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Case Report

Awake craniotomy for trapping a giant fusiform aneurysm of the middle cerebral artery

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Abstract

Background: Giant fusiform aneurysms of the distal middle cerebral artery (MCA) are rare lesions that, because of the absence of an aneurysm neck and the presence of calcified walls and partial thrombosis, can be difficult to clip without sacrificing the parent vessel. Moreover, when the aneurysm is located in the dominant hemisphere, it is not possible to test language and cognitive functions during surgical intervention, making the closure of the parent vessel extremely dangerous.

Case Description: A 46-year-old woman presented with a one-year history of frontal headache without neurological deficit. A magnetic resonance imaging and an angiography showed a giant fusiform aneurysm of the left M2 tract. Because of the location and the absence of a neck, the aneurysm was considered difficult to coil and not amenable to preoperative balloon occlusion; thus, the patient was a candidate for surgical treatment. After a preoperative psychological evaluation, patient underwent awake craniotomy with the asleep–awake–asleep technique. A standard left pterional approach was performed to expose the internal carotid artery, the MCA and the aneurysm originating from the frontal branch of the MCA. Neurological examination responses remained unchanged during temporary parent artery occlusion, and trapping was successfully performed.

Conclusions: Awake craniotomy is a useful option in intracranial aneurysm surgery because it permits neurological testing before vessels are permanently clipped or sacrificed. With the asleep–awake–asleep technique, it is possible to perform a standard pterional craniotomy, which allows good exposure of the vascular structures without cerebral retraction.

Key Words: Awake craniotomy, giant aneurysm, middle cerebral artery, pterional approach

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INTRODUCTION

Distal middle cerebral artery (DMCA) aneurysms are rare lesions that account for approximately 5% of all intracranial aneurysms.[12,15] The great majority of these aneurysms are related to an infectious process originating in other regions.[13] Fusiform aneurysms are even more rarely encountered,[16] and they present many challenges for the surgeon. The structure of the sac, with its calcified walls, inner partial thrombosis and the absence of a real neck, makes it difficult to perform a clipping without sacrificing the afferent vessel; furthermore, trapping without an extra-intracranial bypass increases the risk of postoperative neurological deficit, especially in eloquent areas. Moreover, when the aneurysm is located in the dominant hemisphere, intraoperative testing of motor and language functions is ideal; intraoperative continuous electroencephalography, motor evoked potentials (MEP), and somatosensory evoked potentials (SEP) monitoring only partially address this problem. Preoperative functional testing, such as temporary balloon occlusion, can be hazardous. Wada testing (selective amobarbital injection in the parent vessel) is desirable but may be unreliable or impossible because of the location of the aneurysm.

The authors herein report their experience with a case of a giant fusiform aneurysm of the distal tract of the left middle cerebral artery (MCA). The patient was treated with trapping and exclusion of the aneurysm during awake craniotomy, to allow adequate neurological function monitoring before M2 vessel sacrifice in the eloquent hemisphere.

MATERIALS AND METHODS

A 46-year-old, right-handed, female patient sought a neurological examination for a one-year history of headache. She denied any previous pathology but reported a family history of cavernomatosis. Although her neurological exam was normal, a brain magnetic resonance imaging (MRI) showed an intracranial mass (about 4 cm) located in the left Sylvian fissure; the mass was hypointense in T1 weighted (T1w) sequences and showed inhomogeneous enhancement after gadolinium injection [Figure 1a]. Angio-MRI sequences suggested a giant aneurysm of the left MCA, with partial thrombosis.

The patient was referred to us for angiography with possible endovascular embolization. Angiography confirmed the presence of an aneurysm originating from the M2 tract [Figure 1b]. Iodated contrast showed one afferent and two efferent vessels, leading to the diagnosis of a fusiform aneurysm of the left M2 tract. The endovascular team considered embolization with afferent vessel preservation impracticable. A balloon occlusion test (BOT) of the afferent vessel was then attempted, but the vessel's small diameter and the high risk of rupture made the test impracticable. The patient was a candidate for surgical treatment.

A standard pterional craniotomy with trapping of the aneurysm was planned with the following algorithm. To obtain the best neurological monitoring of motor and language function, the team decided to perform the intervention during awake surgery, with temporary clipping of the afferent vessel for more than 30 minutes. If the patient showed no deficit, trapping would be completed; if any neurological alteration was found, an intraextracranial bypass with a previously prepared superficial temporal artery (STA) would be performed.

Preoperative and intraoperative neurophysiological assessment

A psychologist evaluated the patient with the following tests: The mini-mental state examination, denomination, object recognition, repetition of words and phrases, and simple (counting) and complex (math) calculation tests.

The patient was evaluated with preoperative electroencephalogram (EEG), which did not show significant alterations. An intraoperative neurophysiological assessment was performed with continuous EEG, using a Jasper monitor.

Anesthesia

Local anesthesia was accomplished with 40 ml of 7.5% ropivacaine injected through the left emilateral coronal

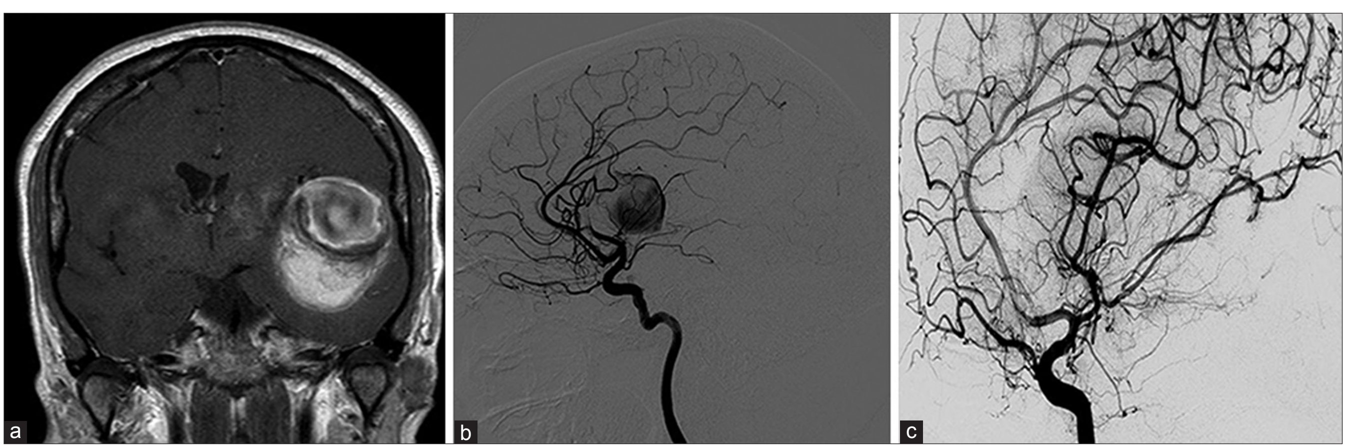

Figure 1: (a) Preoperative MRI, T1w sequences with gadolinium injection: Aneurysm mass located in the left Sylvian fissure, (b) Preoperative angiography showing the aneurysm's injection from a branch of the middle cerebral artery, (c) Postoperative angiography showing the complete exclusion of the aneurysm from the circle

line, the surgical wound incision line and the pinsites of the Mayfield head frame. Bilateral selective blocking of the supraorbital branches of the trigeminal nerves was also accomplished.

Propofol was infused through a dedicated venous line during the opening and closing phases of the surgical procedure, at a dose of 0.1-0.5 mg/kg/h. Two doses of propofol 30 mg were administered immediately before bladder catheter placement and Mayfield head frame positioning. A total of 200 mcg of fentanyl was also infused (100 mcg before Mayfield head frame placement and 100 mcg before skin incision).

Surgical technique and postoperative course

The patient was posed in a supine position with the head rotated at 30°. Coverage was arranged to allow the best visualization for the psychologist and neurophysiologist, while allowing adequate exposition of the surgical field. A 10 cm-long STA was prepared with microsurgical dissection for possible use as a low-flow bypass. Before the craniotomy proceeded, the temporal muscle was injected with a local anesthetic (lidocaine), then exposed and isolated with the one-layer technique and displaced inferiorly. Adequate visualization of the patient's face was maintained for the intraoperative neuropsychological test, although the full exposition of the skull base was easily obtained. The root of the zygoma and the zygomatic process of the frontal bone were exposed.

Standard pterional craniotomy was performed by drilling the sphenoid wing and the roof of the orbit. Local anesthesia of the dura mater was achieved by placing xilocaine-soaked cottonoids on the basal portions of the temporal and frontal bones. The dura mater was opened according to standard procedures and a satisfactory intradural pterional microscopic view was obtained. The Sylvian fissure was markedly swollen, appearing as an underlying mass; it was opened wide under microscopic magnification. The opticocarotid fissure was also opened to obtain proximal control of the internal carotid artery. The left M2 branch was found, and the fusiform aneurysm was exposed, with temporary clipping of the afferent vessel. After 30 minutes, the patient showed no neurological deficits, so the aneurysm was completely trapped and debulked with Cavitron ultrasonic aspirator and microscissors. Closure was performed according to standard procedures. The immediate postoperative neurological examination was normal.

The next day, the patient showed a mild speech deficit, which disappeared within 3 days. Angiography showed the complete exclusion of the aneurysm from the circle [Figure 1c]; injection in the left vertebral artery showed collateral circles from the posterior cerebral artery, which supplied the temporal lobe [Figure 2a and b]. The patient was discharged home 10 days after surgery.

DISCUSSION AND CONCLUSIONS

DMCA aneurysms are rare lesions that account for approximately 5% of all intracranial aneurysms.[12,15] Giant fusiform aneurysms in adults are even more uncommon, with a frequency of 0.06% of all intracranial aneurysms.[1] They arise from a structural defect of the arterial wall and involve a variable length of the artery; the sac can expand concentrically or protrude outward on either side.[7]

DMCA aneurysms can have an infectious etiology (infectious aneurysms – IA); in these cases, an infectious process located elsewhere (i.e., the heart, in the great majority of patients) and embolization of a small fragment of infective material can represent the origin of the aneurysm, which is usually smaller, with high risk of bleeding and located on M3 and/or M4 tracts.[13,14] Our

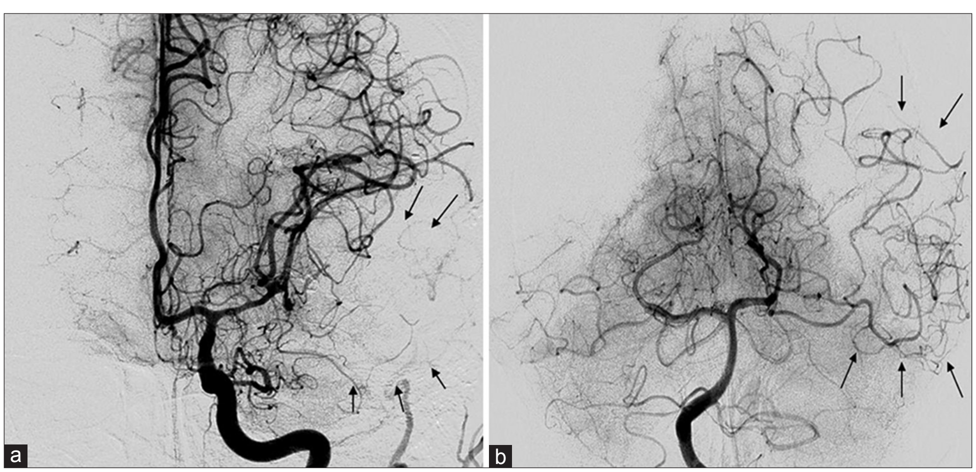

Figure 2: Postoperative angiography, (a) Injection of the left internal carotid artery showing no distribution of the contrast in the left temporal lobe (arrows), (b) Injection of the basilar artery, which demonstrates the collateral circle from the posterior cerebral artery supplying the left temporal lobe (arrows)

patient reported no fever or history of previous infections, all preoperative assessments were normal, and the aneurysms was located on M2 tract, so septic processes and infectious etiology were excluded.

Surgery was planned to obtain a decisive treatment, but the optimal surgical strategy was unclear and options were amply discussed. Direct clipping was excluded because of the absence of a real neck and the presence of arterial branches from the sac; trapping was considered, but doubts remained about the need for an extra-intracranial bypass. Drake and Peerless noted that fusiform aneurysms in adults must be considered a consequence of a structural defect of the entire arterial tract; this feature explains why many cases show collateral circles that exclude the affected artery from the functionally active circulation.[7] In these patients, the relatively low risk of postoperative neurological deficits makes trapping the aneurysm tempting. However, the possible consequences of trapping should be ruled out with imaging and/or functional tests during preoperative planning, and this sort of evaluation can be extremely difficult. Moreover, if the collateral circles are inadequate, parent artery sacrifice could have deleterious effects if the vessel is supplying the eloquent brain. Options to determine the consequences of parent vessel sacrifice include BOT and selective amobarbital injection (Wada testing). Although endovascular test occlusion can be impracticable for peripherally located aneurysms, Wada testing in MCA branches seems unreliable.[13] If parent artery occlusion indicates too many risks, extra-intracranial bypass before aneurysm trapping must be considered.[4-6,10,11]

Intraoperative monitoring with EEG, MEP, and SEP is extremely useful for detecting possible motor and sensory deficits, but language and cognitive functions cannot be tested under general anesthesia. In recent years, awake craniotomy has been amply used to monitor motor and language functions during surgical resection of brain gliomas, with excellent results;[3,8,9,16] however, it has shown poor utility in intracranial aneurysm surgery. In the present study, this technique was used to adequately monitor brain function. If monitoring indicated that trapping could lead to neurological deficits, a bypass would be performed; therefore, a temporary artery was prepared for a possible STA-MCA. Luders, *et al*. reported their experience with the surgical treatment of brain aneurysms during awake surgery: Three patients with radiological diagnoses of DMCA aneurysms (without any previous Sub-Arachnoid Hemorrhage-SAH) were treated with awake surgery to test neurological functions during aneurysm sac clipping. In each patient, the neurological status was unchanged after the aneurysm occlusion, and the postoperative course was uneventful.[13] Our experience shows that this kind of treatment can be applied to giant intracranial aneurysms when necessary.

Awake craniotomy can be a valid surgical option for complex intracranial aneurysms when motor and language function monitoring is mandatory and when the afferent artery occlusion cannot be evaluated with other techniques.

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Commentary

In this article, the use of an awake craniotomy is reported to allow for formal neurological examination of a patient during trapping of a giant fusiform M2 aneurysm. This represents an elegant application of a technique more commonly used during the surgical treatment of intracranial tumors or during cortical resection for epilepsy than in the management of a complex neurovascular problem. It should be noted that such awake intraoperative testing can be challenging and will generally require an experienced surgeon and excellent coordination with the anesthesiology team. The authors should be commended for the smooth execution of this technique and the excellent result.

At our center, the fact that this patient would have tolerated the occlusion would have been predicted by careful evaluation of the preoperative angiogram showing slow filling through the affected middle cerebral artery (MCA) segment and good leptomeningeal collateralization of the affected vascular territory. Intraoperative motor evoked potential's and somatosensory evoked potential's would have confirmed this, and an intraoperative arteriogram would have shown collateralization of the affected territory after temporary clipping of the involved segment.

Despite this, we would likely have performed a low flow, superficial temporal artery-MCA, bypass in this case given the unpredictability of the collateral circulation to prevent an ischemic injury in delayed fashion and given the potential risk to language function, which cannot be properly monitored with electrophysiological testing in the asleep patient.[1,2] In our experience, such a bypass adds less than 1 hour to the procedure, carries minimal morbidity, allows the surgeon to rest better the night of surgery, and improves the safety of the occlusion for the patient.

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