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Carotid Atherosclerosis in Asymptomatic Patients with at Least One Cardiovascular Risk Factor: A Cross-Sectional Study in Yaounde, Cameroon

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Abstract: *Introduction*: Atherosclerosis is a leading cause of vascular disease worldwide. One of its main locations is in the carotid artery which is implicated in 20% of ischemic strokes. This study aimed to determine the frequency of carotid atherosclerosis in a group of asymptomatic patients with at least one cardiovascular risk factor. *Methodology*: This was a cross-sectional study from January to June 2021 (6 months). We included consenting adults followed up at the Yaoundé Central Hospital and the Yaoundé University Teaching Hospital, aged at least 50 years and having at least one cardiovascular risk factor such as hypertension, diabetes, dyslipidemia, smoking, or obesity. A Doppler ultrasound of the supra-aortic trunks was performed on each patient. Statistical analyses were performed using the chi-2 test for bivariate analysis and binary logistic regression for multivariate analyses. The threshold of significance was set at 0.05. *Results*: A total of 75 participants were included of which 26 were men and 49 women. The mean age (SD) was 62.96 (8.87) years. Hypertension was seen in 93.3% of the participants, dyslipidemia in 77.3%, obesity in 48%, type 2 diabetes in 34.7%, and 9.3% were smokers. High cardiovascular risk was seen in 22 (29.4%) participants. Twenty-seven participants (36%) had one or more carotid atheroma plaques, and 11 (14.7%) participants had a stenosis plaque. Hypercholesterolemia and high cardiovascular risk were associated with the presence of carotid atheroma plaque. *Conclusion*: The frequency of carotid atherosclerosis appears to be high in people over 50 years of age with at least one cardiovascular risk factor justifying the importance of control strategies against these factors.

Keywords: Carotid Atherosclerosis, Asymptomatic Patients, Cardiovascular Risk Factors, Yaoundé

1. Introduction

Cardiovascular diseases are the leading cause of death in the world [1]. The most important pathophysiological mechanism implicated in the occurrence of these diseases is atherosclerosis [2], which is a remodeling of the intima and

media of medium and large arteries by the accumulation of lipids and fibrous elements [3]. The presence of several combined cardiovascular risk factors promotes its development and progression [4]. It remains subclinical for a long time and its presence is usually detected with complications [5].

The frequency of subclinical atherosclerosis varies from country to country [6, 7]. Its global prevalence is unknown but we can assess its impact on the population due to the involvement in many cardiovascular pathologies [8]. Atherosclerosis is one of the main causes of myocardial infarction, ischemic stroke, and more than 90% of cases of angina pectoris [9]. Its prevalence increases with industrialization and western lifestyle [10]. In the United States of America, the complications of atherosclerosis have decreased by 30% over the last thirty years due to the primary prevention of cardiovascular risk factors [11]. Currently, sub-Saharan Africa is facing an epidemiological transition characterized by the emergence of non-communicable diseases such as hypertension, diabetes, and dyslipidemias which could be responsible for an increase in atherosclerosis prevalence [12]. This epidemiological transition is induced by the substantial changes in Africans lifestyle with an increase in sedentary and tobacco consumption [12, 13].

Atherosclerosis predominates in areas of blood turbulence (bifurcations) [3]. The arterial territories most frequently affected by atherosclerosis are the coronary arteries, aorta, and carotid arteries [11, 14, 15]. The carotid location of atherosclerosis is responsible for approximately 20% of ischemic strokes [16]. It can remain asymptomatic for many years. However, it can be detected early by making a screening in people with cardiovascular risk factors. This screening can be done either by looking for a carotid murmur on physical examination or more effectively by doing a Doppler ultrasound [8, 10, 17]. Unfortunately, it is often diagnosed at an advanced stage when symptoms appear. Screening programs for people with high cardiovascular risk are often lacking in low- or middle-income countries such as Cameroon [2]. We, therefore, aimed to investigate the presence of carotid atherosclerosis in a group of asymptomatic patients with cardiovascular risk factors in two referral hospitals in Yaoundé, Cameroon.

2. Methods

2.1. Study Design and Setting

We carried out a cross-sectional study, over 6 months (January to June 2020) at the Yaoundé Central Hospital (YCH) and the Yaoundé University Teaching Hospital (YUTH), Cameroon. Yaounde is the political capital of Cameroon with a population of over three million inhabitants.

2.2. Participants

Participants were enrolled at the cardiology outpatient unit of the YCH and YUTH. We included all consenting adults of both sexes aged ≥ 50 years, having at least one cardiovascular risk factor and with no history of stroke and showing no signs or symptoms related to stroke.

2.3. Sample Size Estimation

The Cochran formula was used to estimate the sample size [18]. With an expected prevalence of 5%, an error margin of 5%, and an 80% power, the minimal sample size was estimated at 73 participants.

2.4. Data Collection

Data were collected using a data collection sheet. For all the participants, we collected data on age, sex, and cardiovascular risk factors. For each patient recruited, a blood lipid profile and creatinine were performed. A two-dimensional carotid Doppler ultrasound was performed at the YUTH by a radiologist (JCMA). The intima-media thickness (IMT) of the right and left common carotids was measured at the posterior wall in the longitudinal section. An IMT ≥ 1 mm was considered to be increased. Internal carotid and external carotid diameters were measured approximately 3 to 4 cm downstream of the carotid bifurcation. Any localized structure protruding into the arterial lumen, hyperechoic or isoechoic, and/or intima-media thickening greater than 1.5 mm, was considered to be atheromatous plaque. A decrease of more or equal 30% in the vascular lumen by atheromatous plaque was considered as stenosis. It was calculated according to the North American (NACET) method [19].

2.5. Statistical Analysis

All the data collected were analyzed using the software SPSS version 23. Quantitative variables were expressed as means and standard deviations (SD), while qualitative variables were expressed as counts and proportions. The association between qualitative variables was made using the Chi-square test. Multivariate analysis was done using binary logistic regression. The threshold of significance was set at 0.05.

3. Results

3.1. Clinical Characteristics of the Sample

Overall, 75 participants were included in the study. Among them, 49 women (65.3%) and 26 men (34.7%) with a sex ratio of 0.53. The mean age was 62.96±8.87 years and ranged from 50 to 84 years. Seventy participants (93.3%) had hypertension. Dyslipidemia was seen in 58 (77.3%) participants, obesity in 39 (48%) participants. 26 (34.7%) participants had type 2 diabetes and 7 (9.3%) participants were smokers (Table 1). High cardiovascular risk factors were found in 22 (29.4%) participants and 2 (2.7%) participants had carotid murmur on physical examination. (Table 1).

Table 1. *Clinical characteristics of the sample.*

Variables	Frequency (N=75)	Percentage (%)
Sex		
Female	49	65.3
Male	26	34.7
Cardiovascular risk factors		
Hypertension	70	93.3
Type 2 diabetes	26	34.7
Smoking	7	9.3
Obesity	36	48.0
Dyslipidemia	58	77.3
Sedentary	71	94.7
Cardiovascular risk profile		
High	22	29.4
Moderate	22	29.4
Low	31	41.2
Carotid murmur		
Present	2	2.7
Absent	73	97.3

Patients with hypo HDL cholesterolemia represented 77.3% (n=58) of the population. Total hypercholesterolemia was found in 37.3% of patients (Table 2). Fourteen participants (18.7%) had an elevated creatinine and 16% (n=12) had hyperuricemia.

Table 2. *Biological characteristics and carotid arteriosclerosis in participants.*

Variables	Frequency	Percentage (%)
Lipid profile		
Elevated total cholesterolemia	28	37.3
Elevated LDL cholesterolemia	13	17.3
Low HDL cholesterolemia	58	77.3
Hyper-triglyceridemia	15	20.0
Elevated blood creatinine	14	18.7
Hyperuricemia	12	16.0
Carotid atherosclerosis		
Present	27	36
Participants with a single plaque	13	48.1
Participants with multiple plaques	14	51.9
Absent	48	75
Localization of atheromatous plaques		
Right carotid bifurcation	15	33.3
Left carotid bifurcation	11	24.4
Right internal carotid bulb	9	20
Left internal carotid bulb	4	8.9
Others	6	13.4
Stenosing plaques	11	40.7
Between 30-49%	4	36.4
Between 50-70%	7	63.6
Nonstenotic plaques	16	59.3

HDL: High-Density Lipoprotein. LDL: Low-Density Lipoprotein

Carotid atherosclerosis was found in 27 patients (36%) including 17 men and 10 women. The average age of those with atheromatous plaque was 61.93 (±8.54) years. Of these patients, with carotid atherosclerosis plaques, 13 (48.1%) had a single plaque, and 14 (51.9%) had multiple plaques. The total number of plaques counted in the 27 participants having carotid atherosclerosis was 45. Of the 45 plaques found, 26 (57%) were located on carotid bifurcations. There were 11 stenotic plaques. Strictures between 50 and 69% represented 63.6% (n=7) of the strictures. No patient had a stricture greater than or equal to 70% (Table 2).

3.2. Factors Associated with Arteriosclerosis

In bivariate analysis, there was a statistically significant association between total hypercholesterolemia and the presence of carotid atheromatous plaques (OR=20, p <0.001). We also found that high cardiovascular risk was also associated with carotid atherosclerosis (OR=7, p <0.001). These associations persisted in multivariate analysis. We did not find any statistically significant associations between the presence of carotid atheromatous plaques and hyperuricemia or impaired renal function (Tables 3 and 4). Furthermore, no socio-demographic or clinical characteristics were significantly associated with carotid atherosclerosis in our study.

Table 3. *Bivariate analysis of factors associated with carotid arteriosclerosis.*

Variables	Carotid atherosclerosis		OR (95% CI)	*p*-value
	Yes, n (%)	No, n (%)		
Elevated total cholesterolemia				
Yes	21 (75.0)	7 (25.0)	20.5 (6.1-68.8)	**<0.001**
No	6 (12.8)	41 (87.2)		
Low HDL cholesterolemia				
Yes	18 (31.0)	40 (69.0)	0.4 (0.13-1.2)	0.098
No	9 (52.9)	8 (47.1)		
Elevated LDL cholesterolemia				
Yes	5 (38.5)	8 (61,5)	1.13 (0.33-3.9)	0.839
No	22 (35.5)	40 (64,5)		
Hyper-triglyceridemia				
Yes	6 (40.0)	9 (60,0)	1.23 (0.38-3.95)	0.718
No	21 (35.0)	39 (65,0)		
Elevated blood creatinine				
Yes	6 (42.9)	8 (57.1)	1.42 (0.4-4.7)	0.550
No	21 (34.4)	40 (65.6)		
Hyperuricemia				
Yes	5 (41.7)	7 (58.3)	1.33 (0.37-4.68)	0.655
No	22 (34.9)	41 (65.1)		
Cardiovascular risk				
Low	6 (19.4)	25 (80.6)	0.26 (0.09-1.76)	0,261
Moderate	6 (27.3)	16 (72.7)	0.57 (0.19-1.69)	0.310
High	15 (68.2)	7 (31.8)	7.32 (2.4-22.1)	<0.001

HDL: High-Density Lipoprotein. LDL: Low-Density Lipoprotein

Table 4. *Multivariate analysis, independent factors related to the presence of carotid atheromatous plaques.*

Variables	aOR (95% CI)	*p*-value
Elevated total cholesterolemia	16.48 (4.6-58.6)	< 0.001
High cardiovascular risk	4.95 (1.28-19.13)	0.020

4. Discussion

This study aimed to determine the frequency of carotid atherosclerosis in a group of asymptomatic patients over 50 years of age with cardiovascular risk factors. We found that 36% of participants had carotid atherosclerosis. This frequency is higher than that reported in Cameroon in 1998 by Kingue et *al*. and in Ivory Coast in 2017 by Soya et *al*.

[20, 21]. Indeed, with definition criteria similar to ours, they found lower proportions which were respectively 25% and 22.7% [20, 21]. This could be explained by the fact that their study population was younger than ours, knowing that the prevalence of arteriosclerosis increases with age [22–24]. On the other hand, the increasing westernization of lifestyle in sub-Saharan Africa in general and in Cameroon, in particular, favors an increase in the prevalence of arteriosclerosis [25–27]. Regarding the cardiovascular risk factors, in our study, 93.3% of patients were hypertensive, 48% were obese, and 9.3% were smokers. This is similar to the results reported by Kingue et *al.* where we also found a high prevalence of hypertension at 81.8%, obesity at 32.4% [20]. Atherosclerotic plaques were mainly localized on carotid bifurcations (57%). This is comparable to the results obtained by Kingue et *al.* who found 68% of plaques at the carotid bifurcation [20]. These results are consistent with those found in the literature where the preferential locations of arteriosclerosis lesions are the bifurcations. These could be explained by the fact that variations in flow velocity and shear stress, decreased wall shear, flow separation, and turbulence observed in these regions are hemodynamic potentiators of lesion formation [28]. Seven (9.3%) patients had carotid stenosis between 50 and 69%. This is comparable to the results obtained by Ngo Nonga et *al.* where they found a prevalence of 8.6% of strictures of between 50 and 75% [28].

Regarding factors associated with arteriosclerosis, total hypercholesterolemia was an independent risk factor of carotid atherosclerosis after multivariate analysis. This confirms the data in the literature according to which hypercholesterolemia is a major risk factor for atherosclerotic disease [6, 29–31]. Age was not significantly related to the presence of carotid atheromatous plaques in our study which is different from the results obtained by Kingue et *al.* where the age group ≥ 70 years was an independent risk factor associated with carotid atherosclerosis [20]. This could be explained by the change in the African way of life over time justifying that the age group ≥ 70 years is no longer just the only group representing a risk of plaques [25–27]. Male sex was not a significant factor associated with carotid atherosclerosis in our study. Unlike many studies in the literature where the male sex accelerates the rate of atherosclerosis progression [32, 21]. This can be explained by the fact that our study consisted of older women generally going through menopause (71.1%). As estrogen plays a protective role against the formation of atheromatous plaques, with the drop in estrogen levels during menopause, this protective effect of estrogen against arteriosclerosis decreases considerably [14, 33–36]. Hypertension, diabetes, and smoking were not significantly associated with the presence of carotid atheromatous plaques in our study, which is similar to the results obtained by Kingue et *al*. [20]. These results are in contradiction with many studies that have demonstrated the important role played by smoking, hypertension, and diabetes in the development of atheromatous plaque [37, 38].

A limitation of this study is the relatively small sample size. Thus, our findings could not be generalized to other populations. However, it remains one of the few in Cameroon to explore, using ultrasound, carotid atherosclerosis in asymptomatic patients with cardiovascular risk factors. This interest is all the more justified since certain cardiovascular risk factors in our setting such as hypertension represent a major public health problem. Doppler ultrasound, a reliable, non-invasive, and inexpensive technique, is a tool of choice in our community for the early detection of atheromatous lesions, even asymptomatic.

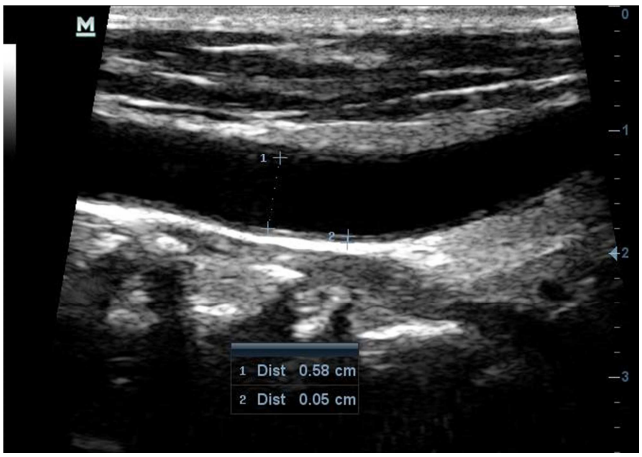

Figure 1. *Measurement of intima-media thickness and common carotid diameter.*

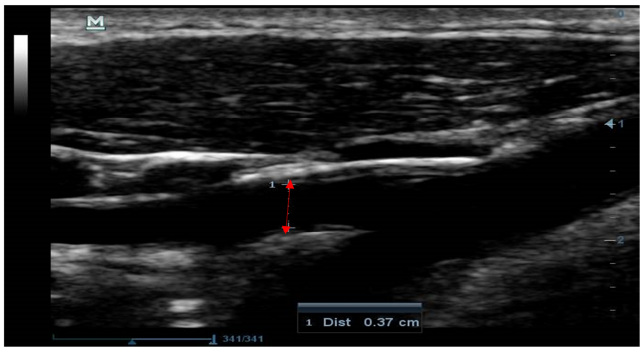

Figure 2. *Measurement of the diameter of the external carotid artery.*

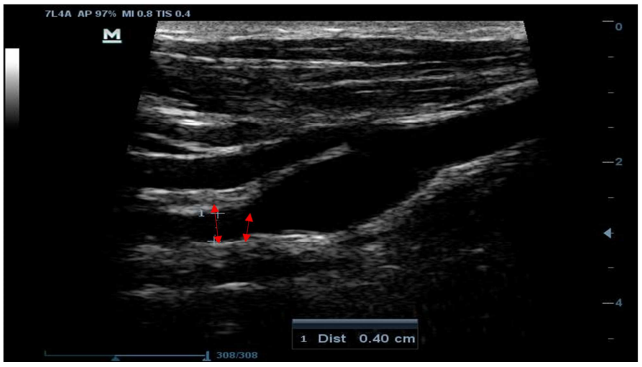

Figure 3. *Measurement of the diameter of the internal carotid artery.*

Figure 4. *Carotid atheroma plaques at the internal carotid bulb and carotid bifurcation.*

5. Conclusion

In this group of patients in sub-Saharan Africa, the most frequent cardiovascular risk factors were hypertension, dyslipidemia, obesity, and diabetes. A high cardiovascular risk profile was seen in a third of the participants. Carotid atherosclerosis was present in 1 in 3 patients over 50 years of age with cardiovascular risk factors. Total hypercholesterolemia and cardiovascular risk were associated with the presence of carotid atherosclerosis. There is a need to make available resources to assay serum lipids and promote the global risk approach in the care of patients in our setting. Preventive strategies to fight the high rate of cardiovascular risk factors should be put in place.

Abbreviations

CVRF: cardiovascular risk factors
IMT: intima-media thickness
YCH: Yaoundé Central Hospital
YUHC: Yaoundé University Hospital Center

Declaration

Authors' Contribution

Conception and design: MKL; NCF; SE; NNB
Data collection: NCF; KYH; MKL; SE; AMJ; MAP; HB; NNB
Data analysis and interpretation: MKL; KYH; NCF; AMJ: MAP:
Manuscript drafting: NCF; KYH, AMJ; MKL:
Manuscript revision: MAP; HB; NNB.
Approval of the final manuscript: All the authors.

Availability of Data and Materials

The datasets used for this study are available from the corresponding author on request.

Ethical Approval and Consent to Participate

The study was approved by the Institutional Ethical Review Board of the University Yaoundé I (Cameroon). All the participants read and signed informed consent before their inclusion in the study.

Consent for Publication

Not applicable.

Competing Interest

The authors declare that they have no competing interests.

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