

Ruptured Saccular Aneurysms Of The Distal Anterior Cerebral Artery: Two Case Reports And A Review Of The Literature

Rüptüre Distal Anterior Serebral Arter Anevrizması: 2 Olgunun Sunumu ve Literatür Taraması

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Abstract

Distal anterior cerebral artery aneurysms are uncommon and constitute only 1.5-9% of all intracranial aneurysms. They are frequently observed at pericallosal and callosomarginal artery bifurcations. The surgical treatment of distal anterior cerebral artery aneurysms is difficult due to the narrow surgical field of vision and because these aneurysms are accompanied by interhemispheric adhesions and other aneurysms. Two patients with saccular pericallosal and callosomarginal junction aneurysm were surgically treated in our clinic between April 2012 and October 2013. The clinical and radiological findings in both cases were analyzed. A unilateral interhemispheric approach was employed during surgery. Case reports and series reported in the English medical literature were reviewed. The incidence of distal anterior cerebral artery aneurysm at our hospital was 8% of all aneurysms that were subject to surgery (25 cases). Both patients were women. An interhemispheric approach was used in both cases. One patient was discharged with a full recovery and the other patient expired. We propose that the surgical difficulties encountered in distal anterior cerebral artery aneurysm and related complications will be minimized with use of the latest advances in microsurgical techniques and adequate knowledge of the surgical anatomy.

Key words: Anterior cerebral artery, intracranial aneurysm, subarachnoid hemorrhage, endovascular procedures, vasospasm, intracranial.

Özet

Distal anterior cerebral arter (DACA) anevrizmaları nadirdir ve tüm intrakranial anevrizmaların % 1.5 – 9'unu oluşturur. Sıklıkla pericallosal ve callosomarginal arterlerin bifurcationunda görülür. Dar görüş alanı, interhemisferik yapışıklıklar ve diğer anevrizmalarla birlikte görülmesi nedeniyle DACA anevrizmalı olguların cerrahi tedavisi teknik olarak zordur. Nisan 2012 ile Ekim 2013 arasında 2 adet sacculer PC-CM junction anevrizması kliniğimizde opere edildi. Bu 2 olgunun klinik ve radyolojik bulguları analiz edildi. Operasyonda unilateral interhemiferik yaklaşım uygulandı. İngilizce tıp literatüründeki case reports ve seriler incelendi. Hastanemizdeki DACA anevrizması insidansı cerrahi tedavi uygulanan tüm anevrizmaların (25 olgu) %8'i idi. Her iki olgu da bayan idi. 2 olgu da interhemisferik yolla opere edildi. 1 olgu tam iyileşme ile taburcu edilirken diğeri öldü. Mikrocerrahi tekniklerin ve cerrahi anatominin yeterince bilinmesi ile DACA anevrizması cerrahisindeki zorlukların ve buna bağlı komplikasyonların en aza indirileceğine inanıyoruz.

Anahtar kelimeler: Distal anterior serebral arter, anevrizma, subaraknoid, hemoraji, kallosomarginal, perikallosal, kliplleme.

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Introduction

Distal anterior cerebral artery (DACA) aneurysms are uncommon and constitute only 1.5-9% of all intracranial aneurysms [1-4]. They are frequently observed at pericallosal and callosomarginal artery bifurcations [2,5-7]. DACA aneurysms are often observed in association with azygos anterior cerebral artery, bihemispheric and triplicated anomalies [8-10]. The surgical treatment of patients with DACA aneurysms is difficult because of the narrow surgical field of vision and because these lesions are observed in association with other aneurysms and interhemispheric adhesions. The surgical approach is also different from that of other aneurysms. While mortality ranges between 0 and 28.6% in the literature, morbidity is reported as approximately 15% [2,11]. In this report, two cases with aneurysms of pericallosal-callosomarginal (PC-CM) junction were presented along with a literature review.

Material and Methods

Two patients with saccular PC-CM junction aneurysm were surgically treated in our clinic between April 2012 and October 2013. These two cases comprised 8% of aneurysms that were treated at our clinic. Information related to the clinical progression of the two patients is summarized in Table 1. Both patients were women, and their respective ages were 75 and 65. Written consent was obtained from cases.

The second patient demonstrated the classical findings of early phase spontaneous subarachnoid hemorrhage. The mean time between the onset of severe headache and referral to our hospital was 30 hours. The Hunt and Hess classification was used for the pre-operative evaluation of both patients [12]. Case 1 was classified as grade III and Case 2 as grade II. Neither patient had a history of loss of consciousness. Epilepsy was not observed in either patient. Both patients had a history of hypertension. In Case 1, hydrocephalus developed in the post-operative period, and therefore, a ventriculoperitoneal shunt procedure was performed.

Computerized tomography (CT) was performed in both patients immediately upon arrival in the emergency room with hyper

dense blood detected in the subarachnoid space of both patients. Magnetic resonance imaging was not indicated in either patient. Cranial Digital Subtraction Angiography (DSA) was performed on both patients on the first day of their hospitalization (Fig. 1a-1b and 2a-2b). A saccular DACA aneurysm with left-sided swelling was detected at the PC-CM junction in both patients. The aneurysmal diameter was 9 mm and 5 mm in Case 1 and Case 2, respectively. No other vascular anomalies or multiple aneurysms were detected.

Once SAH was diagnosed, standard procedures were followed including rest in a quiet room, maintenance of blood pressure within a normal range and diazepam administration for sedation. Dexamethasone was given as corticosteroid therapy (4 mg every 6 hours) to both patients once the diagnoses were established in the emergency room. Anti-fibrinolytic treatment was not administered to the patients. Rebleeding did not ensue in the pre-operative period in either patient.

Although endovascular procedures have improved, surgical treatment of ruptured aneurysm is preferred whenever possible to minimize the risk of rebleeding. Both patients underwent surgery on the 7th day in order to prevent the development of acute-phase vasospasm. Medical treatment was continued until the 7th day. The patients' preoperative grading did not change.

Anesthesia of patients with DACA aneurysm is similar to that administered to patients with other aneurysms. An interhemispheric approach was used at surgery in both cases. Furosemide (20-40 mg), mannitol (0.5 g/kg) and hyperventilation were used to decrease the retraction of brain tissue. Patients were brought into a semi-Fowler's position with 10-15 degrees of head elevation and the neck in mild hyperextension. In each case, the patient's head was stabilized with a 3-pinned skull clamp. An incision was made on the frontal scalp to allow sagittal sinus control. A rectangular free bone flap was raised in front of the coronal suture. The medial craniotomy border was determined to end at the median line or even with the superior sagittal sinus. The dura was placed in the midline and large

bridging veins were secured. A surgical microscope was used with retraction of the frontal lobe. Next, the arachnoid adhesions were dissected. The corpus callosum was recognized by its ivory white color. The distal pericallosal artery was identified and was followed in retrograde fashion to its origin. At this point, the aneurysm was reached. Proximal control of the parent artery was obtained when the aneurysm was identified. After the aneurysmal neck base was prepared, it was clipped. The clip was placed parallel to the pericallosal artery. Stenosis did not develop in the pericallosal or callosomarginal artery and sufficient blood flow was maintained. Routine papaverine was administered to the parent artery.

Aneurysms in both patients were clipped using this approach. Hydrocephalus developed 1 week after surgery in Case 1. Treatment was established by ventriculoperitoneal shunt. Apart from this procedure, a second operation was not performed for any reason. Treatment to ensure hypertensive-hypervolemic control was administered in both patients during the post-operative period.

Results

Case 1

A 75-year-old, right-handed female patient presented to our emergency service with the sudden onset of severe headache and vomiting. She was hypertensive with a blood pressure of 195/105 mmHg. She was admitted with a diagnosis of SAH and classified as Hunt and Hess grade III. She was initially treated conservatively for vasospasm prophylaxis with nimodipine by infusion and with 'Triple H Therapy' (for hypertension, hypervolemia and hemodilution). A DACA aneurysm that was being fed on the left was detected by four-vessel cerebral angiography (Fig. 1). She underwent surgical clipping of the aneurysm through a left frontal parasagittal craniotomy using an interhemispheric approach a week later in May 2012. The aneurysm was identified at the junction of the pericallosal and callosomarginal artery. A Yasargil aneurysm clip (Dimeda Instrumente GmbH, Tuttlingen, Germany) was placed. Hydrocephalus was detected by a CT that was performed 1 week after the operation

following an increase in clouding of consciousness. Therefore, a ventricular-peritoneal shunt procedure was performed. From this date on, the patient developed bifrontal infarction with no improvement in her level of consciousness and with the gradual development of herniation. Late cerebral ischemia due to vasospasm occurred. There was no response to medical treatment, and the patient expired on the 15th post-operative day. We theorized that infarction had occurred due to excessive retraction and/or damage to the bridging veins.

Case 2

A 65-year-old right-handed female presented to our emergency service with the sudden onset of severe headache and vomiting. She was hypertensive with a blood pressure of 210/100 mmHg. She was admitted with a diagnosis of SAH and classified as Hunt and Hess grade II. A CT scan revealed interhemispheric subarachnoid hemorrhage. A DACA aneurysm that was fed on the left was detected by four-vessel cerebral angiography (Fig. 2). She was initially treated conservatively for vasospasm prophylaxis with nimodipine by infusion and with 'Triple H Therapy' (for hypertension, hypervolemia and hemodilution). She underwent surgical clipping of the aneurysm through a left frontal parasagittal craniotomy using an interhemispheric approach one week later in September 2013. The aneurysm was identified at the junction of the pericallosal and callosomarginal artery. A Yasargil aneurysm clip (Dimeda Instrumente GmbH, Tuttlingen, Germany) was placed. Her post-operative recovery was good. After 1 week, the patient was fully recovered and discharged. A control DSA performed at the first post-operative month revealed that the aneurysmal sac was not filled (Fig. 3). She had a Glasgow Coma Scale (GCS) of 15 out of 15 with no focal neurological deficits at 3-month follow up.

Discussion

Clinical series [2,5-7,10,11,13-40] in the medical literature from 1948 to 2013 and isolated case reports [41-64] were reviewed (Tables 2 and 3). We obtained a total of 1237 reported DACA aneurysm cases (apart from our cases). It is believed that Sugar and Tinsley [62] performed the first DACA

aneurysm surgery on a 19-year-old girl in 1948, but they could not visualize the aneurysm during the operation. Therefore, they decided to place the clips onto the pericallosal artery. The girl survived with a left hemiparesis. McKissock et al. [28] reported 7 cases of DACA aneurysm with no definite anatomic location in 1956. Baumann and Bucy [43] reported 1 callosomarginal artery aneurysm that underwent surgical treatment in 1957. Laitinen and Snellman [25] reported 14 cases in 1960. The aneurysm was clipped in 10 of the 14 cases. Lehecka et al. [27] presented a ruptured DACA aneurysm series involving 277 cases in 2008, which is believed to be the largest reported series in the English literature.

Some authors use the term “pericallosal artery” to define the anterior cerebral artery beginning from the anterior communicating artery [19,37]. Perlmutter and Rhoton [65] viewed the anterior communicating artery (ACoA) and pericallosal artery as anatomically consistent but considered the callosomarginal artery as anatomically inconsistent. On the contrary, according to Mann et al. [2] and Snyckers and Drake [6], the pericallosal artery is a continuation of the anterior cerebral artery after the callosomarginal artery takeoff. DACA aneurysms can be observed anywhere along the excursion of the artery. However, they are most commonly observed near the genu of the corpus callosum, generally at the pericallosal artery bifurcation [5, 18, 19, 30]. Baptista [66] reported a 25% incidence of DACA-associated vascular anomalies and classified them into 3 major groups: azygos ACA, bihemispheric ACA and triplicate ACA. Rhoton and Perlmutter [65] defined the microsurgical anatomy of DACA and presented similar results. The most characteristic anomaly in DACA aneurysms among these groups is azygos ACA in which the distal segment of the two anterior cerebral arteries form a single trunk. Azygos ACA is reported in 10% of operated cases [5, 19, 27, 30]. In our patients, a vascular anomaly was not reported at surgery or by angiography. Callosal hematoma is an uncommon feature of SAH and is generally caused by ruptured DACA aneurysms. Jackson et al. [67] defined CT imaging of SAH and DACA in detail. According to his experience, supracallosal hemorrhage is not a predictive feature for

DACA aneurysmal bleeding because it may also be observed in ACoA aneurysm-induced SAH. Ruptured DACA aneurysm may be confused with callosal tumor by CT. Therefore, angiography should be performed to refine the differential diagnosis of aneurysm in callosal lesions. In our case, angiography was performed on the 2nd day of hospitalization.

Some DACA aneurysms may go unnoticed because of their small sizes [19,30,68]. Occasionally, it may be difficult to determine the location of a DACA aneurysm. Moreover, despite filling of both pericallosal arteries by an internal carotid artery, the aneurysm may be filled from only one side. Thus, to prevent misdiagnosis, bilateral angiography should be performed. In our two patients, four vessel angiographies were routinely performed.

Only 2.3-18.7% (mean 5.3%) of all intracranial aneurysms in 28 large series were DACA aneurysms. The incidence of DACA aneurysm at our hospital was 8% of all aneurysms (25 cases) that were subjected to surgical treatment. A female preponderance was apparent in our cases as described in the reports of Ohno et al. [30] and Wisoff et al. [10]. Most of the DACA aneurysms reported in the literature occurred on the left side [4,10,19,37]. Both DACA aneurysms in our 2 cases were on the left side.

The specific clinical manifestations of DACA aneurysms are not defined. Generally, however, they present with the classical findings of SAH. On occasion, the proximal and distal arteries may be occluded due to hematoma, vasospasm or inappropriate clipping. If the callosomarginal artery is occluded, a paracentral lobule infarction occurs, which causes contralateral lower extremity paralysis and, at times, loss of control over micturition and defecation. Andrew et al. [42] and Fisher and Ciminello [16] reported defecation and micturition changes as a result of ruptured DACA aneurysms. Pericallosal occlusion, despite being generally asymptomatic, can create hemiplegia [7,25]. Occlusion of the left DACA can sometimes cause aphasia. Aggressive retraction during surgery or interhemispheric hematoma may frequently cause a syndrome similar to temporary akinetic mutism [69].

Transient ischemic attack [2, 28] and mental deterioration [25] may rarely occur.

DACA aneurysms can be classified, like other intracranial aneurysms, as congenital (saccular), traumatic, mycotic and atherosclerotic. The majority of DACA aneurysms are congenital. It is believed that congenital vascular variations in this region may develop from flow disturbances that may lead to aneurysm formation [4,25]. Both of our patients had congenital (saccular) aneurysms.

Anatomically, both DACA aneurysms in our cases were localized to the PC-CM junction. The incidence of DACA aneurysm at this anatomic site is reported as 71% in literature [2,6,19,25,37].

Multiple aneurysms are observed in approximately one fifth of aneurysm cases. The incidence of multiple aneurysms in association with DACA aneurysm is reported to be approximately 50% [10,14,21,25,30]. A reasonable explanation for this finding could not be ascertained. The common occurrence together of multiple congenital vascular anomalies appears to be a flawed explanation. We did not detect multiple aneurysms in our cases.

In addition, rare giant DACA aneurysms are reported in literature [37,48,55,59-61]. Ohno et al.[30] reported that approximately 75% of unilateral pericallosal aneurysms had diameters smaller than 5 mm. This high percentage may be correlated with a tendency for early rupture. We detected aneurysmal diameters of 9 mm and 5 mm, respectively, in our patients.

According to some authors, difficulties are reportedly encountered in surgery for DACA aneurysms [2,4,21,30,40]. These difficulties are: 1) the operative site is too narrow and deep, 2) intense adhesiveness may be encountered in both cingulate gyri, 3) a wide or large base to these aneurysms, which are generally sclerotic, 4) the dome of aneurysm may be buried inside the cingulate gyrus, and may therefore cause retraction and traction rebleeding, 5) multiple aneurysms are frequently observed, 6) the aneurysm may be located at the bifurcation of the azygos ACA,

7) the cingulate gyrus may be confused with the corpus callosum, 8) intra-cerebral and supra-callosal hematomas can obscure anatomic landmarks, and evacuation of these hematomas may lead to rebleeding, which in turn may cause difficulty in differentiating the callosomarginal artery from the pericallosal artery, and 9) in some cases, it is difficult to determine which anterior cerebral artery is causing the aneurysm on angiography, in which case MRI may be helpful to resolve the relationship of the aneurysmal dome with the hemisphere, and a contralateral approach may be more appropriate for aneurysms with a dome facing the opposite side. We did not encounter any of these difficulties.

At times, it may be difficult to obtain control of the pericallosal artery origin because the proximal end of the DACA lies beneath the genu corpus callosum. Proximal control may be accomplished with dissection of the cervical region. In 1992, Traynelis et al. [70] proposed anterior callosal resection for this purpose. In our cases, anterior callosal resection was not necessary.

DACA aneurysms are prone to rupture during surgical exposure. The reason this may occur is because the dome is generally embedded inside the frontal lobe. While the incidence of intraoperative rupture of other aneurysms in the series of Snyckers and Drake [6] was 13%, the rupture incidence during exposure of DACA aneurysms was reported as 50%. To the contrary, rupture was not reported in the series of Wisoff and Flamm [10] and that of Yaşargil and Carter [4]. In both of our cases, rupture did not occur during exposure. In general, cerebrospinal fluid drainage during aneurysm surgery allows for good exposure. However, the small size of the callosal system in DACA aneurysm diminishes the importance of this advantage. If hydrocephalus develops, an intraoperative frontal ventriculostomy may help provide better exposure. In our cases, preoperative hydrocephalus did not develop.

In the series presented (Table 2), the operative mortality was 0-28.6% with a mean rate of 8.1%. Chhabra et al.[5] reported 28.6% mortality in 67 cases. One of our patients died during the 3rd postoperative week due to vasospasm-related infarction.

Various surgical approaches have been suggested for DACA aneurysms. In 1959, Laitinen and Snellman [25] used a subfrontal approach in their first 10 cases but later preferred an interhemispheric approach. In 1979, Yoshimoto et al. [7] proposed bifrontal craniotomy for all aneurysms from the corpus callosum genu to the ACoA because this approach provided rapid proximal vascular control. In 1990, Ohno et al. [30] separated patients into three groups according to the location of the lesion: infracallosal, genu (including PC-CM junction) and supracallosal aneurysms. They proposed an anterior bifrontal approach for infracallosal and genu aneurysms. In 1991, Fukushima et al. [17] proposed a unilateral approach for anterior midline aneurysms. The most frequently accepted surgical tactic for DACA aneurysms is the unilateral frontal interhemispheric approach [2,4,65,70].

one ruptured DACA aneurysms were occluded by endovascular treatment using a coil [3]. Endovascular treatment of DACA aneurysms, despite its technical difficulties and high complication rate, yields good results and is a feasible alternative method [3].

In conclusion; we propose that the difficulties and related complications encountered in surgery of DACA aneurysms will be minimized with sufficient knowledge of microsurgical technique and surgical anatomy. All DACA aneurysms should be aggressively treated whenever possible because they are prone to early rupture.

Rupture should be always considered in endovascular treatment of DACA aneurysms as an alternative method to clipping. Thirty-

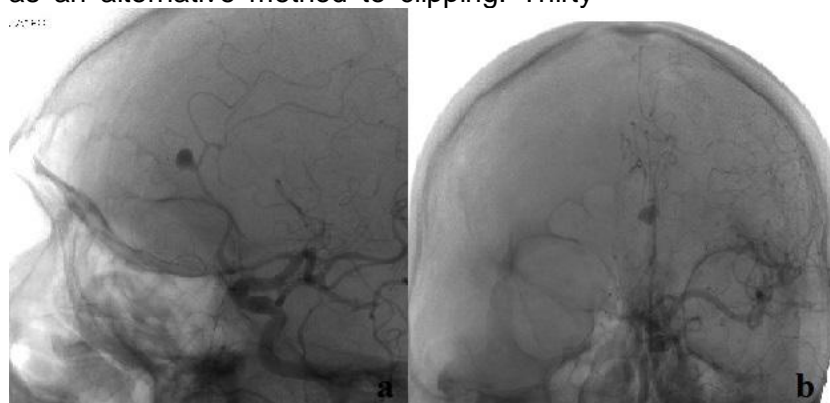


Fig. 1a-b: Preoperative lateral and A-P carotid angiogram showing a distal anterior cerebral artery aneurysm (Case 1).

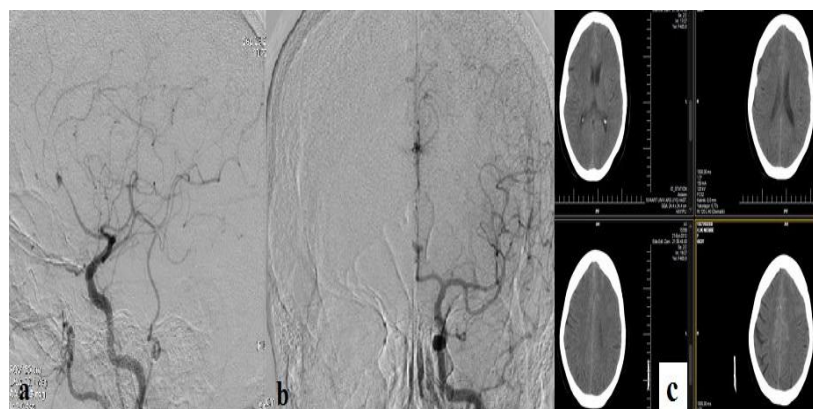


Fig. 2a-b-c: Preoperative lateral and A-P carotid angiogram showing a distal anterior cerebral artery aneurysm. CT scan showing interhemispheric subarachnoid hemorrhage (Case 2).

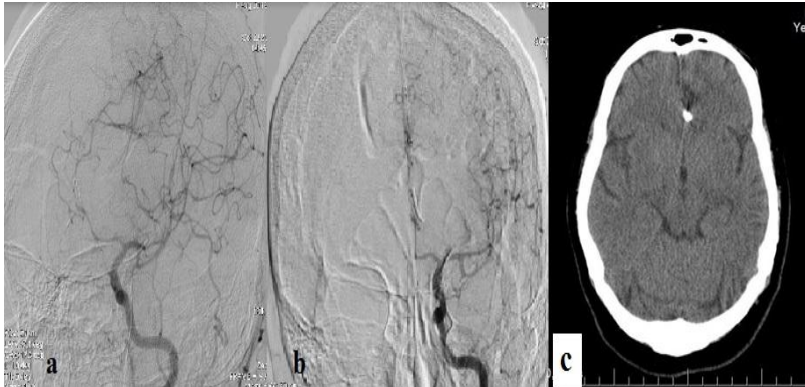


Fig. 3a-b-c: Postoperative lateral and A-P carotid angiogram revealing no residual filling of clipped distal anterior cerebral artery aneurysm. CT scan showing clipping of aneurysm (Case 2).

Table 1. Summary of our cases

Case No	Age/Sex	Preop. Grade *	Etiology	Clinical Presentation	Associated Vascular Anomalies	Treatment	Postoperative Complication	Outcome
1	75/F	III	Congenital	SAH	-	Clipping	Vasospasm Hydrocephalus	Death
2	65/F	II	Congenital	SAH	-	Clipping	-	Good

*According to the classification of Hunt and Hess (11).

SAH: Subarachnoid hemorrhage

Table 2. Previously Reported Series of Saccular DACA Aneurysms

AUTHOR	YEAR	TOTAL ANEURYSM	DACA ANEURYSM	(%) INCIDENCE	NO. OF OPERATED CASES	OPERATIVE MORTALITY
McKissock and Walsh ²⁸	1956	249	7	2,8	4	*
Laitinen and Snellman ²⁵	1960	320	14	4,5	10	1 (10%)
Hamby ¹⁸	1961	107	4	3,7	2	*
Wilson et al. ³⁹	1965	?	4	?	4	*
Pool and Potts ³⁵	1965	?	4	?	4	*
Fischer and Ciminello ¹⁶	1966	?	4	?	3	*
Snyckers and Drake ⁶	1973	437	24	5,5	15	2 (13.3%)
Thomas and Patterson ¹¹	1975	?	36	?	30	7 (23.3%)
Yoshimoto et al. ⁷	1979	1116	34	3	34	1 (2.9%)
Yasargil ^{4,40}	1984	1012	23	2,3	23	0
Mann et al. ²	1984	289	16	5,5	11	0
Wisoff and Flamm ¹⁰	1987	588	20	3,4	20	3 (15%)
Sindou et al. ³⁷	1988	?	19	?	16	0
Ohno et al. ³⁰	1990	459	42	9,1	34	2 (5.9%)
Fukushima et al. ¹⁷	1991	?	26	?	26	2 (7.6%)
Hernesniemi et al. ¹⁹	1992	1150	84	7,3	54	5 (9.2%)
Inci et al. ²¹	1996	494	14	2,8	14	1 (7.1%)
Ng et al. ²⁹	1998	?	30	?	19	3 (16%)
de Sousa et al. ¹⁴	1999	1350	72	5,3	72	5 (6.9%)
Kwon et al. ³⁰	2001	770	19	2,5	19	1 (5.3%)
Kurtsoy et al. ²³	2005	?	12	?	12	0
Chhabra et al. ⁵	2005	?	67	?	67	17 (28.6%)
Dinc et al. ¹⁵	2006	364	26	7,1	25	4 (8%)
Oshiro et al. ³²	2007	365	20	5,5	20	1 (5%)
Pandey et al. ³⁴	2007	2721	41	1,5	13	1 (3.5%)
Steven et al. ³⁸	2007	1109	59	5,3	58	6 (10.3%)
Kim et al. ²²	2007	?	12	?	12	0
Lee et al. ³¹	2008	3577	126	3,5	117	1 (0.9%)
Hsu et al. ²⁰	2008	?	5	?	5	*
Lehecka et al. ²⁷	2008	2243	277	12,3	258	1 (0.4%)
Otani et al. ³³	2009	606	20	3,3	18	2 (11.1%)
Carvi y Nievas. ¹³	2010	?	21	?	10	1 (10%)
Şekerci et al. ³⁵	2011	344	10	2,9	10	0
Orz et al. ³¹	2011	80	15	18,7	15	1 (7%)
		19736	1207	5.3% (mean)	1059	8.1% (mean)

Table 3. Isolated Cases of the Saccular DACA Aneurysm in the Literature

AUTHORS	YEAR	AGE & SEX	LOCATION	SPECIAL FEATURE	TREATMENT	SURGERY OUTCOME
Sugar and Tinsley ⁶²	1948	19 F	Pericallosal	—	Ligated	Fair
Baumann and Bucy ⁴³	1957	39 F	Callosomarginal (R)	—	Trapped	Good
Andrew et al. ⁴²	1965	38 F	Pericallosal (R)	—	Ligated	Good
		62 F	PC-CM J	—	Ligated	Fair
Katz et al. ⁵²	1978	48 F	Pericallosal	Azygos	Conservative	Death
Kondo et al. ⁵³	1979	47 F	PC-CM J	Azygos	Surgery	?
Afshar ⁴¹	1981	29 M	Fronto-polar	—	Clipped	Good
Pozatti et al. ⁵⁹	1982	20 F	Pericallosal	Giant	Ligated	Good
Smith et al. ⁶¹	1982	67 M	Pericallosal	Giant	Excised	Good
Lau et al. ⁵⁴	1984	45 F	PC-CM J (L)	—	Surgery	?
		35 M	PC-CM J	Azygos	Clipped	?
Hayashi et al. ⁴⁸	1985	59 M	DACA	Azygos-Giant	Clipped	Good
		57 M	DACA	Azygos-Giant	None	Unchanged
Maiuri et al. ⁵⁵	1990	64 M	Pericallosal (R)	Giant	None	Unchanged
Preul et al. ⁶⁰	1992	72 M	Pericallosal (L)	Giant	Clipped	Good
Baykal et al. ⁴⁴	1996	48 M	DACA	Azygos	Clipped	Good
		66 F	DACA	Azygos	Clipped	Good
Motohashi et al. ⁵⁸	2004	1 mo F	DACA (R)	—	Clipped	Good
Fujimoto et al. ⁴⁷	2004	59 F	DACA (L)	—	Clipped	Good
Woodworth et al. ⁶⁴	2005	56 M	PC-CM J (L)	—	Clipped	Good
Kashiwazaki et al. ⁵¹	2005	63 M	Pericallosal (L)	Bihemispheric	Clipped	Good
Jagetia et al. ⁵⁰	2007	58 F	DACA (R)	Azygos	Clipped	Good
Huh et al. ⁴⁹	2007	60 F	PC-CM J (L)	Azygos	Clipped	Good
		74 F	PC-CM J (L)	—	Clipped	Good
		78 F	PC-CM J (L)	Azygos	Clipped	Good
Dunn et al. ⁴⁶	2010	52 M	Pericallosal (R)	—	Trapped, Anastomoz	Good
Weil et al. ⁶³	2010	51 F	Callosomarginal (L)	—	Clipped	Good
Choi et al. ⁴⁵	2011	59M	DACA (Bilateral)	Mirror	Clipped	Good
Matsuzaki et al. ⁵⁶	2011	48 M	DACA Accessory	Bihemispheric	Clipped	Good
Mizunari et al. ⁵⁷	2011	62 M	DACA (Bilateral)	Mirror	Clipped	Good

* The percentage of operative mortality is not given in series with less than 10 cases.

DACA, distal anterior cerebral artery; PC-CM J, pericallosal-callosomarginal junction

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