CASE REPORT

The Orbitopterional Approach for Large and Giant Middle Cerebral Artery Aneurysms: A Report of Two Cases and Literature Review

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ABSTRACT

We report two cases of complex middle cerebral artery aneurysms that were surgically treated using the orbitopterional approach in a two-piece method. The objective of this work is to discuss the usefulness of the orbitopterional approach in the surgical management of large and giant middle cerebral artery aneurysms. A 32-year-old man with a giant aneurysm and a 50-year-old woman with a large and complex aneurysm presented with subarachnoid hemorrhages. Both aneurysms were successfully clipped through an orbitopterional approach. This approach permits a more basal view of the vascular structures with only a minor retraction of frontal lobe. It also increases the view angle and amount of working space available. This approach should be considered as an alternative to the classic pterional craniotomy for the surgical management of such complex lesions.

KEYWORDS: Orbitopterional approach, giant aneurysm, middle cerebral artery, subarachnoid hemorrhage

Giant aneurysms of the middle cerebral artery (MCA) represent 13% of all giant intracranial aneurysms.[1] Approximately 4% of the aneurysms located within the MCA are giant and occur most frequently at the bifurcation.[2] The prognosis of these aneurysms is very poor. The rate of rupture is high, and this risk increases over time. The annual rupture rate for a giant aneurysm located in the anterior circulation is 8%, and intra-aneurysmal thrombosis does not preclude rupture or rebleeding of such lesions.[3–5] Complications that contribute to the morbidity and mortality of these aneurysms include the progressive enlargement of the aneurysm with local mass effects and distal ischemic events.[1,6] It is therefore generally indicated to treat large and giant aneurysms. The available therapeutic options include surgery, endovascular therapy, or a combination of both.[6–10]

In the present article, the authors report on two cases of complex MCA aneurysms with previous subarachnoidal hemorrhages that were treated by surgical clipping using the orbitopterional approach. We discuss the various methods of treatment of these complex aneurysms with an emphasis on the possible surgical approaches and the advantages of an orbital osteotomy.

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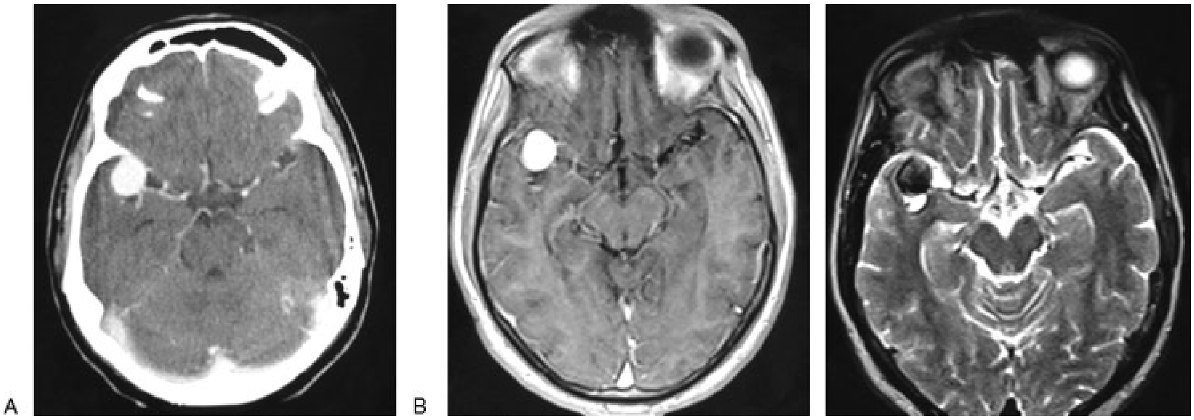

Figure 1 (A) Contrast-enhanced computed tomography scan. (B) Axial T1-weighted contrast-enhanced magnetic resonance (MR) image and (C) axial T2-weighted MR image showing an aneurysm inside the right Sylvian fissure.

CASE REPORTS

Case 1

A previously healthy 32-year-old man was admitted to a regional hospital after an episode of sudden headache with loss of consciousness and seizures. He was diagnosed with a subarachnoidal hemorrhage, and radiological and angiographic investigation showed a giant aneurysm of the right MCA. The patient was referred to our hospital 3 months after the bleed for specialized treatment. At admission, the neurological examination revealed only a mild central facial palsy on the left side. Computed tomography (CT) and magnetic resonance imaging demonstrated a lesion in the right Sylvian fissure, which was indicative of a giant aneurysm of the MCA (Fig. 1). Cerebral angiography detected a giant aneurysm at the bifurcation of the right MCA (Fig. 2). The superior trunk was not seen and the collateral pial anastomoses supplying its vascular territory were mainly comprised of branches of the anterior cerebral artery (ACA).

We opted for direct surgical treatment of the aneurysm by a right orbitopterional approach in a two-piece method. First, a pterional craniotomy was made as described by Yasargil[11] with small modifications,[12,13] and in so doing we preserved the superficial temporal artery for a possible bypass procedure. The dura was dissected free from the sphenoid wing and anterior and temporal fossa, and the periorbita was dissected from the roof and lateral wall of the orbit. Second, a superolateral orbital osteotomy was performed by using a high-speed drill and a small chisel. The first cut started laterally to the supraorbital notch and ended at the lateral aspect of the superior orbital fissure. The second cut began at the orbital rim in the inferior point of the lateral wall, parallel to the zygomatic arch, and was directed toward the inferior orbital fissure. The last cut connected the two previous ones and extended from the superior to the inferior orbital fissures (Figs. 3 and 4). After the dural opening, the superficial layer of the Sylvian fissure was

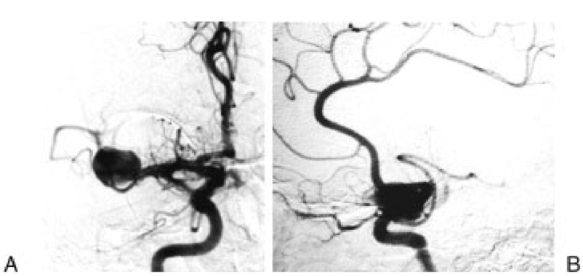

Figure 2 (A) Front and (B) lateral views of the right carotid angiography revealing the giant aneurysm of the middle cerebral artery.

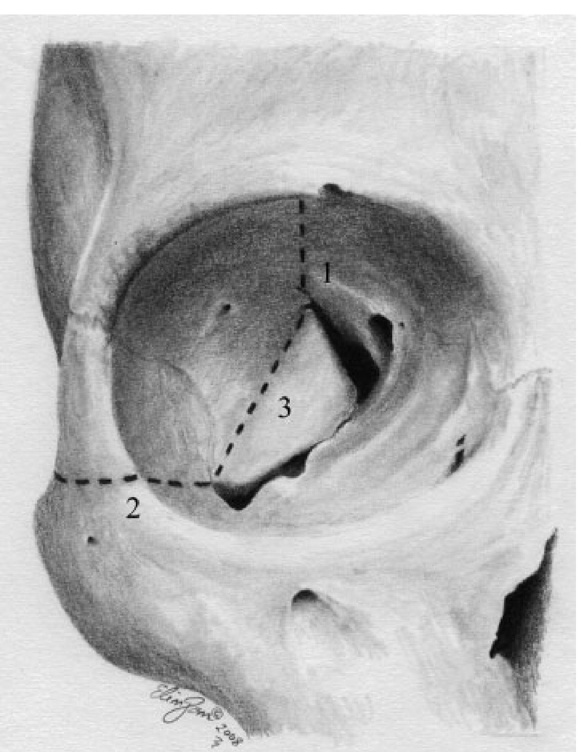

Figure 3 Artistic representation showing the orbital view of osteotomies (dotted lines). The numbers represent the order of cuts.

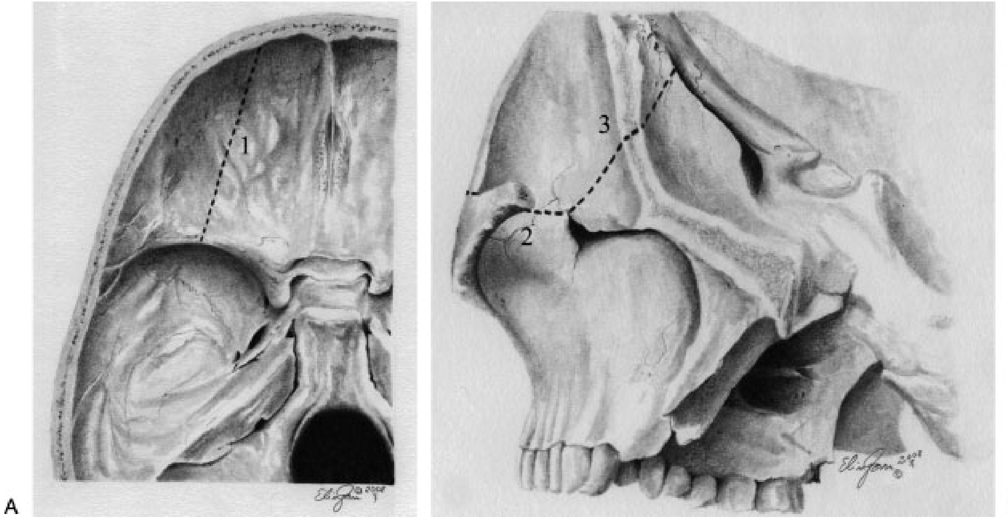

Figure 4 Artistic representation of the osteotomies. (A) Intracranial view of the first cut: dotted line 1. (B) Second and third cuts showed by a combined extra- and intracranial view after the pterional craniotomy. The zygomatic arch was removed to show the inferior orbital fissure.

opened and exposed the aneurysm. The aneurysm filled the fissure, and gaining space by splitting it was not possible. The frontal lobe was slightly retracted and the carotid artery and carotid bifurcation were seen. The MCA was dissected distally to the point of the aneurysm. The lesion measured ~3 cm across its greatest diameter. It was further dissected with care and the inferior trunk was identified. A temporary occlusion of the M1 segment and the inferior trunk was performed under mild hypothermia and a continuous propofol infusion. The aneurysmal sac was opened, and a thrombectomy was performed. Further dissection around the aneurysm was facilitated by internal decompression, and we identified a thin thrombosed superior trunk arising from the aneurysmal sac. A small clip was applied distally to the superior trunk, and it was subsequently transected. Two straight clips were applied to the broad neck of the aneurysm, and the aneurysmal sac was resected. We decided not to perform a bypass because the superior trunk was very thin and totally thrombosed and because the preoperative angiography showed a good collateral circulation from the ACA branches.

The patient's postoperative course was uneventful. A CT scan showed a small ischemic area in the temporal posterior region with no apparent clinical significance, and the postoperative cerebral angiography showed no evidence of continued aneurysm filling (Fig. 5). The patient was discharged from hospital on postoperative day 7 with no new deficits. At the follow-up evaluation after 1 year, temporal muscle atrophy was present but there were no cosmetic bone defects or other complications.

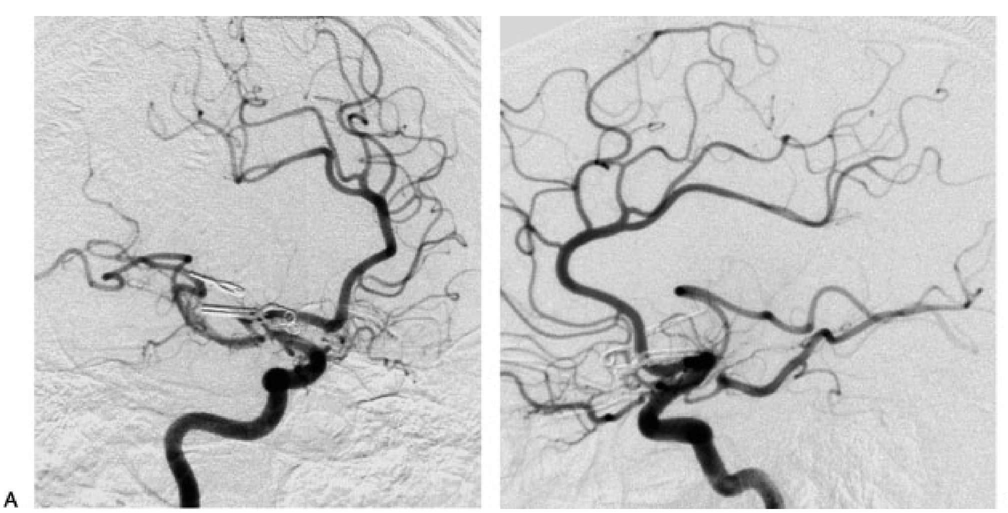

Figure 5 (A) Oblique and (B) lateral projections of the postoperative right carotid angiography showing complete exclusion of the aneurysm from the circulation.

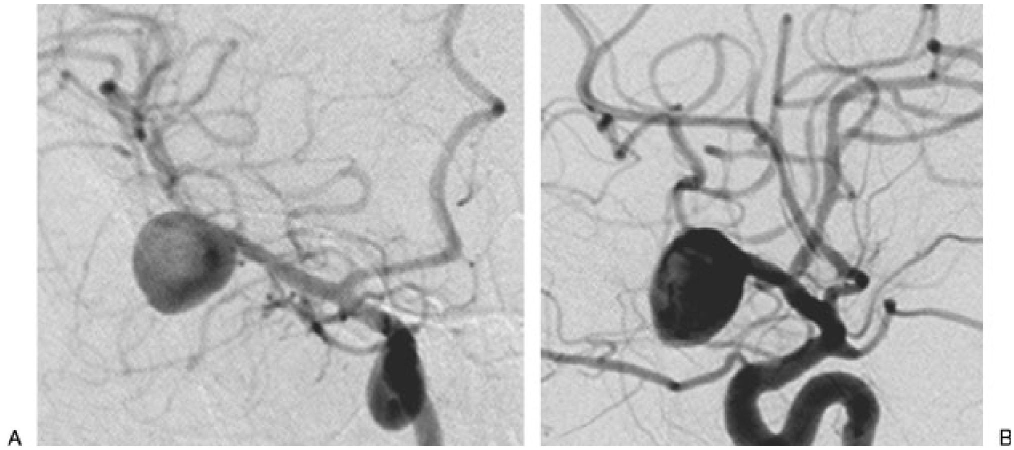

Figure 6 (A) Oblique and (B) lateral projections of the right carotid angiography demonstrating a large middle cerebral artery aneurysm.

Case 2

A 50-year-old woman was admitted to another institution with a history of a sudden, severe headache, nausea, and a seizure. Nuchal rigidity was observed, and a CT scan revealed a subarachnoid hemorrhage. The patient was referred to our hospital 1 month after this episode for treatment. The neurological examination was normal and a cerebral angiogram showed a large aneurysm of ~2 cm in the bifurcation of the right MCA (Fig. 6).

The aneurysm was clipped by an orbitopterional approach in a two-piece method as described in case 1. After opening the Sylvian fissure and basal cisterns, the aneurysm and superior trunk were identified. With mild hypothermia and a continuous propofol infusion, a temporary clip was placed on the M1 segment of the MCA. After this maneuver, the aneurysmal sac softened, which facilitated further dissection. The aneurysm had a large complex neck and was clipped with three clips in a tandem technique with preservation of the superior and inferior trunks.

The postoperative course was uneventful, and the control cerebral angiography showed complete exclusion of the aneurysm from circulation (Fig. 7). At the follow-up assessment after 6 months, a frontal paresis was verified but no bone defects were present.

DISCUSSION

Treatment is indicated whenever possible to improve the severe natural history of large and giant aneurysms. Despite advances in microsurgery and endovascular techniques, treatment of these lesions continues to be a challenge. Endovascular treatment with coil embolization has a significant incidence of rebleeding after coiling and is often associated with both a low complete occlusion rate and a high recanalization rate with coil compaction. Embolization with a liquid polymer with or without stenting has a low complete occlusion rate, and recanalization can also occur. Endovascular deconstructive techniques can be used in selected cases, which are generally associated with a revascularization procedure.[9,14–19]

When compared with endovascular treatments of large and giant aneurysms, surgery has a better rate for the complete obliteration of the aneurysm. Morbidity and mortality related to the surgical treatment of giant

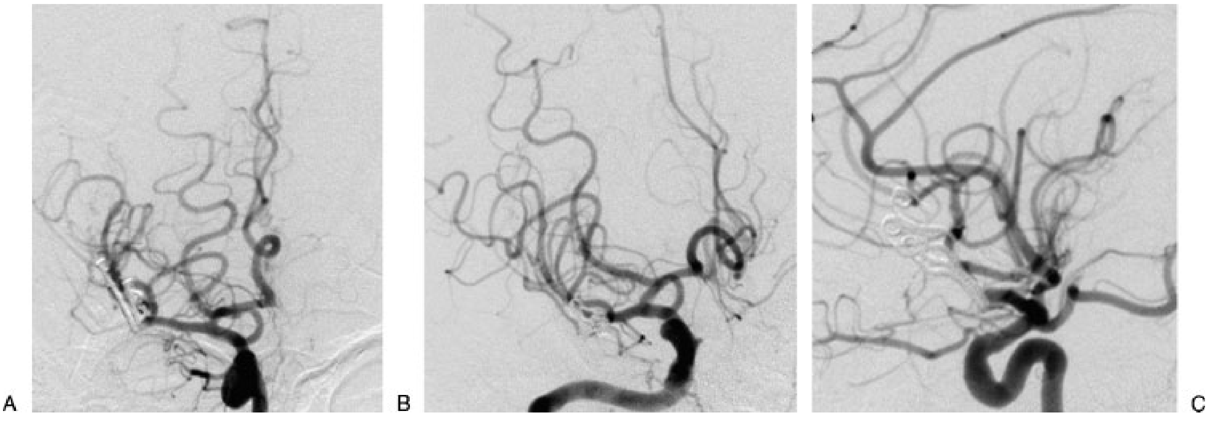

Figure 7 (A) Front, (B) oblique, and (C) lateral views from the postoperative angiography revealing the complete obliteration of the aneurysm.

aneurysms of the anterior circulation are comparable with those of endovascular techniques. Therefore, surgery should be considered as the treatment of choice for these aneurysms if it is feasible. The main objectives of surgery are the exclusion of the aneurysm from the circulation, preservation of blood flow in the parent vessels, and relief of the mass effect of the aneurysm.[10,19,20]

The best method of microsurgical occlusion is by the direct clipping of the aneurysmal neck. Because the necks of these lesions are frequently wide, broad, and thickened, the application of several clips may be necessary to complete the occlusion. When direct clipping is not possible, other techniques, such as the excision of the aneurysm with an anastomosis of the parent vessels or parent vessel occlusion and trapping, with or without a revascularization procedure, should be used.[10,21–25]

Classically, the giant and large aneurysms of the MCA were surgically treated through a pterional craniotomy with extensive drilling of the sphenoid wing.[2,20,26,27] With development of skull base techniques that expand the exposure of the pterional approach and minimize brain retraction, some authors advocate the use of cranial base approaches for giant and complex aneurysms of the anterior circulation.[10,22,28–30]

The orbitopterional approach is a modification of the orbitozygomatic approach, where a pterional craniotomy is combined with a superolateral orbitotomy and preservation of the zygomatic arch.[31–33] It can be accomplished in one- or two-piece methods. In the two-piece method, the pterional craniotomy is made first in the standard fashion, and a superolateral orbitotomy is then performed separately. The one-piece method combines the pterional craniotomy and the orbital osteotomy into one bone flap.[32,34–36] We prefer the two-piece method where the orbital osteotomies can be performed more posteriorly, which diminishes the need for orbital reconstruction and the risk of a blind fracture of the orbital roof.

Possible complications of this approach are cosmetic deformity, enophthalmos, pulsatile exophthalmos, palpebral ptosis, and blindness. We observed a frontal paresis in one case and atrophy of the temporalis muscle in the other. No cosmetic bone deformities or other major complications were seen.

Table 1 Summary of Published Cases of Complex MCA Aneurysm Approached by Orbitopterional Craniotomy

Author and Year	Age (y)/ Sex	Size	Surgical Technique	Approach-Related Complications	Outcome
Smith et al 1989[30]	61/M	—	—	Frontalis weakness	—
	32/F	—	—	None	—
	31/F	—	—	Temporalis atrophy	—
	54/M	—	—	None	—
Sindou and Alaywan 1990[33]	—	Giant	Clipping + aneurysm sac resection	None	—
Origitano et al 1993[28]	54/M	—	—	Displacement of cranial bone flap	—
Ikeda et al 1994[43]	13/M	Giant	Clipping + reinforcement of aneurysm remnant with oxycellulose and cyanoacrylate glue	—	Rebleeding after 3 mo requiring new surgery; GOS: 4
Sekhar et al 2005[44]	49/F	Giant	Clipping + bypass with SVG	None	Internal capsule infarct; GOS: 4
	72/F	Giant	Excision of aneurysm + aneurysmorrhaphy	None	Clotting of aneurysmorrhaphy requiring new surgery; GOS: 5
	51/F	Large	Excision of aneurysm + branch reimplant	None	GOS: 5
	49/F	Small	Excision of aneurysm + arterial patch on MCA bifurcation	Paresis of III, V, and VII cranial nerves	GOS: 5
Present study	32/M	Giant	Clipping + aneurysm sac resection	Frontal paresis	GOS: 5
	50/F	Large	Clipping	Temporalis muscle atrophy	GOS: 5

—, not reported; GOS, Glasgow Outcome Scale; MCA, middle cerebral artery; SVG, saphenous vein graft.

Alaywan and Sindou[37] described an increase in the view angle of 75% with the orbital osteotomy when compared with the pterional craniotomy alone, using the optic-carotid complex as a target. Schwartz and colleagues,[38] using a frameless stereotactic device, also showed a significant increase in surgical exposure with an orbital osteotomy. The area of exposure of the pterional trans-Sylvian approach was increased from 26 to 39%.

The cranial approaches combined with an orbital osteotomy are mainly indicated for lesions of the sellar, suprasellar, and parasellar regions, along with the anterior fossa and orbit.[32,34,39,40] Sindou et al[41] also reported the utilities of these approaches for lesions of the Sylvian fissure and mesial temporal area. Other studies have shown the advantage of this approach for accessing anterior communicating artery aneurysms.[35,39,40,42]

We conducted a literature review on orbital osteotomies in the surgical treatment of complex aneurysms of the MCA (Table 1). Ikeda et al[43] reported a case of a giant fusiform aneurysm at the horizontal portion of the MCA in a child, which was approached by an orbitopterional craniotomy. Sekhar et al[44] published their series of complex MCA aneurysms that needed reconstruction, and four of them (two giant, one large, and one small) were treated by an orbitopterional approach. Sindou and Alaywan[33] reported a case of a giant aneurysm and observed that the orbital removal facilitated the exposure of the neck. Smith et al[30] and Origitano et al[28] recommended the use of orbitocranial approaches to treat complex aneurysms of the MCA.

The main advantages of an orbitopterional approach for complex MCA aneurysms are: (1) it provides multidirectional viewing of the aneurysm, which makes surgical dissection possible via multiple routes; (2) it involves minimal brain retraction; and (3) it enables access to the aneurysm via the shortest possible distance from the surface.[28,30,33,41] We also observed that this approach enabled a greater angle of view and working space around the internal carotid artery and MCA, which allowed for an earlier dissection of these structures and proximal vascular control of the aneurysm. The increased working space also made the dissection and clipping of the aneurysm less difficult when compared with the pterional approach.

In conclusion, we report two cases of complex MCA aneurysms that were successfully clipped via an orbitopterional approach. This approach permits an increase in the angle of visualization and effective working space with the need for only minimal brain retraction, which facilitates the proximal control, dissection, and clipping of aneurysms. It is a safe procedure that we now consider as the optimal option in the surgical management of large and giant complex MCA aneurysms. For complex but small MCA aneurysms, we still prefer to use the classical pterional approach without orbital osteotomy.

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