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Article

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Single center experience and technical nuances in the treatment of distal anterior cerebral artery aneurysms

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Abstract: *Objective*: This study presents the experience of one neurosurgical center in the treatment of 18 consecutive patients with distal anterior cerebral artery (DACA) aneurysms during a 10 years period. Our aim was to compare treatment outcomes of these lesions with intracranial aneurysms in general, and to present technical nuances in surgical treatment. *Methods*: We analyzed the clinical and radiological data of 18 patients treated between 2005 and 2015. All patients were treated surgically using the microscope. No patients were lost to follow-up. We compared treatment and outcome of ruptured DACA aneurysms (n 18) with all consecutive ruptured aneurysms treated in our clinic during the same period (n 446). *Results*: DACA aneurysms accounted for 4% of all intracranial aneurysms. They were smaller (median, 5,5 versus 9 mm) We found only one case with associated aneurysms (5,5%). DACA aneurysms presented more often with intracerebral hematomas (39% versus 26%) than ruptured aneurysms in general. Their microsurgical treatment showed the same complication rates (treatment morbidity, 15%) as for other ruptured aneurysms in literature. Their mortality rate was lower (11% versus 24%). *Conclusion*: Despite their specific anatomic features, and particular surgical technique, with modern treatment methods, ruptured DACA aneurysms have the same favorable outcome and lower mortality as ruptured aneurysms in general.

Key words: Cerebral aneurysm, Distal anterior cerebral artery, Pericallosal artery, Subarachnoid hemorrhage

Distal anterior cerebral artery aneurysms (DACA), frequently referred to as pericallosal artery aneurysms, represent aneurysms that arise distal tot the anterior communicating artery (AComA), most commonly at the origin of the callosomarginal artery. They are uncommon, comprising only 2.7 to 9.2% (mean, 4.4% in 13 large series) of all intracranial aneurysms. (14, 23, 10)

Their location in the interhemispheric fissure, the association with intracerebral hemorrhage, with multiple aneurysms and with vascular anomalies of the anterior cerebral artery (ACA) offer the neurosurgeon

a complex pathology and challenging surgical technique. The complexity of this pathology is completed by the specific anatomic features of DACA aneurysms, such as their small size and the broad neck with originating branches at this level (14, 23).

Anatomy

The AComA is normally divided into five segments, A1 through A5 (Fig. 1). Segments A2 through A5 form the DACA. The A2 segment extends from the AComA to the junction between the rostrum and genu of the corpus callosum. The A3 segment courses around the genu of the corpus callosum and ends at the point where the vessel takes a sharp turn posteriorly. The A4 segment runs superior to the corpus callosum, extending to a point just behind the coronal suture. The A5 segment is the portion of the AComA that lies posterior to the coronal suture (10).

The literature is lacking detailed studies on the anatomy of DACA aneurysms, with the notable exception of the Finnish group coordinated by Hernesniemi et al which divided DACA aneurysms in seven groups, with the Genu of the Corpus Callosum (GCC) as the anatomic landmark for this division (aneurysms at each of these locations require a modified microsurgical approach). 1) Frontobasal aneurysms: located on the A2 frontobasal branches. 2) A2 trunk aneurysms: located directly on the A2 segment. 3) Inferior A3 aneurysms: located on the proximal part of the A3 segment inferior to the GCC. 4) Anterior A3 aneurysms: located on the central part of the A3 segment anterior to the GCC. 5) Superior A3 aneurysms: located on the distal part of the A3 segment superior to the GCC. 6) A4 or A5 aneurysms. 7) Distal branch aneurysms: located on the distal cortical branches originating from the A3 to A5 segments: the callosomarginal artery (CMA) (14, 3).

Objectives

This study presents the experience of one neurosurgical center in the treatment of 18 consecutive patients with ruptured DACA aneurysms during a 10years period. Our aim was to compare treatment outcomes of these lesions with intracranial aneurysms in general, and to present technical nuances in surgical treatment.

Material and methods

We analyzed the clinical and radiological data of 18 patients treated between 2005 and 2015. All patients were treated surgically by clip ligation using the microscope. No patients were lost to follow-up. We compared treatment and outcome of ruptured DACA aneurysms (n 18) with all consecutive ruptured aneurysms treated in our clinic during the same period (n 446).

Results

From the 466 patients treated for ruptured cerebral aneurysms in our department, 18 presented with ruptured DACA aneurysms representing 3,8%. Mean age was 53 years, and females were twice as frequent than men.

We used the classification developed by the Finnish group (14), in order to classify those 18 aneurysms, and as a result we observed that the majority of our cases were type 4 located aneurysms – anterior A3 aneurysms (Table 1).

Table I

Number of patients according to Hernesniemi' classification of DACA aneurysms

DACA aneurysm classification	No of cases (%)
Type 1	1 (5,5)
Type 2	1 (5,5)
Type 3	2 (11)
Type 4	11 (77,5)
Type 5	3 (16,5)

As seen in Table 2, 50% of patients with DACA aneurysms in our clinic were admitted in good clinical condition (Hunt-Hess 1and 2), with only 1 patient being admitted in critical condition (Hunt-Hess- 5).

Table II

Clinical (Hunt-Hess and WFNS scores) and imagistic status (Fisher scale) at presentation

NR	Hunt Hess	WFNS	Fisher scale
1	1	1	2
2	1	1	2
3	3	3	2
4	1	1	3
5	2	2	4
6	3	4	4
7	3	2	3
8	2	1	2
9	1	1	4
10	1	2	2
11	3	2	4
12	3	4	3
13	3	3	4
14	5	5	4
15	3	4	2
16	3	3	4
17	2	3	2
18	1	1	2

Intracerebral or interhemispheric hematoma was seen in 7 patients, representing 38,8% of patients with DACA aneurysms (Figure 1).

From the imagistic point of view, as a protocol, every patient had native head CT scan upon admission. If subarachnoid hemorrhage (SAH) or intracerebral hematoma (ICH) were present raising the suspicion of ruptured aneurysm, the patient was sent to angio suite, for a 4 vessel cerebral angiography (Figure 2).

The medium size of DACA aneurysms in our series was 6.2 mm (range 4.5-12 mm), and 13 patients harboured DACA aneurysms smaller than 7 mm (72.2%).

An interesting finding was the fact that from the 18 patients in our series we had only one case with associated unruptured cerebral aneurysm representing only 5,5%.

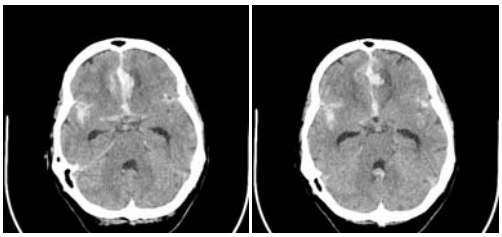

Figure 1 - Non enhanced CT scan of patient with Fisher 3 SAH

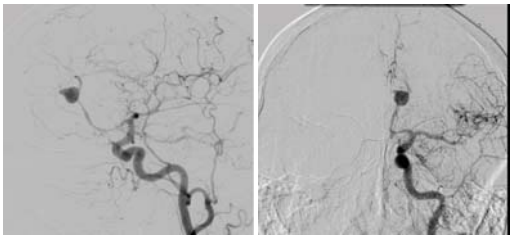

Figure 2 - Left ACI injection on DS angiography on the same patient revealing a type 3 saccular aneurysm on the left DACA

Surgical technique

Our service has an "early surgery" policy, thus 78% of patients were admitted in our service in the first 24h after rupture and 72% underwent early surgery.

As a technique, the goal was to identify the parent vessel and to obtain proximal control as soon as possible, so interhemispheric approach and dissection was carried out following interhemispheric cortical arteries which took us as close as possible to the anterior communicating complex on the anterior fossa floor. After identifying the post communicating segment of the anterior cerebral arteries, dissection along their trajectory was realized with the identification of the saccular aneurysm and the emerging branches.

There are some particular aspects that need to be considered when performing surgery for DACA aneurysms. First the interhemispheric fissure provides a narrow corridor for the approach. There is little CSF present in the

interhemispheric cisterns, so in order to simplify the approach on a swallowed brain, external ventricular drain (EVD) or lumbar drainage can be an option. The arachnoid adhesions make the dissection of interhemispheric cisterns difficult. Additionally, parasagittal veins may represent a challenge – but these structures must be preserved. And of course, once the interhemispheric approach is realized, early identification of parent vessel isn't always easy.

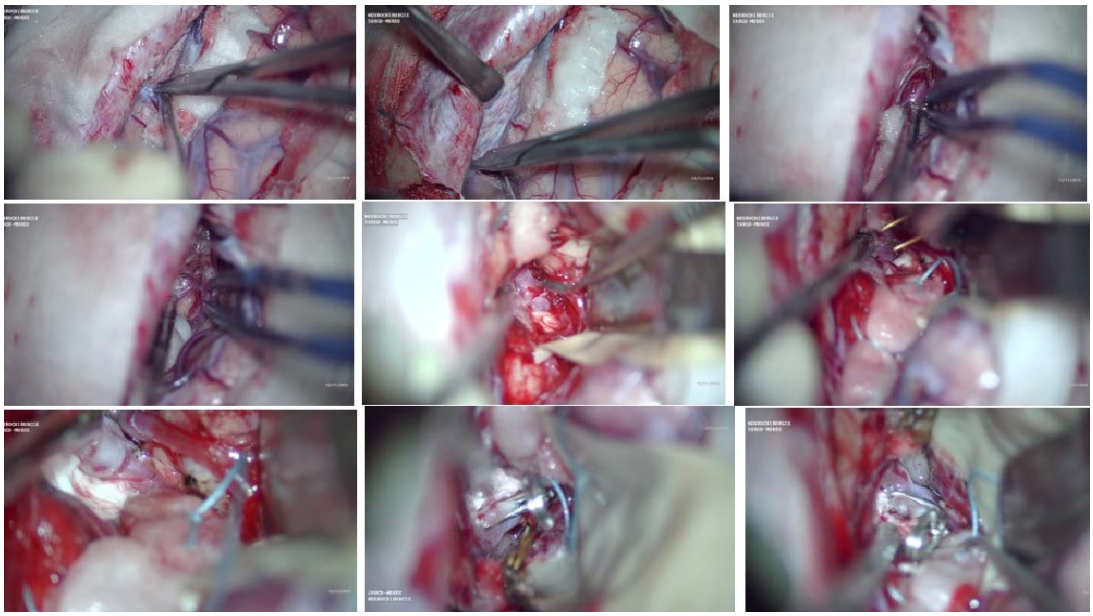

Figure 3 - Intraoperative images of a right frontal interhemispheric approach and clipping of type 3 DACA aneurysm

Outcomes

Clinical outcome was assessed using the modified Rankin Scale (mRS) both at discharge and at six months. We considered good outcome an m RS between 0 and 2.

As seen in Tables 3 and 4 there is a clear relation between the neurological status at admission and the clinical outcome. In the patients group with good neurological status at admission (Hunt-Hess 1 and 2), n-10, there was only one patient (10%) with poor outcome – m RS-5.

Table III

Clinical outcome of patients with DACA aneurysms in our clinic

Outcome at 6 months	
Favorable (mRS 0-2)	12 cases (67%)
Unfavourable (mRS 3-6)	6 cases (33%)

Table IV

Relation between the neurological status at admission and the clinical outcome

H-H/mRS	0	1	2	3	4	5	6
I	3	2	1	0	0	0	0
II	0	1	2	0	0	1	0
III	0	1	1	3	1	1	0
IV	0	0	0	0	0	0	0
V	0	0	0	0	0	0	1

In the group of patients with poor neurological status at admission (n-8), there were 6 patients (75%) with poor outcome (m RS-3-6). The only patient in this group admitted in critical condition (Hunt-Hess-5), died one week after surgery.

Perioperative complications included intraoperative rupture of aneurysm (4 cases – 22,2%), postoperative intracerebral hematoma (1 case-5,5%) and meningitis (1 case – 5,5%). The overall morbidity was 11% (2 cases).

Discussion

Clinical outcome

The outcomes obtained in this small series are comparable to those of previous reports. We evaluated 18 patients treated for ruptured DACA aneurysm. Successful clipping was achieved in all of these patients, with no recurrence of SAH at 6 months and no need for retreatment (2, 28, 25).

Good clinical outcome, measured using m RS (m RS 0 - 2) was achieved in 11 patients (60,5%). In our study, the statistically significant predictor of outcomes in the patients with SAH was the presenting Hunt-Hess score. Patients in a lower Hunt-Hess grade (I and II) had a favorable outcome in 90% of cases, compared with 25% of patients in the Hunt-Hess groups III, IV and V. These results show that, despite the difficulties associated with aneurysms in this location, good results can be achieved in most patients who have a good clinical grade. Poor grade patients remain a significant challenge, particularly those patients with large parenchymal hemorrhages (1, 15, 24, 29).

Ohno et al concluded in their analysis that DACA aneurysms tend to rupture at a smaller size. In their series, 73% of the patients harbored aneurysms smaller than 5 mm. In Pandey et al series, the majority of patients harbored aneurysms smaller than 6 mm. In our series 72% of DACA aneurysms treated were smaller than 7 mm with a median size of 6.2 mm. Thus, the question of whether unruptured DACA aneurysms should be treated at a smaller size compared to the limit of 7 mm set by the ISUIA trial for anterior circulation aneurysms, seems to be a valid one, and needs further investigation (16, 21, 22).

Symptomatic vasospasm represents the most important cause of morbidity in patients surviving SAH and affects up to 30% of patients presenting with SAH caused by ruptured aneurysms in the anterior circulation (6, 8, 17). In our series, only two patients developed clinically significant vasospasm, both with Fisher grade III SAH on CT scans. The majority of our patients were in Fisher Grade II (50%) and IV (39%) and, thus, would not be supposed to develop vasospasm. It seems that patients with distal aneurysms (DACA/MCA) have a lower incidence of spasm because most of these patients tend to have localized bleeding instead of the diffuse SAH.

Surgical technique and nuances

Microsurgical clipping remains the main therapeutic tool, the endovascular treatment being limited by the distal location and complex anatomy of DACA aneurysms. (4, 7, 9)

Nonetheless, surgical clipping of DACA aneurysm presents with specific difficulties compared with other locations, as described in previous studies (11, 13, 26, 27).

The particularities of DACA aneurysms are related to the narrow approach and deep location making the approach less straight forward. As described by the majority of the authors, we utilized a right frontal interhemispheric approach making sure to have proximal control before dissecting and clipping the aneurysm. The approach was adapted to the type of DACA aneurysm ranging from frontobasal approaches for type 1 and 2 DACA aneurysms to frontoparietal craniotomies for the more distally located aneurysms. Although rarely used, neuronavigation can be an important additional tool in the neurosurgeon's armamentarium, making the approach less invasive and more straight forward.

Once the approach realized, early identification of parent vessel is of paramount importance because of the lack of anatomic landmarks which makes safe dissection and clipping of DACA aneurysm difficult. These factors make these aneurysms more prone to early intraoperative rupture, Lehecka et al reporting in their large 501 patients study an incidence of 22% of intraoperative rupture (15). In our study we had similar results, with 5 patients (27,5%) that had early intraoperative rupture. All cases were managed without early or late postoperative complications.

The overall rate of complications was 11% (1 case of meningitis, and 1 case of postoperative intracerebral hematoma), and these complication rates are similar to those reported in the literature for the treatment of DACA aneurysms (9, 13, 14, 19).

Conclusions

DACA aneurysms are usually small with specific anatomic features such as wide neck and association with anatomic variations of ACA. Surgical clipping is a safe and effective method of treatment, but it must be adapted to the location of the aneurysm on the ACA, and proximal control is of paramount importance.

Following the actual trend for the treatment of intracranial aneurysms, most of these aneurysms will eventually be treated by endovascular means (5, 12, 18, 20). Nonetheless, knowledge of the specific features regarding the microsurgical approach and clipping of these aneurysms and the expected outcomes remain an important skill in the arsenal of vascular neurosurgeons.

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