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# Extracranial Carotid Atherosclerosis and Acute Ischemic Stroke in a Tertiary Hospital in Burkina Faso

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## Abstract

**Objective:** To determine the prevalence and risk factors of carotid atherosclerosis among ischemic stroke patients in a tertiary hospital in Burkina Faso. **Methodology:** This was a descriptive and analytical retrospective study of patients admitted at neurology department of Yalgado Ouedraogo University Teaching Hospital with ischemic stroke and cerebral large vessel atherosclerosis in the period from January 1, 2012 to December 31, 2016. **Results:** The prevalence of extracranial carotid atherosclerosis was 23.9%. The mean age of patients was 63.5 years (Range 31 - 90 years). The study population included 65% of men and 35% of women. Hypertension was the most common vascular risk factor (75.6%). Stroke was mostly located in the anterior circulation in 23.9%. Low HDL-C was present in 52% of patients. The majority of plaque was homogeneous (85.2%). Plaque were located in carotid bulbar artery (38.5%) followed by common carotid artery (28.2%) and extracranial internal carotid artery (18.6%). According to cerebral lesion, plaque was bilateral in 45.5%, ipsilateral in 42.3% and contralateral in 12.1% of cases. Tight stenosis was found in 30.1% of patients. There was a significant link between male gender and tight stenosis (p = 0.004). Aspirin was the most antiplatelet therapy used (95.5%). Statin therapy was used in 91% of patients. The mean duration of hospitalization was 12.5 days with a mortality rate of 7.1%. **Conclusions:** Our study showed that extra carotid atherosclerosis was the most common cause of ischemic stroke in Burkina Faso. Man gender was most represented than women.

## Keywords

## 1. Introduction

Stroke is the second most common cause of death worldwide [1]. The incidence of stroke, a cardinal complication of cardiovascular risk factors, appears to be rising in Africa and other low- and middle-income country (LMIC) settings [2]. Therefore, 86% of all stroke deaths around the world were contributed by LMIC in Africa and other continents [3]. Atherosclerotic disease is one of the major causes of ischemic stroke. Cerebral atherosclerosis can be divided into extra-cranial atherosclerosis (ECAS) and intracranial atherosclerosis (ICAS). Carotid artery disease appears to be uncommon in stroke patients in Sub Saharan Africa [4]. In previous studies, carotid atherosclerosis had been associated with stroke among Africans [5] [6] [7]. Patients with a first ischemic stroke are at high risk of developing recurrent stroke due to carotid atherosclerotic plaque rupture [8]. Recurrent ischemic stroke in patients with carotid plaque was significantly aggravated compared with those in patients who have experienced one stroke [9]. Extracranial carotid artery disease was estimated to be responsible for 20% - 30% of ischemic strokes in the United States and Western communities [10]. Therefore, the presence of an atherosclerotic lesion in the carotid bulb or in the extracranial internal carotid artery (ICA) is associated with elevated stroke risk [8]. Race-ethnic differences in the distribution of atherosclerosis are well described. Whites tend to have a higher prevalence of extracranial carotid atherosclerosis than African Americans [11]. In Sub Saharan Africa, especially in Burkina Faso, the prevalence of extracranial carotid atherosclerosis is unknown. The aim of this study was to determine the frequency and risk factors of extracranial carotid atherosclerosis in acute ischemic stroke patients by using Doppler ultrasound, a noninvasive and cost-effective investigation, recommended for the initial evaluation of symptomatic and asymptomatic patients with suspicion for carotid atherosclerotic disease [12].

## 2. Methodology

### 2.1. Study Design

This study was conducted in the neurology department of the Yalgado Ouedraogo University Teaching hospital located in Ouagadougou (Burkina Faso). Burkina Faso is a French speaking country in West Africa who covers an area of 274,000 km$^2$ with a population estimated at 16.248.558 inhabitants according to 2006 Census. The overall mortality rate is 11.8% and the life expectancy at birth is 56.7 years [13].

### 2.2. Study Population

We conducted a 4 years retrospective study on acute ischemic stroke patients admitted at neurology department of Yalgado Ouedraogo University hospital in Ouagadougou (Burkina Faso) during the period from January 2012 to December 2016. We included patients aged over 18 years old who had carotid atherosclero-

sis on Doppler Ultrasound. All the patients had done carotid Doppler ultrasound and further CT angiography if possible. We excluded posterior circulation ischemic stroke, stroke with cardio aortic embolic cause, lacunar stroke, vasculitis, arterial dissection, or fibro muscular dysplasia were excluded on the study.

## 2.3. Data and Analysis

The data were collected and analyzed using the EPI Info software version 7. The results were expressed as a percentage and/or on average. The Pearson Chi-square statistical test was used for the comparison of proportions. P values less than 0.05 were considered statistically significant. The following variables were taken into account in our study: Sociodemographic data and risk factors (age, sex, residence, occupation, modifiable risk factors, *i.e.* hypertension, dyslipidemia, smoking, obesity, diabetes, alcohol consumption) alcohol, oral contraception, pregnancy, migraine and sickle cell disease). Clinical data (The reason for admission, motor deficit, sensory disorders, cognitive functions (oral and written language, praxis, gnosis, memory) and the methods of management (drugs and physiotherapy)). Data from brain imaging (vascular territory, number of lesions, laterality of lesions), as well as associated signs (cerebral atrophy, cerebral edema), cervical ultrasound, data from biological assessments (total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, blood glucose, serum creatinine, and electrocardiogram).

## 2.4. Ethical and Ethical Considerations

For this study, we asked for the agreement of the head of neurology department of Yalgado Ouedraogo University Teaching Hospital. Written informed consent from the patients was not required in this retrospective review. All patient records and information were anonymized and deidentified before analysis.

## 2.5. Definitions

Ischemic stroke was defined according to the sudden appearance of neurological symptoms lasting more than 24 h, in the absence of hemorrhagic signs on the first brain CT scan. The diagnosis of extracranial atherosclerosis was defined by the presence of cholesterol plaque or stenosis in an extracranial artery. We used the criteria of the Nascet [14] to define the degree of carotid stenosis. Hypertension was defined as a self-reported history, taking antihypertensive medication, or a systolic blood pressure ≥ 140 mm·Hg, or a diastolic blood pressure of ≥90 mm Hg at baseline. Diabetes mellitus was defined as a self-reported history, current treatment with insulin or oral hypoglycemic agents, or fasting blood glucose level ≥ 7.0 mmol/l at baseline. Dyslipidemia was defined as a self-reported history, current use of cholesterol lowering medicine, or a total cholesterol level ≥ 6.22 mmol/l or triglyceride ≥ 2.26 mmol/l or low density lipoprotein ≥ 4.14 mmol/l at baseline. Table 1 shows the normal value of lipids.

Table 1. Value of normal value of lipid.

| Lipoproteins | Normal (mmol/l) | High (mmol/l). |
|---|---|---|
| Total cholesterol | <6.20 | ≥6.20 |
| HDL cholesterol | >1 | ≥1.54 |
| LDL cholesterol | <4.12 | ≥4.12 - 4.87 |
| Triglycerid | <1.71 | ≥1.71 |

## 3. Results

### 3.1. Frequency of Extracranial Carotid Atherosclerosis

During study period, 653 patients with ischemic stroke were admitted in Neurology Department. Of whom, 156 (23.9%) had anterior circulation stroke and extracranial carotid atherosclerosis on carotid Ultrasound Doppler.

### 3.2. Sociodemographic and Clinical Characteristics of Population Study

From 156 patients included in the study, 83 (53.2%) were male and 73 (46.8%) female with the mean age of 63.5 years +/− 11.7 (Ranging from 31 to 90 years). Among male patients, the mean age was 64 years while in females it was 63 years. About 63.4% of patients were above 60 years of age (n = 99). One hundred thirty five (86.5%) subjects were married and 21 (13.5%) were single. Seventy six (48.7%) patients had educated. The residence was living in urban in 88 (56.4%) patients. According to profession, 63 (40.4%) patients were housewives, 28 (18%) retired and 27 (17.3%) famers. According to education level, 77 (49.4%) patients were illiterate. The medical records of the subjects studied showed that 23 (14.7%) patients had no identifiable risk factors for atherosclerosis whilst 7 (23.3%) subjects had at least one risk factor for atherosclerosis. Among the later, hypertension was found in 118 (75.6%) patients, hyperglycemia in 71 (32.7%) patients, chronic alcohol consumption in 54 (34.6%) and cigarette smoking in 28 (18.2%). Nineteen (12.2%) patients had past history of ischemic stroke. The Sociodemographic and clinical characteristics of the participants are summarized in Table 2.

### 3.3. Lipid Profile

According to lipid profile, high level of TC was present in 69 (44.3%) patients, LDL C in 58 (37.2%) patients and TG in 42 (27%). Eight (5.2%) patients had high level of HDL C.

### 3.4. Characteristics of Ischemic Stroke Lesions

The majority of ischemic stroke lesions was located in Middle carotid artery in 138 (88.4%) patients. Eighty (51.2%) patients had right sided stroke, 73 (46.7%) left sided stroke and 3 (1.9%) bilateral involvement. Table 3 presents the location of stroke in the 156 patients with extracranial carotid atherosclerosis.

Table 2. Sociodemographic and clinical characteristics of the participants.

| Sociodemographic and clinical characteristics | Population study (N = 156) |
|---|---|
| Age group (years) | |
| <30 | 0 |
| 31 - 40 | 8 (5.1%) |
| 41 - 50 | 14 (8.9%) |
| 51 - 60 | 35 (22.4%) |
| 61 - 70 | 57 (36.5%) |
| 71 - 80 | 34 (21.7%) |
| ≥80 | 8 (5.1%) |
| Male | 83 (53.2%) |
| Married | 128 (82.05) |
| Illiterate | 77 (49.4%) |
| Primary level | 32 (20.5) |
| Secondary level | 42 (26.9%) |
| University level | 5 (3.2%) |
| Urban residence | 88 (56.4%) |
| Vascular risk factors | |
| Hypertension | 118 (75.6%) |
| Hyperglycemia | 71 (32.7%) |
| Chronic alcohol consumption | 54 (34.6%) |
| Cigarette smoking | 29 (18.5%) |
| Obesity | 27 (17.3%) |
| Diabetes mellitus | 24 (15.3%) |
| Previous Stroke | 19 (12.1%) |
| Sickle cell disease | 4 (2.5%) |
| Contraception | 2 (1.2%) |

Table 3. Location of stroke in the 156 patients with extracranial carotid atherosclerosis.

| Location | | | | |
|---|---|---|---|---|
| Cerebral artery | Number( n = 156) | Right side (n = 80) | Left side (n = 73) | Bilateral (n = 3) |
| *MCA* | 138 (88.4%) | 67 | 68 | 3 |
| *ACA* | 12 (7.6%) | 10 | 2 | 0 |
| MCA+ ACA | 6 (3.8%) | 3 | 6 | 0 |

MCA: middle cerebral artery; ACA: anterior cerebral artery.

## 3.5. Neuroimaging of Extracranial Atherosclerosis

Doppler ultrasound was performed in the totality of patents. Atherosclerotic le-

sions were mostly located in carotid bulbar artery in 60 (38.5%). The lesions were unilateral in 86 (55.2%) patients and bilateral in 70 (44.8%) patients. According to cerebral lesion, plaque was ipsilateral in 66 (42.3%) patients, contralateral in 19 (12.1%) and bilateral in 71 (45.5%) patients. The site of plaque was unilateral in 86 (55.2%) patients and bilateral in 70 (44.8%) patients. Right side plaque was seen in 53 (33.1%) and left side plaque in 33 (21.1%) patients. Plaque was calcified in 7 (4.4%) patients, soft in 148 (94.8%) patients and mobile in a male patient (0.6%) patient. The nature of plaque was homogenous in 133 (85.2%) and heterogeneous in 33 (10.2%). According to degree of stenosis, 30 (19.2%) patients had mild stenosis, 79 (50.6%) had moderate stenosis and 47 (30.2%) had tight stenosis. Among patients with tight stenosis (n = 47), occlusion was found in 3 (6.3%), all located in carotid bulbar. Table 4 summarizes Ultrasound characteristics of extracranial carotid atherosclerosis (N = 156). CT angiography was performed in 5 (3.2%) patient's further carotid Doppler ultrasound and confirmed the presence of atherosclerosis plaque in the totality of cases. Calcifications were present in 3 (60%) patients and tight stenosis in 4 (80%) patients.

### 3.6. Risk Factors for Tight Stenosis

According to gender, tight stenosis was more present in male patient than in female patients (p = 0.004). Table 5 gives the degree of stenosis according to patient's gender. According to age, tight stenosis was more present in male patients after the age of 45 years (p = 0.0001) and in female patients after the age of 55 years (p = 0.013). Table 6 gives the distribution of tight stenosis in male and female patients according to age (N = 156). The prevalence of tight stenosis was respectively 75% in sickle cell disease, 70.8% in diabetes mellitus (70.8%) and 64.8% in cigarette smoking (64.8%). Table 7 presents the frequency of tight stenosis according to vascular risk factors (N = 156). The prevalence of tight stenosis was respectively 50.7% in patients with high level of TC, 73.8% in patients with high triglyceride and 43.1% in patients with LDL cholesterol. The prevalence of tight stenosis in patients with high level of HDL C was 100%. Table 8 describes the distribution of lipid profile of patients with tight stenosis.

Table 4. Ultrasound characteristics of extracranial carotid atherosclerosis (N = 156).

| Characteristic | Number (N = 156) | Percentage (%) |
|---|---|---|
| Plaque | 133 | 85.25 |
| Overload | 103 | 66.02 |
| Calcification | 48 | 30.76 |
| Severe stenosis | 47 | 30.12 |
| Occlusion | 4 | 2.56 |
| Wall thrombosis | 3 | 1.92 |

Table 5. Degree of carotid stenosis according to patients' gender (N = 156).

| Degree of carotid stenosis | Population study (N = 150) | Male (n = 83) | Female (n = 73) | P value |
|---|---|---|---|---|
| <60 | 30 (19.2%) | 13 (43.3%) | 17 (56.6%) | |
| 60 - 70 | 79 (50.6%) | 41 (51.8%) | 38 (48.1%) | |
| ≥70 | 47 (30.2%) | 29 (5.0%) | 18 (38.2%) | 0.004 |

Table 6. Distribution of tight stenosis in male and female patients according to age (N = 156).

| Age and gender | Number (n = 156) | Carotid stenosis ≥ 70% | OR (IC 95%) | p-value |
|---|---|---|---|---|
| Male gender | 83 | **29 (34.9)** | | |
| <45 years | 6 | 16.6 | | |
| ≥45 years | 77 | 36.3 | 1.5 (0.5 - 4.3) | **0.001** |
| Female gender | **73** | **18 (24.6)** | | |
| <55 years | 15 | 22.4 | | |
| ≥55 years | 58 | 33.3 | 1.2 (0.1 - 3.5) | **0.013** |

Table 7. Frequency of tight stenosis according to vascular risk factors (N = 156).

| Vascular risk factors | Stenosis ˃ 70% |
|---|---|
| Hypertension ( n = 118) | 47 (39.8%) |
| Hyperglycemia (n = 71) | 35 (49.2%) |
| Chronic alcohol consumption (n = 54) | 35 (64.8%) |
| Cigarette smoking (n = 29) | 21 (72.4%) |
| Obesity (n = 27) | 18 (66.6%) |
| Diabetes mellitus (n = 24) | 17 (70.8%) |
| Previous Stroke (n = 19) | 12 (63.1%) |
| Sickle cell disease (n = 4) | 3 (75%) |

Table 8. Distribution of lipid profile of patients with tight stenosis.

| Lipid profile | Population study (n = 156) | Stenosis > 70% |
|---|---|---|
| **Total cholesterol** | | |
| Normal | 87 (55.7%) | 12 (13.7%) |
| High | 69 (44.3%) | 35 (50.7%) |
| **Triglycerid** | | |
| Normal | 114 (73%) | 16 (14.03%) |
| High | 42 (27%) | 31 (73.8%) |
| **LDL cholesterol** | | |
| Normal | 98 (62.8%) | 22 (22.4%) |
| High | 58 (37.2%) | 25 (43.1%) |
| **HDL cholesterol** | | |
| High | 8 (5.2%) | 8 (100%) |
| Normal | 148 (94.8%) | 39 (26.3%) |

### 3.7. Treatments of Atherosclerosis Stroke

According to treatment, aspirin was used in 149 (95.5%) patients. Dual anti-platelet therapy (DAPT) with aspirin and clopidogrel was prescribed in 6 (3.8%) patients. Statin therapy was used in 142 (91%) patients. The mean duration of hospitalization was 12.5 days (range 2 - 53 days). The hospital stays was 5 - 10 days in 69 (44.2%) patients, >10 days in 54 (34.6%) patients and <5 days in 33(21.2%). Eleven (7.1%) patients died during hospitalization course. One hundred and five (86.5%) patients were discharge to rehabilitation.

## 4. Discussion

### 4.1. Frequency of Extracranial Carotid Atherosclerosis

Our study had shown that the frequency of ECCA was 23.9%, in concordance with literature. About 30% - 60% of ischemic strokes are caused by atherosclerotic disease in the USA and Western communities [10] [15]. In developing countries, the prevalence of extracranial atherosclerosis, using carotid Doppler, ranges from 27.4% in Iran to 78% in India [16] [17] [18]. According to autopsies studies, the prevalence of ECCA varied from 73.3% to 94% [19] [20]. The difference between these studies is due metrological features (location of study, size of study population).

### 4.2. Characteristics of Population Study

The majority of patients with atherosclerosis in this study was male (53.2%), in concordance with many studies [17] [18] [21] [22] [23]. The explanation is that hormonal factors such as estrogen have been observed to play a significant role in slowing the progression of atherosclerotic lesions in females. Also, there was significant relation between male gender and severe atherosclerosis (p = 0.005). According to literature, male gender is also risk factor for extracranial atherosclerosis in Asia [24] [25]. The mean age of patients was 63.5 +/− 11.7 years, comparable to that found by Hadi [17] (62.43 years) but the proportion of patients above 60 years was higher than his study:63.4% versus 55%.In our study, male patients above 45 years and female patients above 55 years had more risk to have severe stenosis than other patients. Older age is an important risk factor for extracranial carotid atherosclerosis, especially in the Chinese and South Koreans [24] [26] [27].

Hypertension was the most vascular risk factor (75.6%) in patients with extracranial carotid atherosclerosis followed by chronic alcohol consumption (34.6%) and cigarette smoking (18.2%). Hypertension was also found to be the major risk factor of extracranial carotid atherosclerosis in other studies [17] [21] [28] [29] [30]. Smoking is also known to be associated with atherosclerosis of the extracranial carotid vessels [27]. The frequency of DM in our study was less frequent in diabetic patients in our study (15.3%) than in the study of Hadi (44%) [17]. DM is an important risk factor for extracranial carotid atherosclerosis [25] [27]. While tight stenosis was most frequent in SCD (75%) and chronic alcohol con-

sumption (64.8%), none study had established a possible role of these vascular risk factors and carotid atherosclerosis. The high frequency of theses is due to its association with hypertension, diabetes mellitus and smoking. In our study, 85% of patients had at least more than 2 vascular risk factors. According to SCD, it is a genetic disease, frequently present in stroke patients in Burkina Faso [31]. Hyperlipidemia was present in 32.7% of patients with carotid atherosclerosis. Tula Dhār in Nepal had showed that almost all of patients of ischemic stroke had both hyperlipidemia and extracranial atherosclerosis on Doppler ultrasound [32]. Also, hyperlipidemia was found to be a common risk factor for extracranial atherosclerosis in Asia [24]. According to lipid profile, high level of TC was observed in 44.3%, LDL C in 37.2%, TG in 27%. The progression of CA atherosclerosis was associated with a higher level of TG, LDL-C, or a lower level of HDL-C [33]. We had observed a highest prevalence of tight stenosis in patients with high level of HDL had tight stenosis (100%). This situation was controverly according to literature which reported that HDL C cholesterol appeared to be particularly protective against the atherosclerotic stroke subtype [34]. There was a poor frequency of patients who had initially high level of HDL C (5.2%).

### 4.3. Carotid Ultrasound

About 30.2% of patients with extracranial carotid atherosclerosis had tight stenosis with higher frequency than that found by Hadi (8.9%) [17], Razzaq *et al.* (21%) [28] and Wasay *et al.* (12%) [35]. Occlusion of the internal carotid artery was found in 6.3% of cases, in concordance with a previous study (2.5%) [36]. In contrast, high incidence of occlusive extracranial internal carotid artery lesions (up to 57%) was found in patients with large hemispheric infarctions [37]. In a post mortem studies, the prevalence of steno occlusive carotid lesion was 64% of the patients studied [38]. Plaque calcifications were found in 4.4% of patients. The risk of embolization or rapid progression would depend on plaque composition especially if it was heterogeneous, diffuse, or focal [39]. In our study, ICA was found to be the commonest site affected as found by other studies. Majority of patients in our study had soft plaques (94.8%) which is in accordance with a study conducted by Razzaq *et al.* (43%) [28] and Hadi (58.9%) [17]. Mobile plaque in internal carotid was present in a male patient in concordance with Bhatti who found that the thrombus is mostly frequent in the internal carotid artery (75%) [40]. This is a very rare ultrasonographic finding which is usually diagnosed after a neurological emergency, such as a transient ischemic attack or cerebral infarction [41]. The etiology of mobile thrombus can be cardioembolism, arterio-arterial embolism, dissection, complicated atherosclerotic plaque and hypercoagulable states [42].

### 4.4. Treatments

Antiplatelet therapy (DAPT) and statin therapy were the main treatments in ischemic stroke due to atherosclerosis, as in our study but in sometimes, aspirin was prescribed together with low molecular weight heparin [43]. According to

literature, statins may also act on biological markers of plaque instability and reduced the carotid intima media thickness consistently with all statins. [44] [45]. In our study, about 30% of patients had straight stenosis but none had carotid endaterectomy which is the most common surgical procedure used to treat stenosis of the extracranial precerebral carotid artery. The reason is the lack of materials and only two vascular surgeons for all the country of 20 million of population.

### 4.5. Limitations of the Study

The present study has some limitations. As this study was a single hospital-based study conducted on patients belonging to lower socioeconomic status having a different clinical and risk factor profile, these results cannot be applied to the general population. According to Ultrasound Doppler, some data (velocity, IMT, number of plaque etc.) were missing in the conclusion of operators. Carotid Doppler was made by many operators (radiologists and cardiologists) in our context, so the result differed from operator.

### 5. Conclusion

Our study had shown that extracranial carotid stenosis was frequent in ischemic stroke patients in Burkina Faso, especially in older patients and men. To reduce the risks of carotid atherosclerosis among these patients, we need to do systematic carotid ultrasound in all patients with vascular risk factors (hypertension, smoking and hyperlipidemia). Also, we need to increase the financial access to cerebral angiography and training for neurosurgeon to do carotid endarterectomy.

### Acknowledgements

### Conflicts of Interest

With regard to the present study none of the authors has to disclose conflicts of interest.

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## Abbreviations

**TC:** Total Cholesterol
**HDL C:** High Density Lipoprotein Cholesterol
**LDL C:** Low Density Lipoprotein Cholesterol
**TG:** Triglycerides
**SCD:** Sickle Cell Disease