In low/middle-income countries, the prevalence of this disease would be higher among women [23, 24]. Comparing data between 2000 and 2010, the prevalence of PAD has increased much more in low/middle-income countries than in high-income countries [25]. Adjusted for age and prevalence of risk factors, the regions of the world that have seen the greatest increase in PAD are Southeast Asia and the Western Pacific regions [25].

Factors correlated with the occurrence of PAD were advanced age (> 60 years, p= 0.02), obesity (p= 0.018), very high cardiovascular risk (p=0.012), erectile dysfunction (p=0.002), and intermittent claudication (p=0.04). These results highlight the need for targeted prevention strategies for these high-risk groups.

Conclusion

This study highlights the high prevalence of peripheral artery disease (PAD) within a cardiology setting. PAD is a common manifestation of atherosclerosis and is associated with the usual risk factors of atheromatous diseases. It is a chronic condition with a typically long subclinical period, and clinical expression often occurs after the age of 60. This underscores the need for multidimensional management that considers socio-economic factors, lifestyle habits, and associated comorbidities. Prevention and treatment of PAD should be integrated into a comprehensive approach to cardiovascular risk reduction.

While our study findings are consistent with global and regional cardiovascular disease trends, future research should involve larger, multicentre samples to better understand and address the specific needs of diverse populations.

Ethics approval and consent to participate: This study was approved by the ethics committee of Cheikh Anta Diop University of Dakar. All patients included in the study signed a written informed consent. For patients who were in shock, the consent was signed by a trusted person.

Consent for publication: Not Applicable

Availability of data and materials: The data and materials of this study are available upon request and ready to be shared. For further information, please contact the corresponding author, Aliou Alassane NGAIDE.

Declaration of Interests: None of the other authors have any conflicts of interest or relevant disclosures.

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Authors and Contributors:

Aliou Alassane NGAIDE and Abdoul KANE designed the study protocol, participated in the data collection and writing of the draft manuscript.

Joseph Salvador MINGOU participated in statistical analysis and interpretation of results.

Ngone Diaba GAYE and Caroline Andreas MEKA oversaw the execution of the study, participated in data analysis and critically revised the manuscript for important intellectual content.

Marguerite Tening DIOUF and Aime Mbaye SY participated in study design and in data analysis. Aknowledgements: Sincere thanks to Professor Abdoul Kane for his unwavering support, his foresight, and his exemplary management.

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