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ORIGINAL PAPER

# Pediatric intracranial aneurysms in Senegal: a series of 10 cases treated in unfavorable socio-economic conditions

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## Abstract

**Objective** The aim of this study is to show the characteristics of pediatric intracranial aneurysms in a sub-Saharan country and to analyze the results of treatment in this challenging medical environment.

**Method** The authors reviewed retrospectively ten patients ≤ 18 years old between May 2013 and December 2016 in Neurosurgery department of Fann Hospital in Dakar. For each child, clinical features, radiological findings, and outcome were determined with mean follow-up of 22 months.

**Results** Ten children were treated for intracranial aneurysm including four boys and six girls. Two patients had evolutive infectious endocarditis with rheumatic heart disease at the time of diagnosis. Neurological signs of deficiency were present in six patients (WFNS ≥ 3).

The diagnosis of aneurysm was made by CT angiography in all patients, and in two of them respectively arteriography and angioMRI were performed in complement. The aneurysm was on the middle cerebral artery in six patients, on the internal carotid artery in two others, anterior communicating artery in another, and the last one was located on the anterior cerebral artery on its 3rd segment. The treatment of the aneurysm was surgical in seven patients and endovascular in one of them. The postoperative course was excellent in two patients and good in the five patients. No postoperative worsening was noted. One child died 4 months in the postoperative course from acute cardiac deterioration.

**Conclusions** In Senegal, pediatric aneurysms represent about 8.3% of all intracranial aneurysms. They are most often located on the MCA and have commonly fusiform shape. Despite difficult treatment conditions, overall outcome was good.

**Keywords** Children · Intracranial aneurysm · Sub-Saharan Africa

## Introduction

Intracranial arterial aneurysm is rare in children and adolescents [8]. Aneurysms in pediatric population (18 years old or less) represent 1–5% of all intracranial aneurysms [1].

Clinical manifestations are atypical compared to those of adults. Fusiform and giant forms are more frequently found than in adults. The internal carotid ending artery is the preferential site [10, 12, 14].

The prognosis is largely related to the pathogenic mechanism.

Surgery remains the preferred treatment for intracranial aneurysms in children [16].

In sub-Saharan Africa, the management of intracranial aneurysms is still fragmentary and in many countries, it is absent. The poverty and the absence of arteriography makes this pathology challenging. Thereby, there are few publications concerning vascular aneurysmal pathology and even fewer in pediatrics.

Senegal is a poor country in West Africa with a population of 15 million people.

There are three hospitals with neurosurgery unit all located in Dakar, the capital. Fann Hospital is the largest of them, where all aneurysms are treated. There is no arteriography, and surgery is the only option for treatment.

The aim of this work is to show the characteristics of pediatric intracranial aneurysms and the treatment results in such difficult conditions.

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We report ten observations of intracranial arterial aneurysms in the pediatric population reviewed between May 2013 and December 2016 at the Neurosurgery department of Fann University Hospital in Dakar, Senegal.

## Patients and method

University Fann Hospital in Dakar (Senegal) has a prospective database for all intracranial aneurysms treated in the Neurosurgical unit since May 2013.

From this database we retrospectively reviewed all cases of patients ≤ 18 years treated between May 2013 and December 2016.

During the same period, 120 patients were hospitalized for cerebral aneurysm and 102 of them were operated in the same department.

For each child, the clinical presentation, radiological data, treatment modalities, and evolution were evaluated.

The initial clinical presentation was assessed using the World Federation of Neurosurgical societies (WFNS) scale.

The Fisher classification [4] was used for the patients diagnosed with subarachoid haemorrage (SAH) at CT scan.

Size and location of the aneurysms were specified by CT angiography and/or arteriography.

The etiology of the aneurysm was researched according to the clinical context.

The aneurysm treatment modality (surgical or endovascular) was reported.

The outcomes was evaluated with the modified Rankin scale [15] (mRS 0–2 was considered as good outcome, mRS 3–5 as poor outcome).

The average follow-up was 22 months.

## Results

Ten children were treated for intracranial aneurysm including four boys and six girls. The youngest was 5 years old and the oldest 18 years old (average age, 14.1 years).

Five children were normally attending school before.

Two patients had evolutive infectious endocarditis with rheumatic heart disease at the time of diagnosis and a history of head trauma two weeks before SAH was associated with a single case.

Six patients had been received with an evident hemorrhage.

According to the WFNS scale six patient were grade 3 and more.

One patient was in a coma at the time of diagnosis.

The interval between the onset of symptoms and admission in our department varied between 1 day and 3 months.

Traumatic etiology concerned one case and the infectious origin was strongly suspected in four others.

The diagnosis of aneurysm was made by CT angiography in all patients, and in two of them respectively arteriography and angioMRI were performed in complement.

The most common location of aneurysm in our series was on the middle cerebral artery (MCA) (six cases). Of the four remaining, two were on the internal carotid artery (ICA), one on the anterior cerebral artery (A3), and one on the anterior communicating complex. One MCA aneurysm was giant and partially thrombosed measuring 43 mm (Fig. 1).

A posttraumatic aneurysm was diagnosed 14 days after severe head trauma. The patient was re-hospitalized with a Glasgow score of 7, whereas he was almost asymptomatic after the first hospitalization (Fig. 2).

The size of the aneurysms varied between 5 and 43 mm.

Two patients had preoperative ischemia to CT scan, but no imaging confirmed vasospasm.

For the treatment seven patients underwent surgery, and consisted of endovascular in one case. Another died at the inducts of anesthesia, and the family refused any treatment in one case.

The giant aneurysm was treated by a clip reconstruction followed by evacuation of the thrombus and excision of a part of the sac.

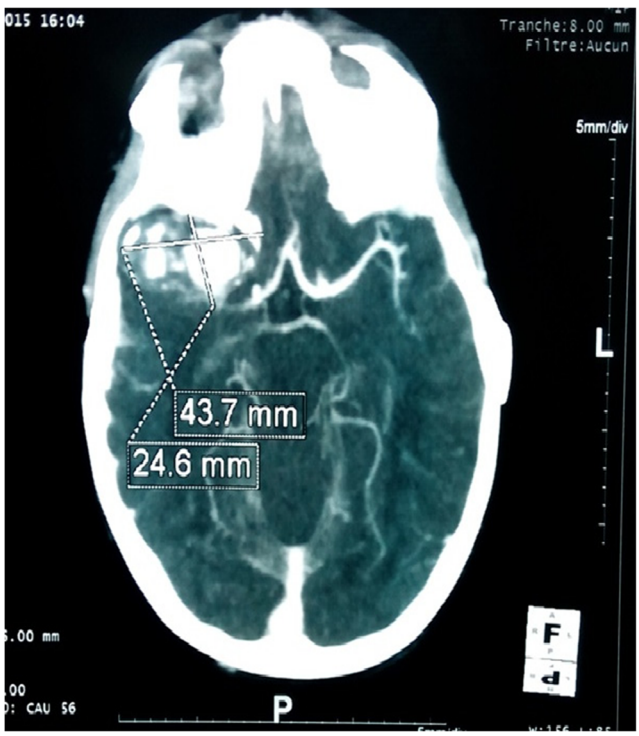


**Fig. 1** Right giant MCA aneurysm partially thrombosed in a 5-year-old boy (case 1)

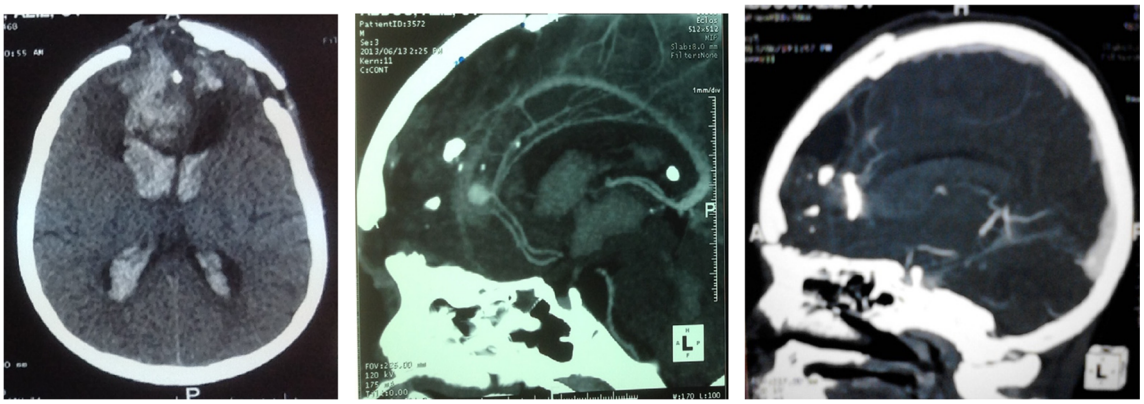


**Fig. 2** (Case 3) Bifrontal and intraventricular hemorrhage 2 weeks after high-energy head trauma (**A**), CT angio showed left ACA aneurysm (**B**), CT control after microsurgical clipping (**C**)

The outcome was excellent for two patients and good for five. No postoperative worsening was noted. One child died 4 months in the postoperative course from acute heart failure. (See summary in Table 1).

Four patients continued normal education. The patient with traumatic aneurysm could not pursue his schooling due to memory problems.

## Discussion

Intracranial arterial aneurysms are rare in pediatric pathology [1, 10, 14].

The first series of intracranial aneurysms in children was published in 1965 by Matson [11]. Then other series [9, 13, 16] followed in the USA and in Western Europe always characterized by a constant low rate. Thus, the largest series, published by Patel and Richardson [13] in 1971, consisted of 58 patients in 24 years; Sanai and al reported in 2006, a series of 32 patients collected in 26 years.

These figures represent between 0.5 and 4.6% in all series.

We collected ten patients over a 3-year period.

Proust and Koroknai-Pal describe a male predominance in their series, which is in contradiction with our results which finds a female predominance with a sex ratio of 2:3. The average age of our pediatric population was 14.1 years with extremes of 5–18 years, which gets closer to the large series of Koroknai-Pal which was 14.5 years with extremes of 3 months and 18 years. The proportion of aneurysm rupture in patients under 20 years of age is about 3.5% and it decreases to 1% in those under 15 years [10].

The most common presentation of pediatric aneurysms is subarachnoid hemorrhage, which may be associated with cranial nerve palsy in giant aneurysms [6].

Four children had no sign of evident hemorrhage. For two of them, presentation was cerebral ischemia but the cerebral scan was respectively done 1 month and 3 months after the onset of symptoms. We think they bleed but the CT has been done after the resorption of the hemorrhage.

The third was hospitalized for a motor deficit related to a giant-thrombosed MCA aneurysm with ischemia on the CT scan. Probably, it is a stroke by migration of thrombus. The last one (case 10) was incidental aneurysm. A CT scan was performed for chronic headaches.

**Table 1** Summary of patients characteristics

| Case | Age/sex | WFNS | Fisher | Location | Aneurysm shape | Size | Treatment | Outcome |
|---|---|---|---|---|---|---|---|---|
| 1 | 5 years/M | 3 | 1 | MCA | Saccular | Giant, 43 mm | Clip | mRS 1 |
| 2 | 11 years/F | 3 | 1 | MCA | Fusiform | 7 mm | Wrapping | mRS 2 |
| 3 | 16 years/M | 4 | 4 | ACA | Saccular | 6 mm | Clip | mRS 2 |
| 4 | 16 years/M | 1 | 2 | ICA | Saccular | 6 mm | Endovascular treatment | mRS 0 |
| 5 | 17 years/F | 3 | 4 | ICA | Saccular | 15 mm | Clip | mRS 1 |
| 6 | 18 years/F | 3 | 4 | MCA | Fusiform | 6 mm | Clip + wrapping | mRS 3 |
| 7 | 13 years/F | 1 | 4 | MCA | Saccular | 4 mm | Wrapping | Death |
| 8 | 14 years/F | 1 | 4 | MCA | Fusiform | 5 mm | Death at induction of anesthesia | |
| 9 | 15 years/M | 3 | 2 | MCA | Fusiform | 9 mm | Clip reconstruction | mRS 2 |
| 10 | 16 years/F | 1 | 1 | AcoA | Saccular | 7 mm | Refusal of treatment | |

The prevalence of multiple forms is quite high in children; in a study published in 2012 by Mehrotra and another in 2013 by Garg, there were respectively 73 aneurysms for 57 patients and 74 aneurysms for 62 patients [6, 12]. Multiple aneurysms are twice more common in the pediatric population than in adults, and are usually dysmorphic.

Giant aneurysms are also strongly described in children; this was the subject of one of our patients with 43 mm of size and located on the middle cerebral artery.

The key examination for preoperative diagnosis is the same as in the adult population, the cerebral arteriography, otherwise CT angiography [14] can be used, the latter being very irradiating should not be used repeatedly in children under 5 years of age. All our patients have benefited from a CT angiography and only one of them from a cerebral arteriography which does not exist in Senegal. So this arteriography has been done in Morocco.

Much of authors agree on the preferential location of pediatric aneurysms, which is the internal carotid artery ending found between 24 and 50% of cases, followed by the middle cerebral artery as described by Ferrante [3]. In 50% of cases, aneurysm is located on the M2 segment [14]. In our series, all the aneurysms found were located on the anterior arterial circulation and 60% of them on the middle cerebral artery.

In our series, infectious etiology was predominant; Gueye in his study of 30 aneurysms has already described mycotic predominance [7].

Treatment depends on the anatomy of the aneurysm, but Drake described a more aggressive attitude for the unruptured aneurysms [2]. The spindle and giant forms must be trapped with or without bypass since they are better tolerated by children [5, 16], 80% of our patients have benefited from surgical clipping.

Authors describe excellent results after treatment with a GOS ≥ 5 between 60 and 80% of patients [5, 14]. In our series, we obtained 70% of modified Rankin scales 1 and 2 despite serious initial presentations and low socio-economic conditions.

For the patient with endovascular treatment, the outcome was excellent as mentioned in Table 1. He was neurologically intact after treatment.

There is a collateral system very effective in children and a great neuroplasticity allowing them a good tolerance to vasospasm.

Two patients died. The first one on the operative table before incision probably from cardiac failure. The second died 4 months after aneurysm treatment from her cardiac disease.

## Conclusion

In Senegal, pediatric aneurysms represent about 8.3% of all intracranial aneurysms.

They are most often located on the MCA and have commonly fusiform shape.

Microsurgery is the only available treatment with good outcomes despite socio-economic unfavorable conditions.

However long-term follow-up is warranted because of the possibilities of recurrence.

## Compliance with ethical standards

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

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