

## Outcome analysis of distal anterior cerebral artery aneurysms with and without neuronavigation

Rajeev M. P.<sup>1</sup>, Pavitharan V. M.<sup>2</sup>, Premkumar Sasi<sup>3</sup>, Pravin Yashwant Waykule<sup>4,\*</sup>, Ambresh A K<sup>5</sup>

<sup>1</sup>Professor and Head, <sup>2,3</sup>Assistant Professor, <sup>4,5</sup>MCh Resident, Dept. of Neurosurgery, Government Medical College and Hospital, Kozhikode, Kerala, India

**\*Corresponding Author:**

Email: pravin\_waykule@rediffmail.com

### Abstract

**Introduction:** The incidence of DACA aneurysms is between 1.5 to 9.0% of all intracranial aneurysms in the literature. Many of these are <5 mm in diameter. In this case series we report 30 cases of DACA aneurysms between 2009-2016, their presentations, associations and management including the use of neuronavigation system.

**Materials and Methods:** Among 375 patients with cerebral aneurysms admitted between 2009-2016, 30 patients (8%) had DACA aneurysms, which were studied retrospectively. We analyse the specific clinical and radiological features, surgical strategies and associated anomalies with these DACA aneurysms.

**Results:** Among the 30 patients with DACA aneurysms, 23 patients (76%) presented with subarachnoid hemorrhage, 7 patients (23%) had intracerebral hematoma, 1 had associated intraventricular haemorrhage and 1 patient had a thrombosed DACA aneurysm. 19 patients had Hunt & Hess grade 1, 8 had grade 2, 1 patient had grade 3 and 2 had grade 4. 23 of the DACA aneurysms (76%) were <5 mm in diameter, 6 were 5-15mm size and 1 had a giant aneurysm (>25mm). 2 patients died preoperatively due to recurrent bleeding. Out of the 28 patients operated, interhemispheric approach was used in 26 patients (92.85%), while pterional approach was used in 2 patients (7.14%). Neuronavigation was used in 16 cases. Postoperative complications included hemiparesis in 2 and death of 1 patient.

**Conclusion:** The special neurovascular features, location of aneurysm and frequent association with anterior cerebral artery anomalies and other aneurysms must be taken into account when planning occlusive treatment of DACA aneurysms. Neuronavigation is helpful in planning craniotomy and precise localization.

**Keywords:** DACA aneurysm, Subarachnoid hemorrhage, Neuronavigation.

### Introduction

Distal anterior cerebral artery (DACA) aneurysms represent about 1.5% to 9.2% of all aneurysms.<sup>1-7</sup> Most common location is at the bifurcation of the pericallosal and callosomarginal arteries. Most of the DACA aneurysms are found to be less than 5 mm in diameter,<sup>5</sup> and giant aneurysms are exceedingly rare.<sup>8</sup> They are commonly associated with additional intracerebral aneurysms, occurring at rates as high as 20% to 25%<sup>4</sup> either MCA or ICA. The surgical treatment of patients with DACA aneurysms is difficult because of the narrow surgical field of vision, the presence of interhemispheric adhesions and location distal to A3 segment of ACA. There is no definite anatomic landmark to identify a DACA aneurysm and the proximal anterior cerebral artery during surgery. It is difficult to localize the aneurysm promptly with adequate proximal control of the supplying vessel. Neuronavigation guided surgery has been used for clipping of DACA aneurysm.<sup>14, 16</sup> In this series we have used neuronavigation to select a convenient surgical approach and to plan the trajectory of entry for clipping of DACA aneurysms.

### Materials and Methods

Among 375 patients with cerebral aneurysms admitted between 2009-2016, 30 patients (8%) had DACA aneurysm. They were studied retrospectively using medical records, including imaging studies and

descriptions of microsurgical findings. Specific clinical and radiological features, surgical strategies and associated anomalies with these DACA aneurysms were studied. Post op results analysed by clinical and angiographic records

**Surgery and Neuronavigation System:** 28 patients underwent clipping of the DACA aneurysm. Interhemispheric approach was used in 26 patients (92.85%), while pterional approach was used in 2 patients (7.14%). In these 2 patients pterional approach was used because aneurysm was located within 2 cm of AcomA and one is associated with additional M1-M2 junction aneurysm. Neuronavigation was used in 16 cases (57.14%) (Fig. 4) during interhemispheric approach.

We use the medtronic stealth station neuronavigation system. CT angiogram of the patients were uploaded into the system and the craniotomy and trajectory of approach planned preoperatively to save time during the surgery.

StealthMerge software was used to auto-merge a variety of exams into 3-D images. Intraoperative registration was achieved by surface matching over the facial surface using the navigation pointer.

Neuronavigation was used in 16 cases where the aneurysm was located in the more distal branches of DACA (i.e distal to A3) where we anticipated difficulty in locating the aneurysm. Neuronavigation system allowed us to identify the aneurysm in all 16 patients.

There was no event of premature rupture during the dissection of aneurysm in any of the patients. Post op results were analysed by clinical and angiographic records. All of these 16 cases had good recovery.

Other 10 cases where we done through interhemispheric approach but neuronavigation was not used. In these patients aneurysms are located mostly A2-A3 junctions and preoperatively we didn't suspect any difficulty to locate the aneurysm. We used low frontal transbasal and interhemispheric approach in these patients and successfully located and clipped the aneurysm.

### Observations and Results

Among 375 patients with cerebral aneurysm admitted between 2009-2016, 30 patients (8%) had DACA aneurysm. The mean age of presentation was 55 years (Table 1). There were 13 male and 17 female patients with DACA aneurysms. 23 patients (76%) presented with subarachnoid hemorrhage, 7 patients (23%) had intracerebral hematoma, 1 had associated intraventricular haemorrhage and 1 patient had a thrombosed DACA aneurysm (Table 2). 19 patients had Hunt & Hess grade 1, 8 had grade 2, 1 patient had grade 3 and 2 had grade 4 (Figure 1). 3 patients presented with an unruptured DACA aneurysm. 23 of the DACA aneurysms (76%) were <5 mm in diameter, 6 were 5-15mm size and 1 had a giant aneurysm (>25mm) (Table 3). Most common location of the DACA aneurysm was pericallosal/callosomarginal (PC/CM) junction (Table 3). 6 patients (20%) had other associate aneurysms (Table 4). 1 patient had an associated AVM, 1 patient had PCKD and 1 patient had history of atrial myxoma excision (Table 5). CT angiograms (CTA) or cerebral angiograms were used in all patients before surgery. 2 patients were died preoperatively due to recurrent bleeding. Among the 28 patients operated, 26 (92.85%) were through an interhemispheric approach and 2 (7.14%) were by pterional approach (Table 6). Postoperative complications included hemiparesis in 2 patients and death of 1 patient. Fig. 2 & 3 show pre op and post op CT angiogram showing DACA aneurysm before clipping and obliteration of the aneurysm after clipping.

**Table 1: Clinical characteristics**

Clinical characteristics	No of Patients
Age <40 yrs	1
40-60 yrs	21
>60 yrs	8
SEX	M: 13 (43.33%) F: 17 (56.66%)
Hypertension	16
Diabetes mellitus	3
CAD	2

**Table 2: Radiological features**

Radiological features	No of Patients
CT Brain	SAH: 23 IPH: 7 IVH: 1
Ruptured DACA aneurysms	27 (90%)
Unruptured DACA aneurysms	3 (10%)
Aneurysm size	<5mm: 23 (76.66%) 5-15mm: 6 (20%) >25mm: 1 (3.33%)
Thrombosed aneurysm	1

**Table 3: Aneurysm location**

Location	No of Patients
A2	4 (13.33%)
A3	6 (20%)
PC/CM junction	16 (53.33%)
A4	4 (13.33%)

**Table 4: Multiple aneurysms**

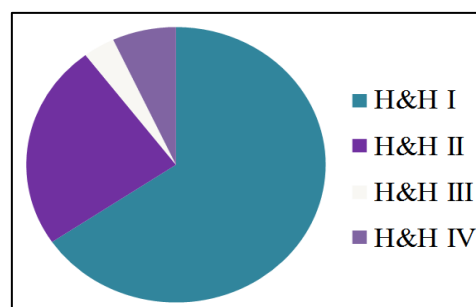
Location	No of Patients
A1	1
ACom	3
MCA	1
MCA+PCA	1

**Table 5: Anomalies and associations of ACA**

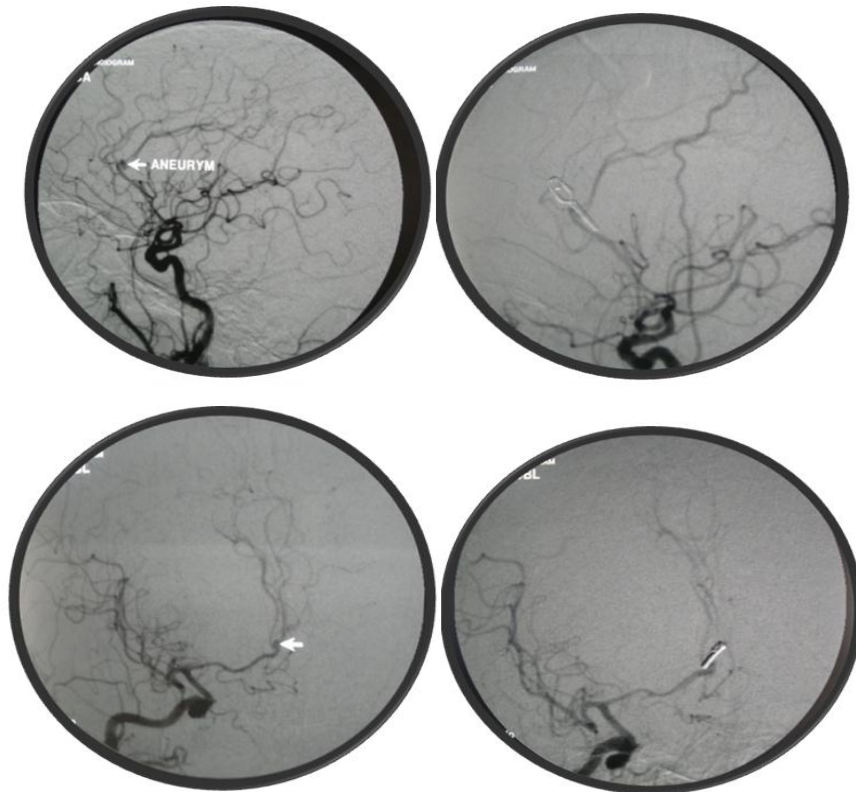
Azygous ACA	3
Hypoplastic A1	1
AVM	1
PCKD	1
Atrial myxoma	1

**Table 6: Treatment and outcome**

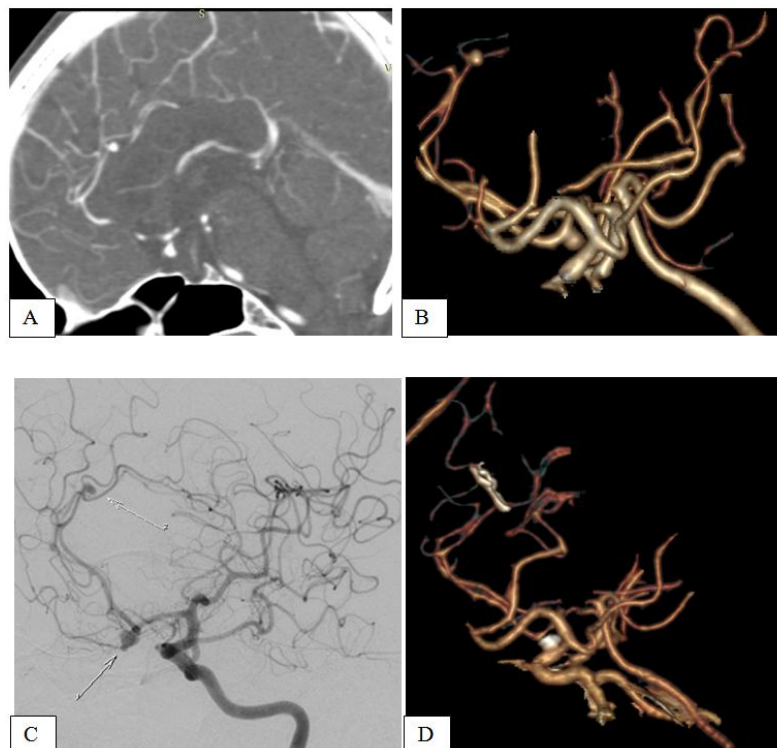
Clinical characteristics	No of Patients
Preoperative death	2
Surgery: Interhemispheric	26 (92.85%)
Pterional	2 (7.14%)
Neuronavigation guided	6 (57.14%)
Morbidity None	25 (89.28%)
(R) Hemiparesis	2 (7.14%)
Post op Mortality	1(3.57%)



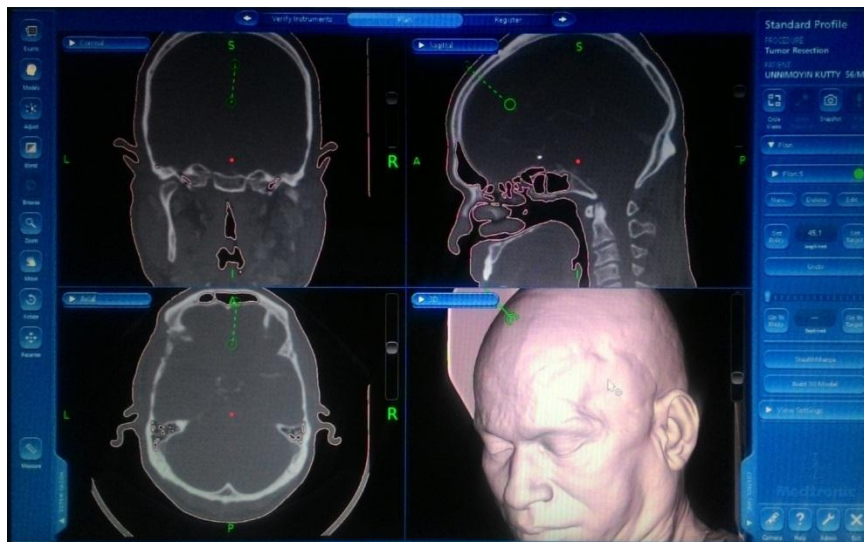
**Fig. 1: Hunt & Hess grade**



**Fig. 2:** Pre and post operative images of DACA aneurysms showing complete obliteration of the aneurysms



**Fig. 3:** A) Pre op CT angiogram showing DACA aneurysm and associated ACom aneurysm. B) 3D reconstruction of CT angiogram of same patient. C) DSA of same patient. D) Post op 3D reconstructed CT angiogram of the same patient showing complete obliteration of the aneurysms. ACom aneurysm was operated at a later date



**Fig. 4: Computer screenshot of the intra op use of neuronavigation to localize the aneurysm and plan the craniotomy and the trajectory of surgical approach**

### Discussion

The incidence in our series was 8% comparable to other studies.<sup>1-4</sup> There was female preponderance in our series (57.7%) similar to the literature.<sup>3,9</sup> Mean age of presentation was 55 years. Post operative outcome was comparable to other studies.

Neuronavigation was used in 16 of our cases which helped in precise localization and planning of the aneurysm.

Brain tumor, vascular malformation, or other lesions are good candidates for the neuronavigation guided surgery and its application for intracranial aneurysms is in the early stages.<sup>13,17,18</sup> Unique characteristics to DACA aneurysm is its location on the corpus callosum in the midline surrounded by both hemispheres and has a small subarachnoid cistern.

The neuronavigation system used in surgery for DACA aneurysm helps with specific operative difficulties. There are certain difficulties related to the surgical approach of DACA aneurysms: a narrow and deep operative field in the interhemispheric fissure and the callosal cistern, dense adhesions between the hemispheres, frequent adhesions of the aneurysm to surrounding structures and poor landmarks for identification of the aneurysm or proximal artery. These problems make DACA aneurysms more prone to premature rupture than other intracranial aneurysms.<sup>10,11</sup>

The prevention of premature rupture is a good rationale for application of the neuronavigation system; this is because it can help the surgeon to identify the aneurysm and/or the proximal artery before and during surgical exposure.<sup>14</sup>

Many advantages of the neuronavigation system have been reported during the past two decades,<sup>14, 19-21</sup> these include: the precise localization and guidance to cerebral lesions, optimal preoperative planning of skin

incision and craniotomy, increased 3-dimensional orientation during surgery and increased operator confidence. During surgery for a DACA aneurysm especially distally located aneurysms (distal to A3) the neuronavigation system provides the shortest and most direct trajectory to the aneurysm, as well as observation of the relationship between the aneurysm, adjacent arteries and brain structures.

### Conclusion

The morbidity and mortality rates of DACA aneurysms in our series were similar to other aneurysms and comparable with the other studies. Microsurgical clipping is a safe and effective treatment method for DACA aneurysms. Neuronavigation is helpful in identifying a DACA aneurysm especially distally located (distal to A3), planning craniotomy and precise localization. It also has an added benefit of a small craniotomy. Hence we recommend using neuronavigation, when available, for DACA aneurysm surgery, where the aneurysm is usually small and is deeply located without any landmarks to identify it.

### References

1. Baptista AG. Studies on the arteries of the brain. II. The anterior cerebral artery: some anatomic features and their clinical implications. *Neurology*. 1963;13:825.
2. Becker DH, Newton TH. Distal anterior cerebral artery aneurysm. *Neurosurgery*. 1979;4:495.
3. de Sousa AA, Dantas FL, de Cardoso GT, et al. Distal anterior cerebral artery aneurysms. *Surg Neurol*. 1999;52:128.
4. Dinc C, Iplikcioglu AC, Bikmaz K, et al. Distal anterior cerebral artery mirror aneurysms and middle cerebral artery aneurysms. *Neurol Med Chir (Tokyo)*. 2006;46:438.
5. Kwon TH, Chung HS, Lim DJ, et al. Distal anterior cerebral artery aneurysms: clinical features and surgical outcome. *J Korean Med Sci*. 2001;16:204.
6. Lehecka M, Lehto H, Niemela M, et al. Distal anterior cerebral artery aneurysms: treatment and outcome analysis of 501 patients. *Neurosurgery*. 2008;62:590.

7. Lehecka M, Porras M, Dashti R, et al. Anatomic features of distal anterior cerebral artery aneurysms: a detailed angiographic analysis of 101 patients. *Neurosurgery*. 2008;63:219.
8. Maiuri F, Corriero G, D'Amico L, et al. Giant aneurysm of the pericallosal artery. *Neurosurgery*. 1990;26:703.
9. Ohno K, Monma S, Suzuki R, et al. Saccular aneurysms of the distal anterior cerebral artery. *Neurosurgery*. 1990;27:907.
10. Yaşargil MG, Carter LP. Saccular aneurysms of the distal anterior cerebral artery. *J Neurosurg*. 1974;40:218–23.
11. Chhabra R, Gupta SK, Mohindra S, Mukherjee K, Bapuraj R, Khandelwal N, et al. Distal anterior cerebral artery aneurysms: bifrontal basal anterior interhemispheric approach. *Surg Neurol*. 2005;64:315–9.
12. Lee SH, Bang JS. Distal Middle Cerebral Artery M4 Aneurysm Surgery Using Navigation-CT Angiography. *J Korean Neurosurg Soc*. 2007;42(6):478-80.
13. Schmid-Elsaesser R, Muacevic A, Holtmannspotter M, Uhl E, Steiger HJ. Neuronavigation based on CT angiography for surgery of intracranial aneurysms: primary experience with unruptured aneurysms. *Minim Invasive Neurosurg*. 2003;46(5):269-77.
14. Kim TS, Joo SP, Lee JK, Jung S, Kim JH, Kim SH, et al. Neuronavigation-assisted surgery for distal anterior cerebral artery aneurysm. *Minim Invasive Neurosurg*. 2007;50(3):140-4.
15. Mann KS, Yue CP, Wong G. Aneurysms of the pericallosal-callosomarginal junction, *Surg Neurol* 1984;21:261-6.
16. Hermann, E.J et al. Surgical treatment of distal anterior cerebral artery aneurysms aided by electromagnetic navigation CT angiography. *Neurosurg Rev* (2015) 38:523–530.
17. Barnett GH, Kormos DW, Steiner CP, Weisenberger J. Use of a frameless, armless stereotactic wand for brain tumor localization with twodimensional and three-dimensional neuroimaging. *Neurosurgery* 1993;33:674–678.
18. Roessler K, Ungersboeck K, Dietrich W, Aichholzer M, Hittmeir K, Matula C, Czech T, Koos WT. Frameless stereotactic guided neurosurgery: clinical experience with an infrared based pointer device navigation system. *Acta Neurochir (Wien)* 1997;139:551–559.
19. Muacevic A, Uhl E, Steiger HJ, Reulen HJ. Accuracy and clinical applicability of a passive marker based frameless neuronavigation system. *J Clin Neurosci* 2000;7:414–418.
20. Tirakotai W, Sure U, Benes L, Kriscsek B, Bien S, Bertalanffy H. Imageguided transsylvian, transinsular approach for insular cavernous angiomas. *Neurosurgery* 2003;53:1299–1304.
21. Krishnan R, Raabe A, Hattingen E, Szelenyi A, Yahya H, Hermann E, Zimmermann M, Seifert V. Functional magnetic resonance imaging integrated neuronavigation: correlation between lesion-to-motor cortex distance and outcome. *Neurosurgery* 2004;55:904–914.