Use of STA-MCA Anastomosis for Clipping of Giant Middle Cerebral Artery Aneurysm
—Case Report—

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Abstract
A 50-year-old female developed subarachnoid hemorrhage due to rupture of a giant aneurysm in the left middle cerebral artery (MCA). One month later, direct surgery was performed on the aneurysm. The superficial temporal artery was anastomosed to the cortical artery of the parietal MCA segment. The MCA was exposed and trapped for 40 minutes during barbiturate infusion, with electroencephalographic and somatosensory evoked potential monitoring. During MCA trapping, the aneurysm was collapsed by dome puncture and obliterated by neck clipping. After surgery, she had only mild amnestic aphasia and an infarct in the medial temporal lobe demonstrated by computed tomography. However, cerebral angiography disclosed complete occlusion of the MCA by the displaced aneurysm clip, and perfusion of the distal MCA segments through the anastomosis. The initial bypass procedure prevented a disastrous outcome in this patient and is recommended for direct surgery on MCA aneurysms.

Key words: direct surgery, giant aneurysm, intraoperative monitoring, middle cerebral artery, STA-MCA anastomosis, trapping

Introduction
Direct surgical treatment of giant middle cerebral artery (MCA) aneurysm has resulted in poor outcome or death in 30% of patients. The main cause of these poor results is an occlusion of the parent artery and/or its branches due to the clipping itself or to clip migration, and aneurysm rupture due to incomplete obliteration. Temporary trapping of the parent artery is often necessary for aneurysm clipping. The time limit for trapping requires intraoperative monitoring of somatosensory evoked potentials (SEPs) or cortical cerebral blood flow (CBF) measurement.

We describe a patient who underwent direct surgery for a ruptured left MCA aneurysm of 40 mm diameter. We also discuss the usefulness of preliminary superficial temporal artery (STA) to MCA anastomosis and intraoperative monitoring during giant aneurysm surgery.

Case Report
A 50-year-old female suddenly experienced severe headache and vomiting in December, 1991, and was immediately brought to our hospital. She was alert, with neck stiffness and Kernig's sign but no other neurological deficit. Computed tomographic (CT) scans demonstrated a large high-density mass surrounded by a clot in the left Sylvian cistern. Cerebral angiograms disclosed an aneurysm of 40 mm diameter in the trifurcation of the left MCA (Fig. 1 left). The frontal, parietal and temporal segments branching from this location were visualized for a longer time but with less opacity, suggesting delayed circulation. Surgery was postponed. One week later, postcontrast CT scans showed the aneurysm was highly enhanced, except the posterior crescent-
shaped part. This crescent was of high intensity on a T1-weighted magnetic resonance (MR) image, suggesting thrombus (Fig. 2). Her condition remained uneventful until January, 1992, when surgery was performed on the aneurysm.

General anesthesia was induced with orotracheal intubation and barbiturate was infused continuously with electroencephalographic (EEG) and SEP monitoring. SEPs were periodically recorded on the scalp of left parietal region in response to bipolar stimulation of the right median nerve. The rate of barbiturate infusion was chosen to cause a burst-suppression pattern on the EEG every 3 seconds. A large, question mark scalp incision was made in the left frontotemporoparietal region to involve the longest section of STA possible. The posterior branch of STA was dissected from the skin flap and anastomosed to the cortical artery of the parietal segment just above the Sylvian fissure after craniotomy and dural incision. The latency of the SEP N20 peak stayed between 22.64–22.96 msec, a little prolonged over normal (18–20 msec), probably due to the deep anesthesia with barbiturate infusion. The proximal segment of the MCA was then dissected in the Sylvian fissure to expose the aneurysm beyond the origin of the lenticulostriate arteries. The MCA was pursued more distally, and the frontal and parietal segments were identified. However, the temporal segment, presumably running anteriorly and then posterolaterally under the aneurysm, was hidden. The neck of the aneurysm was as wide as 15 mm. Clips were placed on the proximal segment of the MCA beyond the origin of the lenticulostriate arteries, and on the frontal and parietal segments. The dome of the aneurysm was punctured by a 25 gauze needle and 20 ml of blood was aspirated. The aneurysm completely collapsed. A 35 mm straight clip was successfully applied to the neck portion and another 15 mm clip more medially to prevent migration of the first clip toward the parent artery (Fig. 3). The clips were removed from the MCA and the position of the clips on the neck portion were confirmed to not kink the arterial trunks. The MCA was occluded for 40 minutes, but there was no significant further prolongation of the SEP latency which was then 22.64–23.60 msec. Barbiturate infusion was stopped and the wound was closed.

She awoke a little later than usual with only mild amnestic aphasia. CT scans demonstrated a shrunk aneurysm appearing as a high-density area and a low-density area in the left medial temporal lobe (Fig. 4). Cerebral angiograms disclosed complete occlusion of the MCA by the clips, distal to the origin of the lenticulostriate arteries, and perfusion of the...
frontal and parietal segments by antero- and retrograde flow through the anastomosis (Fig. 1 right). Visualization of these segments was more rapid than before surgery, suggesting faster circulation. The temporal segment was, however, occluded by the clips. She was discharged in good condition after 3 months.

**Fig. 3** Intraoperative photograph (left) and illustration (right), showing the giant aneurysm, temporary clips on the proximal and distal segments of the left MCA (arrowhead), 35 mm clip on the neck portion of the aneurysm (double arrow), and the punctured dome of the aneurysm (arrow).

**Fig. 4** Postoperative CT scans, showing a shrunk high-density aneurysm and a low-density infarct in the left medial temporal lobe.

Discussion

Direct surgery on a giant cerebral aneurysm requires i) exposure of the aneurysm, ii) trapping of the parent artery, iii) incision of the aneurysmal dome and removal of the thrombus, iv) clipping of the aneurysmal neck, and v) release of the trapping.\[16,31\] Temporary trapping is crucial for successful clipping of a giant aneurysm. Therefore, thorough pre- and intraoperative studies are necessary to evaluate cerebral tolerance to probable ischemia and intensive protective therapy for the brain.

The preoperative occlusion test for the internal carotid and vertebrobasilar arteries using a balloon technique can demonstrate changes in clinical manifestations, CBF, SEPs and auditory brainstem responses. However, this is impossible in the MCA and so the time limit for vascular occlusion should be set using perioperative physiological studies. Jabre and Symon\[16\] suggested that 5-10 minutes is the maximum permissible when MCA occlusion includes the deep perforating segments, and 10-15 minutes is permissible when it includes the distal segments, based on 66 patients with temporary vascular occlusion during aneurysm surgery. Giant aneurysms allow much more prolonged MCA occlusion, because collateral circulation may already exist encouraged by partial occlusion of the main artery. Use of barbiturate\[27\] or mannitol\[29\] presumably prolongs the permissible occlusion time. Kidooka et al.\[15\] and Symon et al.\[31\] recorded SEPs using bipolar stimulation of the median nerve during aneurysm surgery and found that the central conduction times, the interpeak latencies between the N14 and N20 peaks, were prolonged by the temporary MCA clipping. Prolongation of more than 1.0-1.2 msec or disappearance of the N20 peak adversely affected the postoperative conditions in some patients. They concluded that SEP is a useful index of intraoperative ischemic events. A thermal diffusion probe has also been used to measure the cortical CBF continuously during vascular occlusion.\[60\] Actual CBF augmentation through the extra- to intracranial bypass can be observed with this methodology, but the correlation to
clinical outcome cannot be evaluated. SEP is therefore a more suitable evaluation.

Proximal occlusion of the parent artery or trapping of the aneurysm with an extra- to intracranial bypass procedure has been used for the treatment of surgically inaccessible giant aneurysms, especially in the internal carotid artery.1,4,12-19 Trapping or resection of a giant MCA aneurysm with a bypass has been reported.2,14 Complications include ischemic events and rupture of the aneurysm. The multicenter study in Japan12 reported that the ischemic events and rupture of the aneurysm. The incidence was higher in older patients, on the left side (39%) rather than the right side (15%), and in their incidence was higher in older patients, on the left side (39%) rather than the right side (15%), and in gradual ligation (39%) rather than abrupt ligation (20%). Possible mechanisms include the development of emboli at the occlusion site or inadequate flow from the anastomosis.3,10 Rupture of a previously unruptured giant aneurysm after bypass surgery has been attributed to the resultant change in pressure/flow dynamics.3,18,23 The bypass caliber should be as small as possible consistent with adequate CBF after occlusion, and the parent artery should be completely occluded as soon as possible after the bypass. Definitive aneurysm surgery should also not be delayed after the bypass.

In our patient, direct surgery was essential for the giant aneurysm, since it had ruptured and had a wide neck unsuitable for intravascular balloon embolization. There were three other possible courses in our case. Firstly, temporary trapping of the MCA, followed by clipping of the aneurysm, without bypass. We were not sure how long the temporary trapping would be needed, or whether the brain could tolerate ischemia even with continuous barbiturate infusion. We were also afraid that the aneurysm could not be successfully clipped, requiring permanent trapping of the artery. Furthermore, a clip on a giant aneurysm, even when successfully placed, may migrate toward the parent artery resulting in occlusion. This fact really occurred. The 35 mm straight clip, used in our case, has a holding pressure of 150–200 g. The pressure was insufficient to obliterate an aneurysmal neck as wide as 15 mm. In retrospect, a booster clip was required to reinforce the pressure by more than 100 g, instead of the additional 15 mm clip in the medial portion. Without a bypass, the outcome would have been disastrous. The second was a bypass procedure, followed by cerebral angiography to confirm the patency and direct surgery. The bypass procedure may have induced rerupture of the aneurysm due to the subsequent hemodynamic changes. The patency of the bypass was demonstrated by the intraoperative SEP changes. The third was testing of direct clipping, followed by a bypass procedure only if long temporary trapping was needed. The giant aneurysm had a history of rupture. If rerupture occurred before the aneurysm and surrounding arterial trunks was made, the outcome would also have been disastrous.

We conclude that an initial bypass procedure and temporary trapping are safer for direct surgery on giant MCA aneurysms.

References

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