



Management of Intracranial Arteriovenous Malformations: Experience of the Neurosurgery Department of Specialty Hospital-Rabat

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cerebral arteriovenous malformations (cAVM) constitute an uncommon but serious neurovascular pathology due to the hemorrhagic risk linked to the natural evolution of the disease. Cerebral arteriovenous malformations (AVMs) are often revealed in young adults by several types of neurological symptoms, including epileptic seizures, recurrent headaches, progressive neurological deficits, or intracranial hemorrhages. The aim of this study is to report the experience of the neurosurgery department at the Specialty Hospital in RABAT, covering 30 consecutive cases of

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cerebral AVM treated surgically in our department. Highlight the epidemiological and semiological profile of this pathology; highlight the benefit of microsurgical treatment, as well as certain prognostic factors compromising the therapeutic result. This is a retrospective study of 30 cases of operated arteriovenous malformation collected over a period of 5 years in the neurosurgery department of the Specialty Hospital in RABAT.

The total number of our patients is 30. The average age of patients is 40.5 years, with extremes of 16 years and 65 years. Among the 30 patients, 19 are male and 11 are female, for a sex ratio of 1.72. The average time to diagnosis was 3 months. Clinically, the main symptom remains headaches. Symptomatic treatment includes analgesic and antiepileptic treatments. Curative treatment is based on neurosurgery, embolization, and radiosurgery. The evolution was favorable in 91.6% of cases, with total recovery in 45.45% of cases, while 54.5% of cases retained after-effects such as motor deficit.

Keywords: Neurosurgery; ventricular hemorrhage; focal deficits.

1. INTRODUCTION

- Cerebral arteriovenous malformation (cAVM) is a congenital lesion generally consisting of a cluster of abnormal vessels (the "nidus") that have formed around one or more arteriovenous shunts located in the cerebral vascular network. [1]
- 14 per 10,000 individuals (0.14%) and appear at any stage, with a peak frequency between 30 and 40 years [2,3,4].
- The most common clinical presentations of cAVMs are intracranial hemorrhage, epilepsy, chronic headaches, and focal deficits [2,5].
- Management involves monitoring, microsurgical treatment, endovascular treatment, and radiosurgery [1].
- The aim of this work is to report our experience and study the different

epidemiological, diagnostic, therapeutic, and evolutionary aspects of this anomaly.

2. MATERIALS AND METHODS

- This is a retrospective descriptive study of 30 patient cases admitted for a cAVM, carried out in the neurosurgery department at the Rabat Specialty Hospital, over a period between 2019 and June 2023.
- For each patient, the following variables were studied:
 - Epidemiological data.
 - Clinical and paraclinical information,
 - Therapeutic and progressive modalities.
- The study included all patients who were hospitalized in the department for the management of a cAVM.

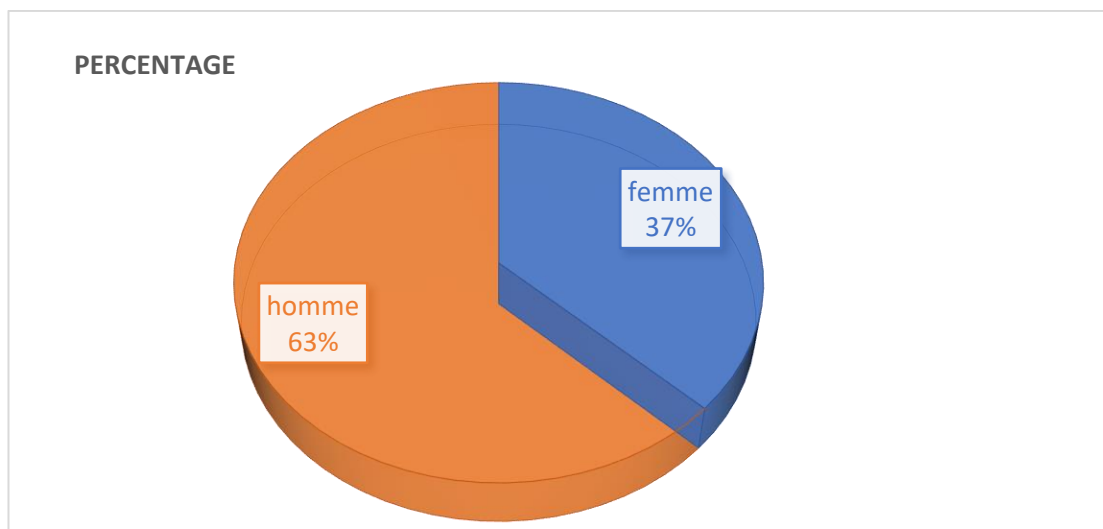
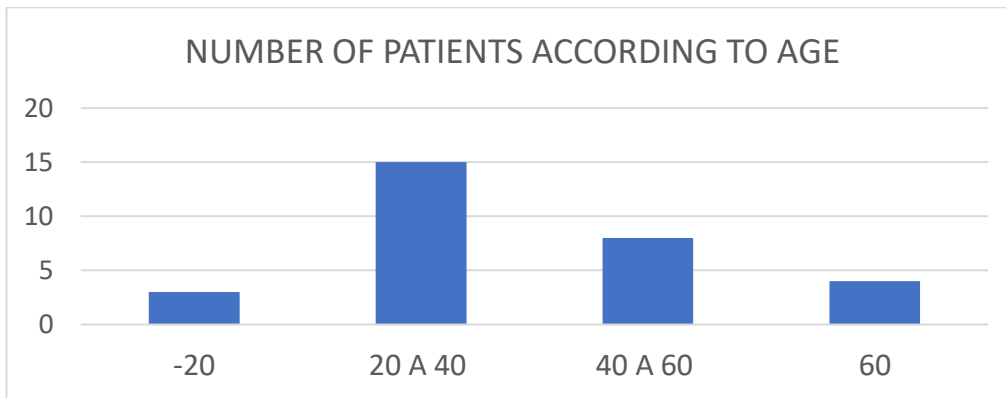


Chart 1. Distribution according to sex



Graph 1. Distribution according to age group

Table 1. Distribution of patients according to clinical data

Clinical data	Number and % of patients
Headache	30(100%)
Disturbance of consciousness	15(50%)
Seizures	8(26.66%)
Motor signs	15(50%)
Aphasia/slow speech	5(16.66%)
Cranial nerve compression	6(20%)
Vision problems	2(6.66%)
Sensitive signs	1(3.33%)
Cerebellar SD SC	1(3.33%)

3. RESULTS

- During the study period, 30 patients presented a cAVM, representing a frequency of 6.6 cases per year. The average age of onset was 32 years.
- A sex ratio of 1.72 (19 men to 11 women).

4. RADIOLOGICAL EXPLORATION

- **Brain computed tomography (CT)** was carried out in 95.8% of cases.

It showed signs in favor of a cerebral hemorrhagic accident in 25 patients, or 83.33%, including 79.2% having isolated or associated cerebral hematomas and 9.52% having isolated ventricular hemorrhage.

It revealed hydrocephalus in two cases.

Cerebral arteriography :

- Confirmation of the diagnosis in 100% of cases.

- The AVMs were of superficial location in 75% of cases compared to 25% of deep location and of lobar location in 80% of cases, i.e., 24 cases, 12.5% of cases at the level of the posterior cerebral fossa, and 7.5% of cases. at the level of the basal ganglia.
- The size of the nidus varies between 1 and 5 cm.
- The cAVM is supplied mainly by the middle cerebral artery in 50% of cases, the anterior cerebral artery in 33.3% of cases, and the vertebro-basilar system in 16.7% of cases.
- Venous drainage of the nidus was superficial in 71.4%, deep in 23.8%, and combined in 4.8%.

Table 2. According to the classification of Septzler and Martin, the AVMs in our series are classified as follows

Grade	Effective	Frequency
Grade I	1	3.33%
Grade II	8	26.66%
Grade III	19	63.33%
Grade IV	2	6.66%
Grade V	0	0%
Total	30	100%

5. THERAPEUTIC SUPPORT

- The support arrangements were based on two components:

Symptomatic treatment includes analgesic and antiepileptic treatments.

Curative treatment based on neurosurgery, embolization, and radiosurgery.

- 16 patients, or 53.33%, benefited from surgical treatment with total excision of the cAVM.
- 4 patients only had evacuation of the hematoma since the AVM was deep in location.
- Embolization was carried out in 7 patients 24 hours before the surgical procedure, i.e., 23.33% of cases.
- Radiosurgery occurs in 36.66% of cases.

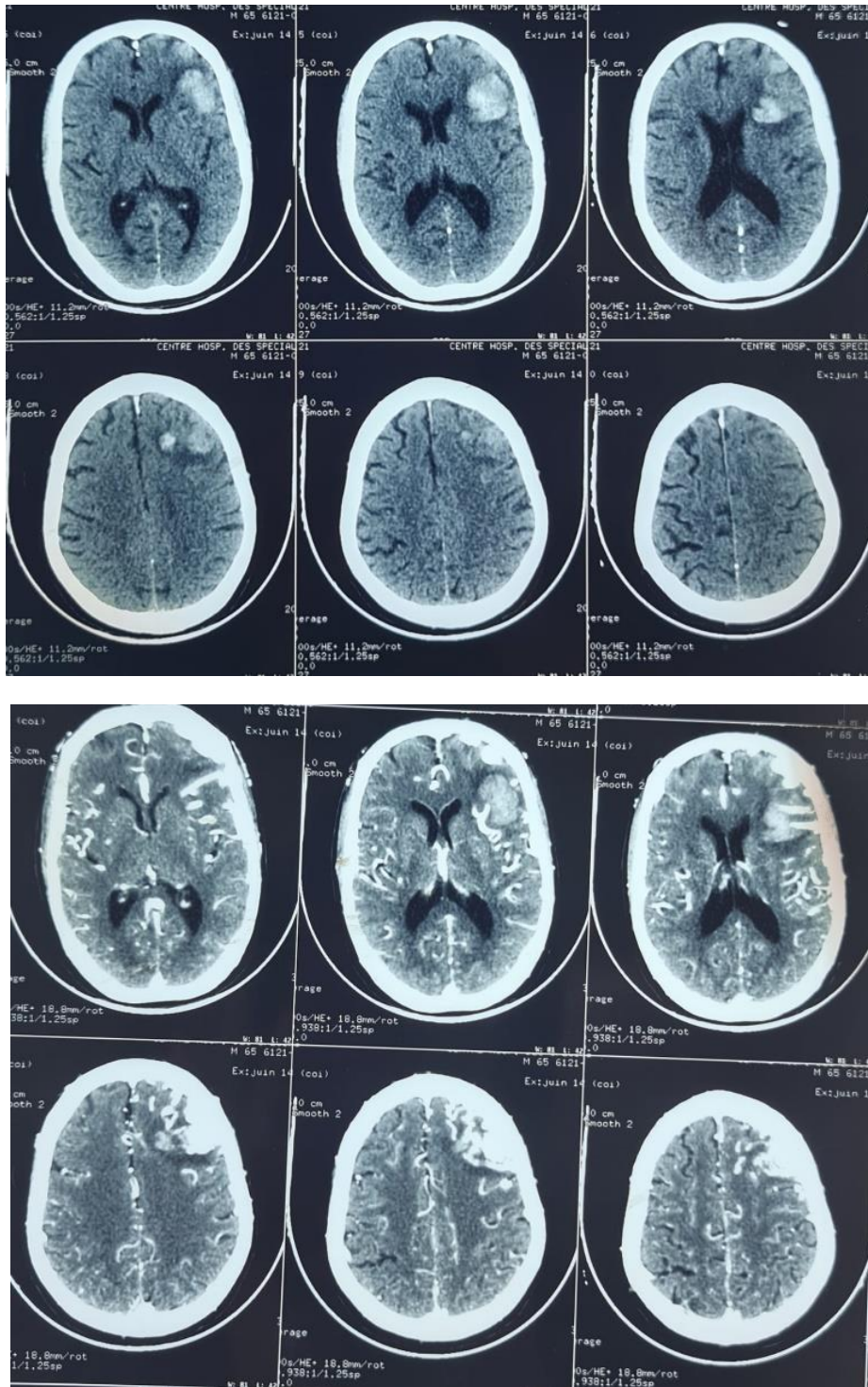


Fig. 1. Brain CT with angiographic sequences showing a left frontal AVM



Fig. 2. Right frontal AVM subtotally embolized preoperatively

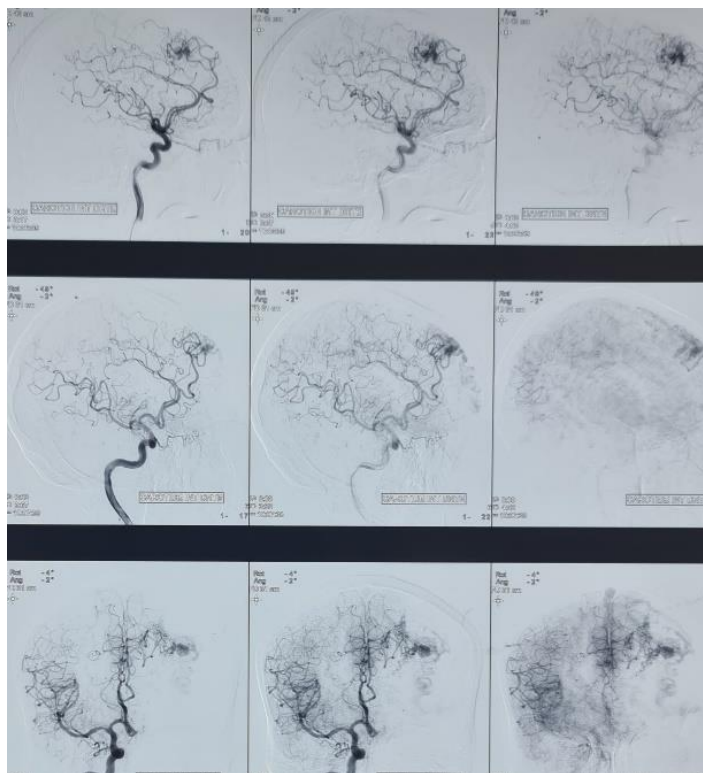


Fig. 3. Cerebral angiography showing a left frontal AVM

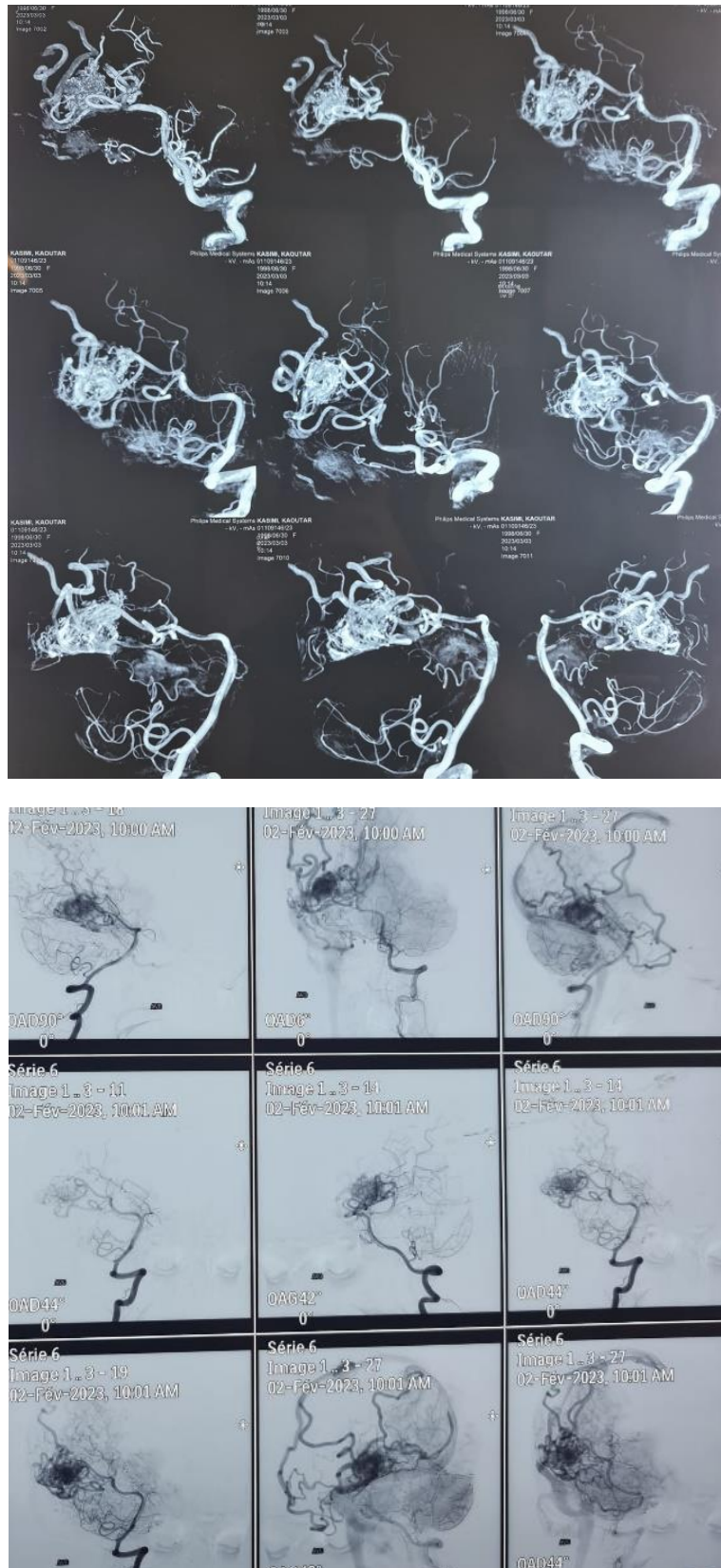


Fig. 4. Cerebral angiography, which shows a grade 2 right temporal AVM according to the Spetzler-Martin classification

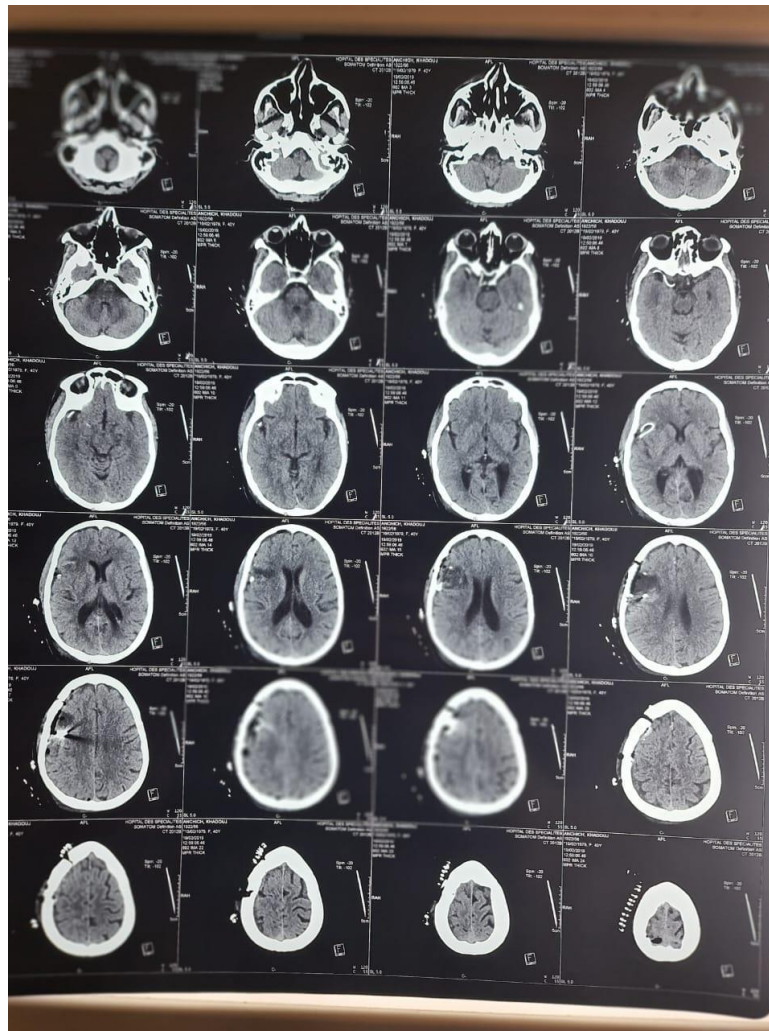


Fig. 5. Postoperative cerebral CT of an excision of a right frontal AVM operated 24 hours after embolization

6. EVOLUTION

- The evolution was favorable in 91.6% of cases, with total recovery in 45.45% of cases, while 54.5% of cases retained after-effects such as motor deficit.
- Complications were recorded in 8.4% of cases: postoperative meningitis in one patient and a sensorimotor deficit of the hemibody in the other.

7. DISCUSSION

- AVMs have an incidence that varies between 0.89 and 1.34/100,000 per year.
- The prevalence is estimated at 0.94 per 100,000 inhabitants per year and a frequency of 14 per 10,000 individuals [6].

- They often become symptomatic in young adults between 30 and 40 years old, according to Stapf et al. [2].
- In a retrospective study of 701 patients, the average age was 31 years, which agrees with the average age in our series [7].
- AVMs are often revealed in young adults by several types of neurological symptoms.
- Intracranial hemorrhage is the most common mode of clinical presentation, with a frequency between 30% and 82%; in our series, we noted a frequency of 83.33% [2,8,5].
- The annual bleeding rate is estimated between 2% and 4% (Ondra et al., 1990; Kondziolka et al., 1995; Brown 2000) [2,5,9]. Itoyama et al. found that the risk of rebleeding after a first hemorrhagic episode is 6.9% in the first year, 1.9% per

- year after 5 years, and 0.9% after 15 years [9,10].
- Recent longitudinal analyses suggest that, apart from the criterion of initial hemorrhage, other topographical, angio-architectural, and hemodynamic factors positively influence the hemorrhagic risk of an AVM [10,11].
 - The angioarchitectural factors are: Deep location, unique deep venous drainage, presence of intra- or juxta-nidal aneurysms, small size of the nidus, presence of venous stenosis, and presence of venous reflux.
 - The hemodynamic factor is represented by high pressure in the afferents and efferents of a cAVM [2,7,12].
 - Several recent studies suggest that the morbidity and mortality of ruptured cAVMs are lower than those of other causes of hemorrhage, and only 2% of all intracranial hemorrhages are related to ruptured cAVMs [7,5,13].
 - Intracranial hemorrhage most often conditions the vital and functional prognosis due to its topography and abundance [13]. Hemorrhages from cAVMs are meningeal in 30% of cases, parenchymal (23%), intraventricular (16%), and in combined locations in 31% of cases [13,14]. In our series, we have parenchymal localization in 52.5% of cases, 9.5% isolated ventricular hemorrhage, and 38% combined localization.
 - Crawford et al., in their series of 217 cases, report that of the of the patients who presented with a hemorrhagic accident, 62% did not present a neurological disability, 25% had minor instability, and 6% had major deficits, with a risk of death estimated at 29% and a morbidity rate estimated at 45% [9].
 - In our series, we estimate that 41.7% of patients present neurological deficits.
 - Epilepsy is the second most common symptom in patients with cAVM; according to the study by Ondra et al., 24% of patients with cAVM presented convulsive seizures, which is consistent with the results of our series (26%) [2,9]. As well as the discovery of AVM during the assessment of late-onset epilepsy [4].
 - However, there are other modes of presentation that are documented. Pool et al. observed that apart from the initial symptoms of hemorrhage (42%), epilepsy (33%), other symptoms such as neurological deficit (23%), headache (14%), aphasia (8%), or tinnitus (2%) [7,5]
 - The imaging evaluation of cAVMs requires selective visualization of the different compartments of the lesion in order to decide on the therapeutic strategy [2,12].
 - Cerebral angiography remains the reference method, but non-invasive imaging techniques such as magnetic resonance angiography (MRA) provide interesting information.
 - These two techniques make it possible to provide prognostic arguments on the hemorrhagic risk through the angio-architectural study [2,12].
 - CT is most often reserved for the emergency context of the detection of a hematoma [12].
 - Bharatha et al. reported the rarity of multiple cAVMs in the same patient [4]. In the event of multiple lesions, underlying conditions such as hereditary hemorrhagic telangiectasia (Rendu-Osler/hereditary hemorrhagic telangiectasia), arteriovenous malformation syndrome, and cerebrofacial arteriovenous metamerism syndrome should be sought [4].
 - The most commonly used system for the classification of cAVMs is that of Spetzler-Martin, which uses three criteria: the size of the nidus, the location of the cAVM, and venous drainage. It assigns a score of 1 for small (<3 cm) cAVMs, 2 for medium-sized (3-6 cm), and 3 for large (>6 cm). The location of the nidus is in a non-functional (0) or functional (1) territory. Venous drainage is scored as superficial only (0) or including drainage to deep cerebral veins (1). The score obtained makes it possible to divide the AVMs into three classes and to guide the therapeutic attitude. Class A includes Spetzler-Martin grades I and II; class B grades III; and class C grades IV and V [1].
 - In their series, Spetzler et al. found that 79% of cAVMs <3 cm, 29% of cAVMs between 3 and 6 cm, and 12% of cAVMs >6 cm present intracranial hemorrhage [15].
 - The prognosis of cAVMs also depends on their location; Willinski et al. observed that hemorrhages seem to be more frequent for deep lesions [16,15].

- The main feeding artery is affected in the majority of cases, the sylvian artery (ACM) in 32%–57% of cases, then, in decreasing order, the anterior cerebral artery (ACA) in 28%–40% of cases, and the vertebro-basilar system (SVB) in 12% of cases (Masahiro et al., Turjman et al.) [14,12]. The results found in our series are close to those of Misahiro et al., with a frequency of 50% for ACM, 33.3% for ACA, and 16.7% for SVB.
- Deep venous drainage is a factor that plays a role in the spontaneous and therapeutic prognosis of cAVMs, according to a multi-various study focused on the angioarchitectural parameters of 631 cAVMs [2,10,13,11,12].
- The specific treatment of cAVM is a priori invasive and requires the application of one or the combination of several therapeutic techniques: endovascular embolization, surgical excision, and/or stereotactic radiotherapy.
- Microsurgery constitutes the oldest therapeutic strategy, with an average complete eradication rate of up to 97%, without or with pre-surgical embolization (Stapf et al., 2002c) and an average overall postoperative morbidity of 8.6% [2,9,15].
- Thus, the size of the AVM and its location in the eloquent and/or deep zone constitute therapeutic prognostic factors for surgery alongside the Spetzler and Martin grades [15].
- Depending on the angio-architecture and the material used, complete obliteration can be achieved by embolization alone in 11%, 17%, or 40% of cases [8].
- Morbidity reported after endovascular treatment is 0.4% to 12.5% of cases, and mortality is 0.4% to 7.5% [8].
- Radiosurgery constitutes the third aspect of the treatment of cAVMs; it is reserved for small cAVMs or residues not excluded after surgery or embolization and located in areas that are difficult to access [16].
- BCVA volume is also a major factor in radiosurgery failure [16].
- Determining the factors linked to the rupture of cAVMs and the predictive factors of response to each therapeutic means is imperative with regard to an adapted therapeutic strategy.

8. CONCLUSION

- cAVMs are uncommon compared to other vascular malformations but are more serious due to the hemorrhagic risk linked to the natural evolution of the disease.
- Determining prognostic factors constitutes the tool for establishing an appropriate therapeutic plan.
- The latter most often requires consultation between a multidisciplinary team: A neurosurgeon, neuroradiologist, and radiotherapist.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

CONSENT

As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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