EDITORIAL

ATENA: The first prospective, multicentric evaluation of the endovascular treatment of unruptured intracranial aneurysms

The prevalence of intracranial aneurysms is between 1 and 5% of the adult population [1]. With the increasing availability of noninvasive imaging techniques (CT, MRI, CTA, MRA), the incidental discovery of unruptured intracranial aneurysms is more and more frequent. The most important risk of intracranial aneurysms is the rupture (incidence: 8–10/100,000 aneurysms), resulting in intracranial hemorrhage which is associated with 30–67% mortality and 15–30% morbidity [2]. The strategy of treatment of unruptured intracranial aneurysms (UIA) is still controversial and takes into account the natural history, the risk of rupture as well as the risk of therapeutics. The natural history was analyzed in a large series of patients and the risk of rupture of UIA was determined according to the location and size of aneurysms [3]. However, the methodology of this study was largely criticized and a lot of questions regarding the natural history of UIA remain unanswered. In a large meta-analysis [4], mortality and morbidity of the surgical treatment were 2.6 and 10.9%, respectively. The risks of the endovascular treatment were until recently only analyzed in monocentric and/or retrospective series [5,6]. In 2003, the French Society of Neuroradiology decided to conduct a registry to analyze the results of the endovascular treatment of UIA in a prospective and consecutive series without changing the indications, the strategies and techniques currently used in each participating center.

What is ATENA?

“Analysis of Treatment by Endovascular approach of Nonruptured Aneurysms” (ATENA) is a prospective and consecutive registry which was conducted in 27 French and Canadian centers to evaluate feasibility, safety and efficacy of the endovascular treatment of UIA. Patients harboring unruptured, untreated intracranial aneurysms, less than 15 mm were included. Fusiform and dissecting aneurysms were excluded as well as aneurysms associated with brain AVMs. In case of recent subarachnoid hemorrhage (less than one month) related to another aneurysm, patients were not included. In each center, modalities of treatment were defined by a local multidisciplinary team including neurosurgeons, neuroanesthesiologists and neuroradiologists.

From June 2005 to October 2006 (17 months), 649 patients were included in 27 Canadian and French neurointerventional centers, more specifically, 468 females (72.1%) and 181 males (27.9%) aged between 22 and 83 years (mean of 51.2 ± 11.3 years). Age distribution was as follows: 18 to 30 years in 17 cases (2.6%), 31 to 40 years in 96 cases (14.8%), 41 to 50 years in 199 cases (30.7%), 51 to 60 years in 205 cases (31.6%), 61 to 70 years in 98 cases (15.1%) and above 70 years in 34 cases (5.2%). Aneurysms were discovered incidentally in 420 patients (64.7%), after rupture from another aneurysm in 128 patients (19.7%), during exploration of neurological symptoms related or unrelated to the aneurysm.
in 85 patients (13.1%) and during familial screening in 16 patients (2.5%). Cigarette smoking was encountered in 40.8% (260/637) and hypertension in 30.2% of patients (192/636).

The 649 included patients were harboring a total of 1100 aneurysms including 137 previously ruptured and 963 unruptured. Out of these 963 unruptured aneurysms, 739 were treated by endovascular approach during the study period and constitute the study population. Aneurysms were located on anterior circulation (91.9%) that concerned carotid siphon (38.7%), middle cerebral artery (29.5%), anterior cerebral artery and anterior communicating artery (18.5%), intracavernous (5.1%); while those located on posterior circulation in 8.1% of cases concerned basilar artery (6.2%), vertebral artery (1.5%) and posterior cerebral artery (0.4%). Surprisingly, most treated aneurysms were small despite the results of ISUIA showing that the risk of bleeding in this group is low [3], that is to say, smaller or equal to 6 mm in 58.8% of cases and 7—15 mm in 41.1% of cases. ATENA is the reflect of the current practice in France and the 7 mm threshold defined by ISUIA is not the only criteria to decide if an unruptured aneurysm has to be treated or not. Clinical factors (age, previous subarachnoid hemorrhage, ...), morphology and chronological modifications of the aneurysm are also taken into account for the therapeutical strategy. The size of the neck was smaller or equal to 4 mm in 69.1% of cases and greater than 4 mm in 30.9% of cases. Dome to neck ratio was smaller or equal to 1.5 in 52.4% of cases and greater than 1.5 in 47.6% of cases.

### Adverse events and morbimortality at one month in ATENA

The results of ATENA were previously published [7]. Endovascular treatment of UIA was feasible in a high percentage of cases (95.7%). Interestingly, the rate of failure is significantly different according to the aneurysm size: 5.7% in 1—6 mm aneurysms and 2.3% in 7—15 mm aneurysms. It is probably the witness of a less aggressive approach in case of small aneurysms in relation with ISUIA results. The rate of failure is lower in carotid siphon group (2.2%) than in posterior circulation group (6.7%), MCA group (6.4%) and ACA/Acom group (5.1%), but it is not significant. In the large majority of cases (98.4%), selective treatment using coils was performed. The balloon remodelling technique was used in 37.3% of selective treatment and intracranial stenting in 7.8%.

Adverse events with or without clinical modification were encountered in 15.4% of patients. Most of them were thromboembolic (7.1%), intraoperative rupture (2.6%) and device related problems (2.9%). No clinical modification was associated with most adverse events. Adverse events were associated with a modification of the neurological status in 5.4% of patients: transient neurological deficit in 1.9% of cases, permanent neurological deficits in 2.6% of cases and deaths in 0.9%.

The factors affecting the occurrence of adverse events were analyzed. The rate of thromboembolic complications and intraoperative rupture was not significantly affected by aneurysm location, dome to neck ratio or technique of treatment. On the contrary, the rate of thromboembolic events was significantly higher in aneurysms greater than 7 mm (1 to 6 mm: 4.6%; 7 to 15 mm: 9.9%; \( P = 0.005 \)). Intraoperative aneurysmal rupture was significantly more frequent in small size aneurysms (1 to 6 mm: 3.7%; 7 to 15 mm: 0.7%; \( P = 0.008 \)). At one month mortality was 1.4% (nine patients) and morbidity (mRS > 1) 1.7% (11 patients). Causes of deaths were: anaesthetic complication (just before aneurysm treatment) in one patient, intraoperative rupture in three patients, thromboembolic complications in two patients, device related problem associated with thromboembolic and hemorrhagic complications in one patient and intracranial bleeding not anatomically related to the aneurysm in two patients. Among the 11 patients with one month worsening of clinical status, morbidity was due to thromboembolic complications in six patients, to intraoperative rupture in four patients and to intracranial hematoma unrelated to aneurysm occurring few days after discharge of the patient in one case.

Morbidity and mortality were not significantly different according to sex, preoperative mRS and associated conditions (smoking, hypertension). On the contrary, morbidity and mortality rates were higher in patients older than 60 years: mortality is 1.2% in patients with age smaller or equal to 60 years and 2.3% in patients above 60 years (NS); morbidity is 1.2% in patients with age smaller or equal to 60 years and 3.8% in patients above 60 years (\( P = 0.036 \)).

### Anatomical results of ATENA

According to the analysis conducted by the treating neuroradiologist, postoperative aneurysmal occlusion was observed as such:

- complete occlusion: 436 aneurysms (59.0%);
- neck remnant: 160 aneurysms (21.7%);
- aneurysm remnant: 143 aneurysms (19.3%).

Anatomical follow-up will be obtained at one year and analysis of postoperative, and one year anatomical results will be performed by an independent core laboratory.

### Will ATENA results modify the strategy of treatment of UIA?

Endovascular treatment of UIA is feasible in a high percentage of UIA (95.7%) with low morbidity and mortality rates (1.7 and 1.4%, respectively). Main causes of mortality are intraoperative rupture followed by thromboembolic complications. Morbidity is mainly related to thromboembolic complications. In ATENA, the rate of complications is significantly linked to aneurysm size. The rate of intraoperative rupture is higher in small aneurysms and thromboembolic complications are more frequent in aneurysms greater than 7 mm. Morbidity and mortality at one month is higher in patients older than 60 years. Midterm and long-term follow-up is now needed to evaluate long-term anatomical results and the protection afforded by endovascular treatment against bleeding.

the literature [4], the morbidity and mortality of the endovascular treatment seems to be lower than those of surgical treatment. A comparison of surgical and endovascular treatment was recently performed in a large retrospective cohort study showing that endovascular treatment was associated with fewer adverse events (6.6% versus 13.2%), decreased mortality (0.9% versus 2.5%), and shorter lengths of stay (4.5 days versus 7.4 days) compared with neurosurgical treatment [8]. If an active treatment has to be performed, the first line treatment is then probably endovascular.

But when should we decide to do an active treatment of UIA? A case by case analysis remains certainly necessary [9,10].

**Next steps of ATENA**

The mid- and long-term anatomical results as well as the protection afforded by endovascular treatment against bleeding are important points to analyze and follow-up of patients included in ATENA is scheduled for one and three years.

**Acknowledgment**

This study was financially supported by the French Society of Neuroradiology.

**References**


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