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A Prognostic Challenge of Brainstem Stroke for the Countries of Sub-Saharan Africa: Case of Togo

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Abstract: Background and purpose – Brainstem stroke (BSS) is a particular anatomo-clinical variety of strokes. In Sub-Saharan Africa, its epidemiological, therapeutic and prognostic data are rare. The aim of the study was to describe epidemiological aspects and factors associated with the prognosis of BSS in adult patients followed-up at University Hospital Campus of Lomé. A prospective cohort study was carried out from January 1st 2014 to June 30th 2017 (3.5 years) in the department of neurology. It included patients with BSS. Epidemiological characteristics, initial symptoms, brain imaging findings at admission, etiologic factors, therapeutic particularities and outcome measures were assessed. Among the 2,857 patients with stroke, 79 cases of brainstem (2.8%) were diagnosed. Ischemia and hemorrhage were identified in 50 (63.3%) and 29 (36.7%) patients, respectively. Recurrence was observed in 8 patients (10.1%). Hypertension was the main etiological and risk factor. Motor physiotherapy and speech therapy implemented early and associated with other therapies in survivors, had led to the improvement of general state of more than half of the latter. Early mortality and overall mortality were 24 and 31.6%, respectively. Unfavourable prognosis was strongly correlated with diagnosis delay, high blood pressure, deep loss of consciousness, big hematoma volume, presence of encephalic complications and occlusion of basilar arterial trunk. BSS is a less common illness. The main factors identified are associated with an elevated rate of death. Vital prognosis improvement results in factor management and functional rehabilitation.

Keywords: Brainstem Stroke, Epidemiology, Clinical Aspects, Prognosis, Lomé

1. Introduction

For decades, Brainstem stroke (BSS) has been considered as peculiar from the epidemiological, clinical, therapeutic and prognostic levels [1, 4].

Epidemiology of BSS remains poorly known despite the extraordinary advances in vascular neurology. Available data show a variable prevalence after 50 years old (1-10%) and high mortality (60-85%) [1, 3, 5]. Countries of Sub-Saharan Africa (SSA) are not spared by this problem. Studies carried out in SSA are fragmentary and focus on hemorrhages [4, 6].

Symptoms of BSS are variable and require a semiological fineness and an efficient brain imaging [7]. Unfortunately, for many countries of SSA, medical imaging (CT-scan, CT angiography, MRI) is either unavailable or difficult to access [4, 6].

At therapeutic level, there is a great heterogeneity that takes the type of stroke, etiology and intensity of motor deficit into account [8]. In developed countries, on the one hand, thrombolysis and/or thrombectomy produce encouraging results in the treatment of infarcts [8]. On the other hand, many countries of SSA do not have these therapies.

From the prognostic level, very few studies are available in SSA. Those published focus partly on the survival of some patients with brainstem hematomas [4, 6].

To take up the challenge related to the BSS in SSA, it is

essential to identify the factors. Thus, the present study was undertaken. The purpose of this study is to describe the epidemiological aspects and factors associated with the prognosis.

2. Subjects and Methods

A prospective study was carried out in the department of neurology of University Hospital Campus of Lomé, from January 1st 2014 to June 30th 2017. This study was focused on patients with BSS confirmed by brain imaging: CT-scan and MRI without axial diffusion sequence owing to low magnetic field (0.5 tesla). Patients were exhaustively examined.

Diagnosis of BSS was performed according to WHO criteria [9] which were improved by Neau and Godenèche [10] taking the anatomical topography of disease into account.

Inclusion criteria were: age, over 18 years old; hospitalization followed by external follow in the department of neurology during the period of study; for the cases of multiple strokes, the location of one of them at the brainstem and being suggestive of a recent symptomatology; patients or bedside parents who agreed to take part in the study after informed consent; patients of rural and urban areas who resided in Lomé during the period of study.

Exclusion criteria were: patients whose stroke diagnosis was not confirmed by brain imaging; patients with multiple strokes, including one at the brainstem, without a recent symptomatology; patients with a symptomatology that was suggestive of a brainstem involvement, but in whom brain CT-scan was normal and confirmation by means of MRI was not available; post-traumatic hemorrhages; cerebral or cerebellar hemorrhages were extended to the brainstem; meningeal peri-mesencephalic hemorrhages.

Age, sex, incidence, prevalence, recurrence and mortality were epidemiological variables of study.

Clinical variables were: modifiable risk factors, hospitalization causes, Glasgow-Liege score, hospital admission deadline, temperature, blood pressure, level of consciousness (no loss, poor loss, moderate loss, or deep loss) and information from brain imaging. For the variable "information from brain imaging", it was noted:

In the case of hematoma (HBSS): the extension in height (bulbar, protuberant, peduncular) and anteroposterior extension (unilateral tegmental, tegmento-basal, bilateral tegmental, massive), according to the classification of Chung and Park [11]; the possible presence of complications (ventricular contamination or flood, axial involvement, hydrocephalus). The extent of lesions was determined by means of volume and maximum transverse diameter;

In the case of ischemia (IBSS), the topography according to the affected arterial territory.

Etiological research was performed using MRI and/or cerebral palsy, cardiac echo-Doppler and sup aortic trunks, coagulation assessment, standard electrocardiogram (ECG) and ECG Holter of 24 hours in patients whose strong suspicion of cardio- embolic origin was accepted despite the normal standard ECG. Etiologies of IBSS were ranked according to the Toast classification [12].

Resuscitation measures (conventional oxygenation) were implemented in some patients. Physical rehabilitation measures (motor physiotherapy and speech therapy) were implemented early (the fifth day of hospitalization) in patients as soon as their clinical state allowed doing these therapies.

Active therapies in the case of IBSS were implemented according to the protocols established in our service: out of an emboligenic heart disease, aspirin administered intravenously at the dose of 1 g/day for 5 days, then relayed by platelet antiaggregant at the dose of 250 mg/day, if hospital admission before 6 hours; heparin at curative dose in emboligenic cardiopathy; platelet antiaggregant administration only if admission beyond 6 hours and in the case of massive deficit.

In the case of HBSS, systemic anti-edematous administration and external ventricular derivation were indicated in the case of compressional hematoma with hydrocephalus.

Outcome in 1 month was assessed using 4 items: improvement; stabilization; aggravation with survival; aggravation without survival.

Functional outcomes in 3 and 6 months were assessed using the modified Rankin score. Score of ≤ 2 on the scale (range: 0 to 6) was defined as good.

Statistical analysis was performed using the SPSS software version 21. Qualitative and quantitative variables were assessed, respectively, by the frequencies and averages associated with standard deviation. Fisher's test was used to demonstrate a significant difference between two quantitative variables. Pearson correlation test was used to compare two groups. P value of < 0.05 was considered as statistically significant.

3. Results

3.1. Epidemiological Data

Among the 2,857 patients with stroke, 87 cases of BSS were identified. All of them or their parents agreed to take part in the investigation. Eight patients were excluded because of the lack of brain imaging. Thus, the rate of participation of patients was 90.8% (n = 79). No patient was lost sight of.

Of the 79 patients, there were 40 women (50.6%) and 39 men (49.4%). Average age of patients was 55.8 ± 12.6 years old, with limits of 29 and 86 years old. IBSS and HBSS rates were, respectively, 63.3 (n = 50) and 36.7% (n = 29).

Based on the 2,857 diagnosed strokes, prevalence of BSS was estimated to 2.8% (95% CI: 2.2-3.4%).

Among the 79 BSS, 71 were new cases. Crude incidence was 22.7 per 1,000 person-years (PY) (95% CI: 11- 61% o). Crude incidence by stroke type was 24.1 and 21.3%o PY, respectively, in IBSS and HBSS patients.

Recurrence was discovered in 8 patients (10.1%). The previous episode of stroke was 2 years at least. Of the 8 patients, one patient had HBSS totally regressive. The other 7

had IBSS, with hemiparesis sequelae in 6 of them and a modified Rankin score of ≤ 2 in all of them.

3.2. Clinical Data

Modifiable risk factors are shown in Figure 1.

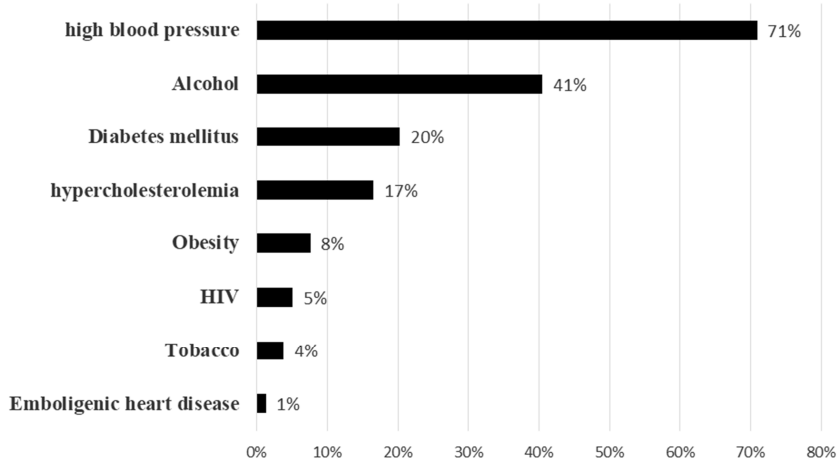

Figure 1. *Distribution of modifiable risk factors.*

Hospitalization was caused by motor deficit in 44 patients (55.7%), impairment of consciousness in 29 patients (36.7%), dysarthria in 3 patients (3.8%), headache in 2 patients (2.5%) and dizziness attacks in 1 patient (1.3%).

Disease onset was abrupt in 68 patients (86.1%) and in successive shocks during 24 hours to 7 days in 11 patients (13.9%). There was no particular schedule for symptom onset in all patients.

Hospital admission time against to symptom onset was 111 hours at least (range: 1 to 720 hours). Of the 50 IBSS patients, 3 (6%) were hospitalized within 4:30 hours and 10 (20%) before 6:00 hours. Among the 79 patients, 15 (19%) and 64 (81%) were hospitalized within 5 hours and beyond 5 hours, respectively.

At hospital admission, patients had a mean arterial pressure of 163.80/96.80 ± 28/18.5 mm Hg, average Glasgow-Liège score of 16.50 ± 4.90 and average temperature of 37.1 ± 0.6°C. Decrease of consciousness level was correlated with high arterial pressure (p = 0.019).

CT-scan was performed in all patients in the first position, unlike MRI executed in delayed time Time of CT-scan performing against to symptom onset was 4.5 days at least, with limits of 1 hour and 30 days.

According to the anatomical location, hematomas were extended in 65.5% of cases (n = 19) (Figures 2), protuberant in 20.7% of cases (n = 6) and mesencephalic in 13.8% of cases (n = 4).

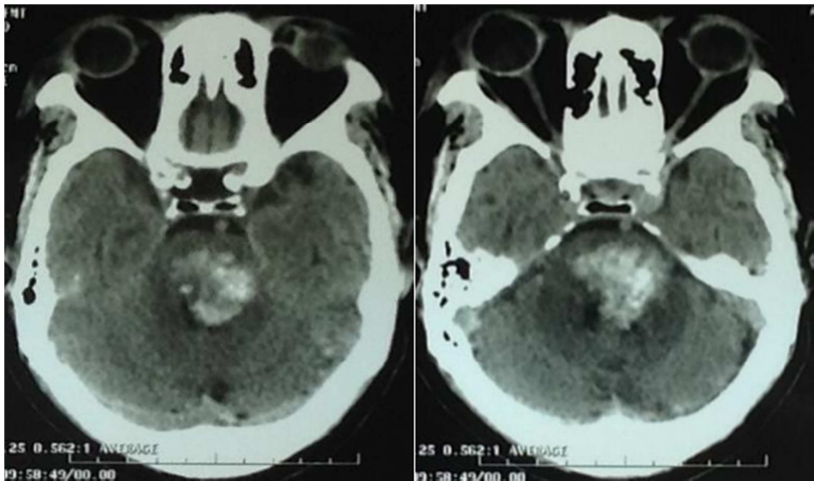

Figure 2. *CT-scan shows an extensive massive bulbo-pontic hematoma.*

The extended hematoma was initially protuberant before being extended to the bulb or mesencephalon. Of the 19 extended hematomas, 16 had encephalic complications: ventricular flood (n = 9), hydrocephalus (n = 5) and axial involvement (n = 2). Hematoma volume was < 5 ml in 17% of cases, 5 – 15 ml in 52% of cases and > 15 ml in 31% of cases. The presence of encephalic complications was correlated with hematoma volume (> 15 ml) (p = 0) and high blood pressure (p = 0.017).

Among the 50 cases of IBSS, 10 (20%) were lacuna cerebri. Affected arterial territories are shown in Table 1.

Table 1. *Distribution of affected arterial territories in patients with ischemic brainstem stroke.*

	Patients (n)	Percentage
Basilar artery	21	42
Perforating basilar trunk artery	10	20
Posterior inferior cerebellar artery	6	12
Vertebral artery	6	12
Superior cerebellar artery	3	6
Anterior inferior cerebellar artery	3	6
Anterior spinal artery	1	2
Total	50	100

Etiologies of HBSS were high blood pressure (89.6% of cases), vascular malformations (7% of cases) and coagulation disorder (3.4% of cases). According to the Toast classification, IBSS were divided into 3 classes: atherosclerosis of large arteries (58%) (Figures 3 and 4); occlusion of small vessels (38%); cardio-embolic stroke (4%). Cardiac sources of cerebral embolism were at high risk in one case (atrial fibrillation with left ventricular thrombus) and moderate risk in another one (segmental hypokinesia of the left ventricle with sinusal cardiac rhythm).

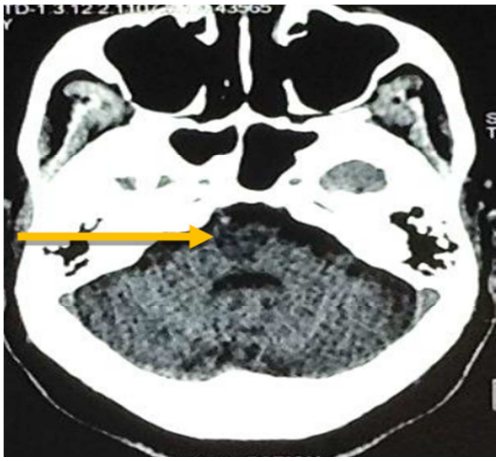

Figure 3. *CT-scan shows a bilateral paramedian bulbar ischemia attributed to damage of anterior spinal artery.*

Figure 4. *CT-scan shows a right dorso-lateral mesencephalic ischemia attributed to damage of superior cerebellar artery.*

3.3. Therapeutic Measures and Outcome

Resuscitation measures were implemented in 48.1% of cases (n = 38). They depended on the decrease of the level of consciousness and volume of hematoma (≥ 15 ml) (p = 0).

Anti-thrombotic treatment (heparin and antiplatelet therapy) was administered in ischemic patients, including those with severe motor impairment. Heparin at curative dose was administered in 2 IBSS patients with cardiac embolism. Aspirin was intravenously administered in 6 patients with occlusion of large arterial trunks. Thrombolysis or external ventricular bypass did not implemented in patients.

Motor physiotherapy and speech therapy had been indicated as early as the fifth day of hospitalization in 70 and 21 patients, respectively.

Early mortality was 24.1% (n = 19) during the first 7 days. Among the 19 deaths, we noted 10 HBSS and 9 IBSS. Early mortality was correlated with the volume of hematoma (> 15 ml) (p = 0), presence of encephalic complications (p = 0.004), high blood pressure (p = 0.04), deep decrease of consciousness level (p = 0.032).

In 1 month, no deaths were reported. We noted a general state improvement in 35 patients (24 IBSS and 11 HBSs) (58.3%), stabilization in 22 patients (15 IBSS and 7 HBSS) (36.7%) and worsening without death in 3 patients (2 IBSS and 1 HBSS) (5%).

Outcome in 1 month was correlated with hematoma volume (< 15 ml) (p = 0.001).

In 3 months, among the 60 patients, there were 3 deaths. Mortality in 3 months was correlated with occlusion or tight stenosis of large vertebrobasilar arterial trunks (p = 0.012). In 6 months, 3 deaths were recorded. 0verall mortality was 31.6%.

Outcomes in 3 and 6 months are shown in Figure 5. In 3 months, functional outcome depended on the volume of hematoma (< 15 ml) (p = 0.003) and early implementing of speech therapy (p = 0.017). In 6 months, it depended on the affected arterial territory (perforating arteries of the basilar trunk) (p = 0.034), early implementing of functional rehabilitation (p = 0.001) and speech therapy (p = 0.003).

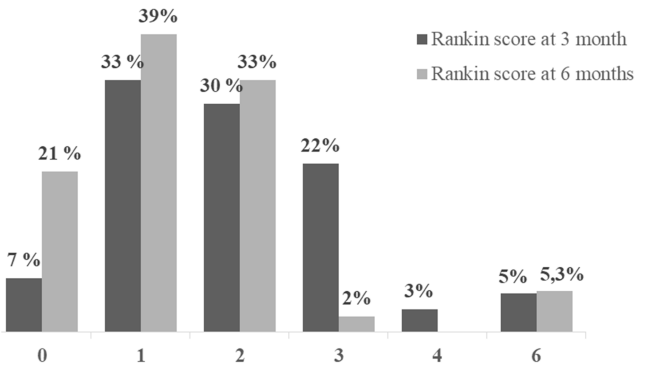

Figure 5. *Distribution of modified Rankin scores at 3 and 6 months.*

4. Discussion

4.1. Epidemiology

In the present study, BSS prevalence is in the interval reported by other investigators (1 – 10%) [1, 4, 13]. This prevalence is probably underestimated owing to the exclusion of 8 patients who had not a confirmation brain imaging, early deaths in casualty before admission of patients in the department of neurology, lack of knowledge of BSS with misleading clinical expression (during isolated symptoms or a fluctuating initial outcome) [3].

Incidence studies of BSS are very rare [14]. It is difficult to compare our data with those reported in literature which are mainly related to strokes in general [15].

In patients over 55 years old, literature reports a higher standardized annual incidence in IBSS patients than in those of HBSS [16, 17]. Our results corroborate these epidemiologic findings.

Low rate of recurrence reported in this study could be explained by high mortality that limits survivors' number.

4.2. Risk Factors

Average age of patients in our series is lower than those reported by other researchers [1, 3] and estimated at 58 and 59 years old, respectively. Our patients with a young age are subject to work-related or low income-related stress and lifestyle changes which could increase the prevalence of modifiable risk factors. In the present study, hypertension, excessive alcohol consumption and diabetes mellitus are the main modifiable risk factors. Our data confirm those of literature [1, 18, 19].

4.3. Etiologies

As reported by Raison *et al* [1], we have identified vascular malformations in patients with HBSS and discovered that hypertension is the main etiological factor of hemorrhages.

IBSS has most often cardio-embolic and atheromatous origins [7]. In our study, cardio-embolic origin is poorly represented. This finding could be explained, either by the difficulty in confirming it because of the coexistence of atherosclerosis [12], or by the completion of 24-hour ECG only in patients strongly suspected of having a cardio-embolic IBSS, despite the variable embolic risk of some patients, thus underestimating the frequency. It is essential to perform preferably a long-term ECG, ranging from 7 to 30 days, in all patients who made a large IBSS, as well as a transesophageal echography. The optimization of diagnosis of paroxystic atrial fibrillation, as well as the visualization of various cardiac abnormalities in absence of cardiac history (thrombus of left atrium, patent foramen oval and/or interatrial septal aneurysm, aortic plaques) and in sinus rhythm, would be guaranteed [20, 21].

4.4. Prognosis and Associated Factors

Prognosis of patients in our study is better than those reported in literature [1, 5, 22-24]. Prognosis was more favourable in cases of infarction and unilateral tegmental hematoma than in those of bilateral tegmental hematoma and massive hematoma. This difference could be explained by the size of lesion rather than by its location [11] and factors such as oxygenation, anti-thrombotic therapy, young age of patients and low temperature, that are associated with a better prognosis [2].

Early mortality in the present study is close to that reported by Diallo *et al* [4]. All early deaths encountered during the first week of hospitalization could be due to diagnosis delay, constraints related to diagnostic and therapeutic management, besides predictive factors of mortality such as hematoma volume, decrease of consciousness level, presence of encephalic complications and occlusion of basilar arterial trunk [1, 4, 23, 25].

At hospital admission, rate of patients with the decrease of the level of consciousness was lower than those reported in literature (40 to 80%) [1, 4, 26]. It could be probably underestimated in our series owing to patients who had multiple causes. Only the primary cause of admission was accepted. In this case, impairment of consciousness was secondary.

Occlusion or tight arterial stenosis in the vertebrobasilar territory is strongly correlated with mortality in 3 months. Studies reveal that mortality in 3 and 6 months is related to infectious complications of decubitus such as pneumonias. The latter are often related to swallowing disorders [27]. These findings could probably explain the mortality in 3 and 6 months in this cohort. Thus, early management of swallowing disorders in the acute phase of stroke is needed here.

In 3 and 6 months, literature reports that more than half of patients continue to improve significantly, progressing by one point at least on the modified Rankin scale [27]. Our results report a gain of 2 points between 3 and 6 months. The improvement of functional outcome could be explained by early functional rehabilitation. The latter improves the autonomy of patients, and thus, the quality of their future life [2].

4.5. Strengths and Weakness of Study

Absence of patients lost sight of and hold in position of all patients in Lomé during the period of study significantly contributed to the achievement of this cohort, as recommended in a qualitative epidemiological investigation of stroke [14].

In addition, although financial resources of patients were low, CT-scan and MRI were performed. These two tests that help in determining diagnosis and therapeutic orientations, are strongly recommended in a stroke investigation[27]. IBSS and HBSS are explored, respectively, by MRI and CT-scan [1, 3, 23]. In IBSS cases, exploration of sub-temporal structures by CT-scan is very imperfect [28]. One of the peculiarities of our study is the neuroimaging exploration in all patients with BSS by CT-scan in the first position and MRI performed in delayed time. We have used this procedure owing to low financial resources of patients.

Intravenous administration of aspirin in patients with ischemia, in whom thrombolysis was indicated, is the other

particularity of this study. It is an alternative to thrombolysis that is not available in SSA [5]. The small size of the sample of patients treated by aspirin and lack of controls and yield suggest that a further study of this alternative should be carried out.

Patients' low financial resources, reducing the practice of useful explorations, and insufficient therapeutic management resources (neurovascular unit, rtPA thrombolysis, intubation equipment, electric syringes, and ventricular drainage) are main difficulties.

5. Conclusions

BSS is a less common anatomo-clinical entity. Multiple factors have a clear effect on the increase of the rate of death. Factor management and early functional rehabilitation improve vital prognosis in Togo.

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Conflicts of Interest

The authors have no financial relationship relevant to this article. They have no conflicts of interest.

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