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Microsurgical Management of Intracranial Aneurysms in Côte d'Ivoire: A Series of 128 Cases

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Abstract

Introduction: The management of intracranial aneurysms in sub-Saharan Africa is essentially surgical. In this retrospective study, the authors report their experience in surgical management of intracranial aneurysm in Côte d'Ivoire. **Methods:** We carried out a retrospective study on patients operated for a ruptured or unruptured intracranial aneurysm between January 1st, 2012 and December 31st, 2018. Data on epidemiological characteristics of patients and aneurysms, treatments and patient outcomes were analyzed. **Results:** One hundred twenty eight aneurysms were operated. Sixty-six percent of the patients were female. According to the World Federation of Neurosurgical Societies (WFNS) scale, 58, 5% of patients were in grade I. Fisher scale showed 29% of Fisher 2 and 49% of Fisher 4. The aneurysms were mainly located on the internal carotid artery in 38% and anterior complex in 36%. The average size of aneurysms was 6.5 mm. In 81.4% the size of the aneurysms was less than 10 mm. Most aneurysms (90%) were treated at late stage. According to the modified Rankin Scale, 92 patients (83%) had good outcome, 7 patients (6%) had poor outcome, and the mortality rate was 11%. **Conclusions:** This study shows encouraging results if we refer to the overall post-operative results. However, there is a sub-diagnosis and low treatment rate of ruptured intracranial aneurysms. The improvement of intracranial aneurysms management requires improving the standard of health in the country.

Keywords

Intracranial Aneurysm, Microsurgery, Cote d'Ivoire, Subarachnoid Haemorrhage

1. Introduction

Microsurgery which has been for a long time the only treatment of intracranial aneurysms has been supplanted by endovascular treatment since the results of

the International Subarachnoid Aneurysm Trial (ISAT) [1]. Currently endovascular treatment has become by far the first-line treatment of the great majority of ruptured and unruptured intracranial aneurysms. Some authors mention the end of surgical treatment of intracranial aneurysms [2].

In most sub-Saharan African countries, microsurgery remains the main treatment of intracranial aneurysms because of the unavailability of endovascular treatment. In most time, this microsurgery involves clipping or wrapping. Rarely other techniques including trapping or proximal artery occlusion by surgical ligation are performed. The timing of microsurgery after aneurismal subarachnoid haemorrhage is controversial.

In Côte d'Ivoire, a developing country in West Africa, surgery remained the only treatment of intracranial aneurysms until 2018, when endovascular treatment became part of the therapeutic arsenal in treatment of intracranial aneurysms in the country.

In this paper, authors reported the epidemiological characteristics of their patients, the characteristics of aneurysms and the result of their management.

2. Patients and Methods

We carried out a retrospective study on patients operated for one or more ruptured or unruptured intracranial aneurysm whom underwent microsurgical treatment of their aneurysm between January 1, 2012 and December 31, 2018. Of the 160 patients treated for intracranial aneurysm, 111 were retained. Other files were incomplete. Each patient had at least a CT head scan for the diagnosis of intracranial haemorrhage and CT angiography for the diagnosis of intracranial aneurysm. For each patient, data on age, sex, World Federation of Neurological Surgeon (WFNS) score at admission, Fisher grade, seat and size of the aneurysms, associated evolutionary complications (hydrocephalus, vasospasm, rebleeding), type of surgical treatment used, and quality of patient survival (assessed by Modified Rankin Scale at 1 year) were analyzed. The data collection and the making of graphs were made from excel. Statistical analyzes were performed on SPSS version 22.

3. Results

According to the protocol, 111 patients with 128 operated aneurysms were selected.

Age and sex

Men accounted for 34% of patients versus 66% for women. The age of the patients ranged between 13 and 78 years old with a mean age and a median age of 46 years (**Figure 1**).

Aneurysms characteristics

A total of 128 aneurysms were diagnosed including 107 ruptured aneurysms and 21 unruptured aneurysms. These aneurysms were multiple in 15 patients (13.5%). Aneurysms were present in the anterior cerebral circulation in 98.5% and in the posterior cerebral circulation in 1.5% (**Table 1**).

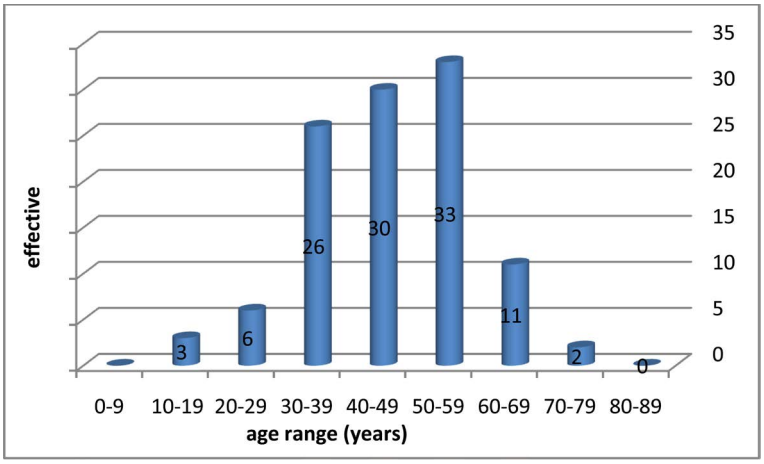

Figure 1. Distribution of patients according to the age.

Table 1. Distribution of aneurysms by anatomic location.

	Right	Midline	Left	Total
Anterior cerebral artery				
Anterior communicating artery		33		33
Proximal to anterior communicating	3		3	6
Pericallosal	4		3	7
Subtotal	7	33	6	46
Internal carotid artery				
Proximal or ophthalmic region	1		3	4
Posterior communicating region	25		17	42
Bifurcation	2			2
Cavernous internal carotid	1			1
Subtotal	29		20	49
Middle cerebral artery				
Bifurcation	16		10	26
Distal to main bifurcation	3		2	5
Subtotal	19		12	31
Posterior circulation				
Basilar bifurcation		1		1
Posterior cerebral artery	1			1
Subtotal	1	1		2
Total	56	34	38	128

Of the 107 ruptured aneurysms, 33 were located in the anterior communicating artery, 32 were located in the internal carotid artery and 27 in the middle cerebral artery. Aneurysms were sacciform in 123 cases (96%) versus 5 fusiform aneurysms (4%).

The average size of the aneurysms was 6.5 mm with extremes of 2 and 27 mm. The size of the aneurysms was less than 10 mm in 81.4% of cases and 2 cases of giant aneurysm (size greater than 25 mm) were operated.

Preoperative condition

The WFNS grade is shown in the histogram below with a clear predominance of grade 1 (58.5%) (Figure 2).

Cerebral CT scan was able to classify the patients according to Fisher score with a clear predominance of grade 4 (Figure 3).

The WFNS score at the time of surgery was 0 in 4 patients, 1 in 94 patients, 2 in 4, 3 in 8 and 4 in 1 patient.

Timing of surgery and overall surgical result

The average time between rupture and surgical exclusion was 31 days with a range from 1 to 180 days. One hundred and fifteen (90%) aneurysms were treated 8 days or more after rupture. Only ten aneurysms (8%) were operated within 72 hours and 3 (2%) between 4 and 7 days after aneurysmal rupture. While waiting for surgical treatment 14 (12.6%) patients survived rebleeding, 17 (15.3%) cases of acute and chronic hydrocephalus were observed, 2 cases of delayed ischemia.

Surgical treatment consisted of clipping in 118 (92%) aneurysms versus 10 (8%) wrapped aneurysms.

During surgery 20 cases of intraoperative aneurysm rupture occurred. Immediate postoperative complications occurred in some patients. Six (5.4%) operative

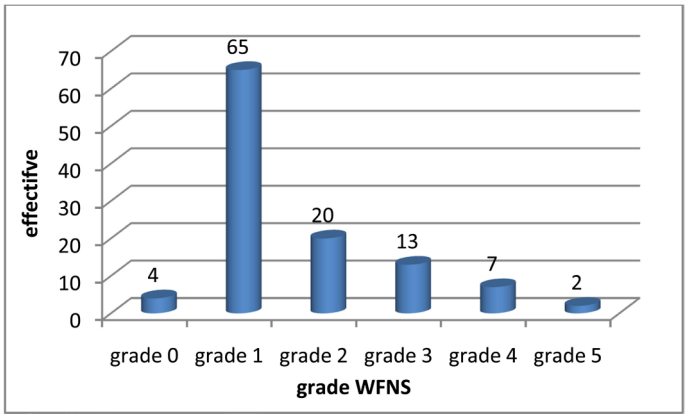

Figure 2. Distribution of patients according to the WFNS score.

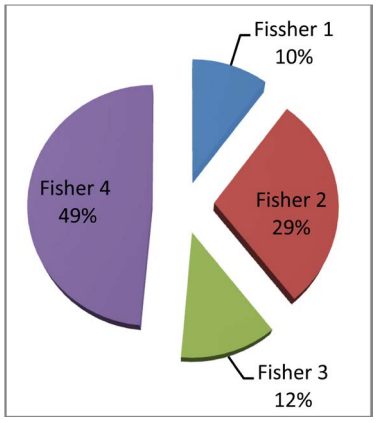

Figure 3. Distribution of patients according to the Fisher score.

revisions were performed for early postoperative complications, including 4 extradural hematomas and 2 cases of malignant cerebral oedema.

CT angiography after microsurgery was performed in 61 patients with clipped aneurysms and revealed complete exclusion in all cases.

A good mRs (modified Rankin Scale) score was observed in 92 (83%) patients, a poor score in 7 (6%). The mortality rate was 11%, *i.e.* 12 patients (Table 2).

No case of rebleeding occurred after at least 1 year follow-up.

Sequel of epilepsy was observed in 5 (4.5%) patients.

4. Discussion

Although there are very few publications about intracranial aneurysms in Africa, particularly in sub-Saharan countries, intracranial aneurysms are not uncommon [3] [4] in this part of the word. Surgery remains the only therapeutic modality available in several African countries.

Age and sex

Our study population consisted mainly of young adults with an average age of 46 years. Thioub *et al.* found in their study, in Senegal, an average age similar to ours (45.9 years) [3]. The average age of patients in the ISAT study was 52 years [1]. The average age of our patients is lower than those of the ISAT study (t = −5.135, ddl = 110, confidence interval −8.47 to −3.75 95%). In our series the peak of incidence is reached a decade rather (4th and 5th decades) than in most studies where this peak is between the 5th and 6th decade [1] [5] [6] [7]. This could be explained in part by the characteristics of the Ivorian population:

- essentially young population,
- low life expectancy (ranging from 46.6 years in 2000 to 53.5 years in 2016) [8].

A predominance of females is generally reported in most studies [6] [7] [9]. It was also observed in ours (66%). ISAT study found 37% of male and 63% of female [1].

Britz Gavin, W. *et al.* reported a clear predominance of female (66.3%) in their study [10].

Table 2. Patients outcomes according to WFNS score.

WFNS at admission	Good outcomes (mRS 0 - 2)	Poor outcomes (mRS 3 - 5)	Mortality; n
0	3	1	0
I	54	5	6
II	17	0	3
III	11	0	2
IV	5	1	1
V	2	0	0
TOTAL	92	7	12

WFNS, World Federation of Neurosurgical Societies.

Several explanations of the female predominance of aneurysmal subarachnoid haemorrhage have been discussed in the literature. Because the incidence is highest in women after menopause, it has been suggested that female sex hormones may play a key role in the formation and growth of intracranial aneurysms [11] [12] [13]. According to Okamoto *et al.* [13] the occurrence of menopause at a relatively low age and/or nulliparity are associated with an increased risk of subarachnoid haemorrhage, including aneurysmal rupture, in contrast a high number of pregnancies and multiparity would be protective factors. This phenomenon is explained by the high level of progesterone during pregnancy, which causes progesterone-oestrogen ratio in favour of progesterone. Early menopause and nulliparity are associated with elevated estradiol levels. Oestrogen promotes elevated blood pressure and decreased vascular resistance. It is clear therefore that progesterone is a protective element against the risk of vascular injury. It is thus understood that the drop in her rate after menopause exposes the woman to vascular lesions in general and particularly to subarachnoid haemorrhages by aneurismal rupture. This explains the female predominance of subarachnoid haemorrhage by aneurysmal rupture after the age of menopause.

Aneurysm Characteristics

Aneurysm locations

The international subarachnoid aneurysm trial (ISAT) found that 95% of aneurysms were located in the anterior cerebral circulation [1]. In our series 98.5% of the operated aneurysms were located in the anterior cerebral circulation. This could be explained by the fact that the aneurysms of the posterior cerebral circulation, which are easily amenable to endovascular treatment, have been rejected by surgery. The distribution of ruptured aneurysms according to their location varies according to the studies. In our series, the ruptured aneurysms that we operated were as much found in the anterior communicating artery as in the internal carotid artery. The predominant seat of ruptured aneurysms varies according to studies. However, most studies like ISAT [1] and Thioub study [3] report a predilection at the anterior communicating artery.

Form of aneurysms

We observed a high prevalence of sacciform aneurysms 96% against only 4% for fusiform aneurysms. Thioub *et al.* reported 92.3% of sacciform aneurysms and 7.7% fusiform aneurysm in their series [3].

Size of aneurysms

Many studies have attempted to determine a critical size at which an aneurysm is likely to rupture and thus justify its treatment.

In our series, the average size of aneurysms was 6.5 mm. The sizes of the aneurysms were less than 10 mm in 81.4%. Thioub *et al.* observed that 73% of operated aneurysms were smaller than 10 mm [3].

Preoperative condition

The major clinical manifestation of intracranial aneurysms is subarachnoid haemorrhage, which is the first manifestation in more than 90% of cases [14].

This aneurysmal rupture with onset of intracranial haemorrhage was the most common finding (96.5%) in our series.

Timing of surgery and overall surgical result

Despite the progress made in the surgery of intracranial aneurysms, there is no consensus about the optimal time for performing this surgery in order to obtain the best results in ruptured aneurysm. The work of Nieuwakamp, D.J. *et al.* [15] and Zhao, C. *et al.* [16] failed to prove the influence of surgical timing on patient outcomes. Yao, Z. *et al.* [17] in their study observed that early surgery was superior to late surgery in reducing a poor outcome and death rate when patients were in good condition on admission, and decreased the incidence of poor outcome when patients were in poor condition on admission.

The majority of our patients were operated at the late stage for several reasons:

- delayed diagnosis especially for late consultation,
- financial difficulty because there is no national social security and care is in most cases the responsibility of the patient,
- the current protocol in our service recommends to operate the patient either within 3 days following the rupture or beyond the 15th day.

We recommend early surgery to prevent early rebleeding especially since it does not seem harmful to the patient.

Aneurysm surgery

Most authors, like Lafuente [6] and Thioub [3], report that clipping is by far the most commonly surgical technique used in intracranial aneurysm surgery. This technique was used in 92% of the aneurysms we treated.

5. Conclusions

This study shows encouraging results if we refer to the overall postoperative results. However, there is a sub-diagnosis and a low treatment rate of ruptured intracranial aneurysms because of the weakness of the country's health system.

The improvement of intracranial aneurysms management requires the establishment of national social coverage and improvement of the technical platform of the health structures in the country.

Conflicts of Interest

The authors declare that the article content was composed in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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