

RECANALIZATION OF LONG-LASTING MIDDLE CEREBRAL ARTERY OCCLUSION BY A COMBINATION OF SURGICAL AND INTERVENTIONAL APPROACHES: TECHNICAL CASE REPORT

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OBJECTIVE AND IMPORTANCE: In strictly selected cases of middle cerebral artery (MCA) occlusion, revascularization by extracranial-intracranial (EC-IC) bypass can be considered. The interventional recanalization of the occlusion under direct surgical control has not been reported in the literature so far.

CLINICAL PRESENTATION: A 39-year-old Caucasian female patient had experienced an ischemic stroke 15 years before she came to our attention. At that time, occlusion of the right MCA was diagnosed by angiography. Her neurological deficit resolved within 6 months. Fifteen years later, the patient experienced repeated numbness of her left-sided extremities, which was refractory to medical treatment. Angiography revealed an occluded M1 segment of the MCA. Perfusion computed tomography without and after CO₂ stimulation disclosed impaired cerebrovascular capacity.

INTERVENTION: The patient was scheduled for EC-IC bypass. The MCA tree was exposed, and the occluded portion was found to be 10 mm long. We then decided to reopen the vessel by balloon dilation under direct visual control. A catheter was advanced to the M1 origin, where a guidewire was passed into the vessel lumen. With only a little help from the surgeon, it was surprisingly easy to direct the guidewire through the occluded segment. At this time, flow through the M1 segment was re-established. Flow through the MCA that had occluded for 15 years was re-established.

CONCLUSION: On the basis of our experience, in nonatherosclerotic occlusions, intravascular intervention may be considered.

KEY WORDS: Combined approach, Middle cerebral artery occlusion, Recanalization

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The development of sophisticated diagnostic tools, including single-photon emission computed tomography (CT), perfusion CT, and positron emission tomography, and the introduction of interventional neuroradiology have been directly linked to the notable increase in active treatment of cerebral ischemia (1, 10, 17, 19, 25). The redefined indications for extracranial-intracranial (EC-IC) bypass and the possibilities for interventional radiology, together with a better understanding of the hemodynamic properties of the brain's vascular supply, are bringing some new insights and approaches for treating cerebral ischemia (7, 12, 21). This is especially true in cases where the two subspecialties can collaborate as a team to provide

services to patients. The sections below further document such an approach in an unusual case of one of our more unique patients.

CASE REPORT

A 39-year-old Caucasian female patient had experienced an ischemic stroke 19 years ago during her pregnancy. The stroke was major, leaving the patient with dense hemiparesis. The condition, however, resolved slowly during the next 6 months, after which the patient exhibited no apparent signs of deficit. At that time, the occlusion of the M1 segment of the right middle cerebral artery (MCA) was demonstrated angiographically. The patient was treated medically, and no active measures

were undertaken. Her pregnancy continued normally, and a healthy child was delivered without complication.

She came to our attention 15 years later after experiencing repeated numbness of her left-side extremities as well as the left side of her mouth. The patient experienced these attacks, which always lasted several minutes, at least twice a month during the preceding 6 months despite aggressive medical treatment.

On admission in 2000, her neurological status indicated only a mild increase of her left-sided reflexes; otherwise, she was neurologically intact. CT showed two small, old infarcts in the right basal ganglia (Fig. 1). Ultrasonography indicated normal carotid arteries extracranially. Angiography disclosed a right MCA occlusion directly at the MCA origin, with some moyamoya-like vascularization (Fig. 2). It was rather complicated to discover the origin of the occlusion because it had happened long ago. Nevertheless, we assumed that the origin of the occlusion was nonatherosclerotic. Both perfusion CT and single-photon emission CT without and after CO₂ stimulation disclosed a grossly impaired cerebrovascular reserve capacity. In accordance with our EC-IC protocol, the patient was scheduled for EC-IC bypass (2).

Surgery

A curved cranial skin incision was made, and both branches of the superficial temporal artery were inspected. Direct dopplerometry indicated that neither of the branches had sufficient flow. The decision to switch to a high-flow bypass was made, and the incision was extended to allow a pterional craniotomy. Simultaneously, the saphenous vein was harvested from the right calf, and the carotid bifurcation at the neck was exposed. The usual recipient for our grafts is the anterior temporal artery. Thus, the sylvian fissure was dissected and the MCA tree was exposed, disclosing an abnormal vasculature. The most prominent arteries were those of the anterior choroidal artery branches and the recurrent artery of Heubner, all of which were as much as 1.5 mm in diameter, passing along the occluded M1 segment and entering the brain underneath. The occluded portion, in which no flow was observed, was approximately 10 mm long and appeared comparable to a thick, fibrous band (Fig. 3A). No atherosclerotic changes were observed, and all arteries apart from the occluded segment appeared healthy. At this point, several options were considered, including high-flow bypass and end-to-side bypass from the distal M1 back to C6 with an interposition of a saphenous



FIGURE 1. Computed tomographic image showing two small ischemic lesions (arrow) in the right basal ganglia.

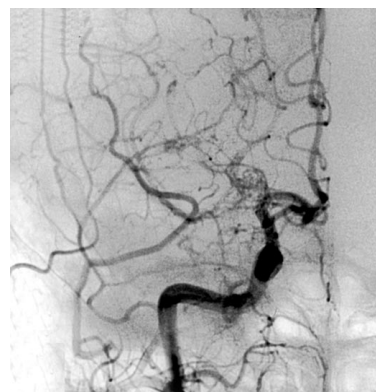


FIGURE 2. Preoperative angiogram showing occlusion of the M1 segment of the right MCA.

vein graft. Finally, the decision was taken to reopen the vessel by balloon dilation under direct visual control. Accordingly, our interventional neuroradiological team was summoned. The sheath was introduced into the exposed common carotid artery, and the catheter was advanced to the origin of the M1 segment under angiographic guidance. A Stealth 2-mm balloon (Boston Scientific, Boston, MA) was introduced proximal to the MCA occlusion with the use of Sorcerer 9 wire (Balt, Montmorency, France). Then the Sorcerer 9 wire was exchanged for Zero Valve wire (Boston Scientific). The occluded segment branched from C7 to A1 at a right angle. The guidewire was easily passed through the vessel lumen, and with a little help from the surgeon, it was surprisingly easy to direct the guidewire through the occluded segment. As soon as the wire passed the occlusion, flow through the M1 segment was re-established (Fig. 3B). The M1 segment appeared surprisingly normal, though slightly narrowed. After this maneuver, the balloon was introduced and balloon dilation was performed. The M1 segment appeared normal after this procedure, and normal flow was ascertained by direct dopplerometry. Before endovascular maneuvers, heparin (5000 U intravenously) was administered. We did not encounter any problems with perioperative bleeding. Papaverine was applied to the exposed arterial tree, and then the wounds were closed in a layered fashion.

The patient made an uneventful recovery and was later discharged to home. Angiography performed 3 days after surgery disclosed reopening of the M1 segment. Cerebrovascular reserve capacity measurements performed by single-photon emission CT without and after CO₂ stimulation disclosed normalization of the circulatory parameters. Repeat angiography 3 months postoperatively showed normal MCA filling (Fig. 4). Three years after surgery, the patient underwent an operation for a lumbar disc herniation at our department. At that time, the patient was neurologically intact, and transcranial Doppler and perfusion CT revealed normal flow properties in the right cerebral hemisphere. Four years after reopening of the long-lasting MCA occlusion, the patient is enjoying a normal and productive lifestyle. Follow-up mag-

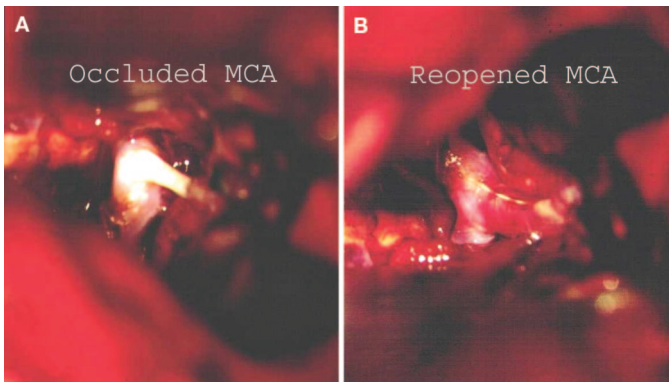


FIGURE 3. Intraoperative photographs showing the occluded MCA (A) and the reopened MCA (B). The glidewire can be observed within the vessel.

netic resonance angiography in September 2004 revealed a patent right MCA (Fig. 5).

DISCUSSION

After publication of the EC-IC bypass study, enthusiasm for these procedures with respect to cerebral ischemia of atherosclerotic or occlusive origin markedly decreased (9). However, the bypass procedure, along with several variations thereof (e.g., high-flow bypasses at the base of the cranium), has survived in some cases. Various bypasses have recently been used, e.g., in the management of cranial base tumors (3, 26) and giant intracavernous aneurysms (4, 11, 14). A few publications are trying to restore confidence in the EC-IC bypass in strictly selected subgroups of patients with cerebral ischemia of hemodynamic origin (13, 22, 24). Presently, the Carotid Occlusion Surgery Study is being conducted, and the final results should elucidate the role for EC-IC bypass in such cases (1).

Another line of progress is represented by interventional neuroradiology, which recently has shown success in intracranial stenosis, by either percutaneous balloon dilation (18) or stenting procedures (15, 16). Such procedures require similar indication criteria as those of EC-IC bypasses. The major advantages of interventional neuroradiology are its capability to restore normal flow through the original vessels and its less invasive nature. Regarding matters of decision making, the availability of both techniques

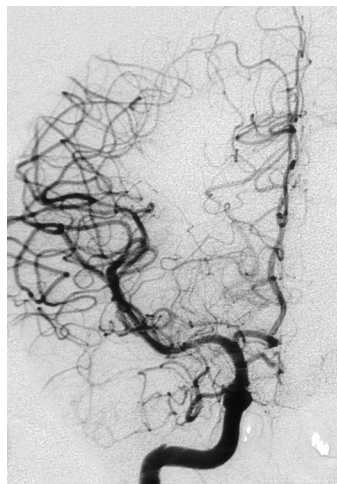


FIGURE 4. Angiogram taken 3 months after the surgery showing a patent right MCA and no signs of stenosis.

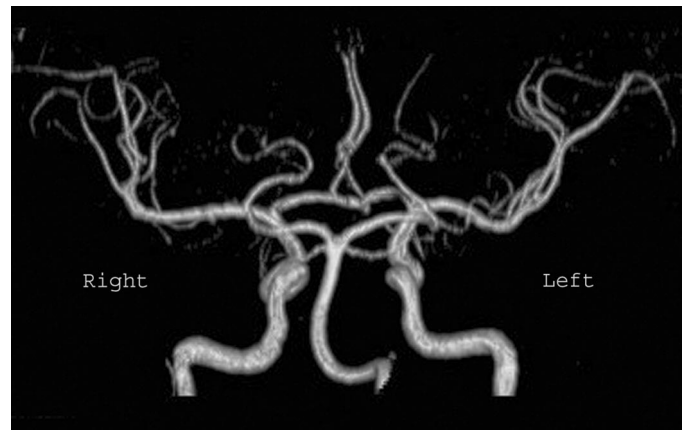


FIGURE 5. Magnetic resonance angiogram taken 4 years after the surgery showing a patent right MCA.

is advantageous. In most instances, microneurosurgery and interventional neuroradiology should both be considered in the planning for which procedures should be performed.

Various reports exist on emergency embolectomy of the MCA (8, 20, 29). Recently, however, the trend is to use thrombolysis for the treatment of an acutely occluded MCA (6, 23, 27, 28). Some attempts at transcatheter snare MCA embolus removal have also been conducted (5).

To our knowledge, there is no report in the literature on flow restoration in a long-lasting MCA occlusion. Our patient is the first in whom reopening was achieved with the combined techniques of microneurosurgery and interventional neuroradiology. We also think that this is the first report in which a patient with a proven occlusion was successfully treated after 15 years of blockage. It is most probable that the interventional approach would have been sufficient by itself. However, we did not think that reopening of the vessel would be possible after 15 years of occlusion. Actually, before surgery, we never considered the interventional option as viable but rather chose to perform the EC-IC bypass, which was indicated according to our protocol (2). Consequently, the decision to include an interventional approach was determined during the operation. We were unable to perform a regular EC-IC bypass, and the decision to summon the interventional team was made only after considering other possibilities. If the interventional technique had proved unsuccessful, we would have proceeded with the high-flow bypass procedure. We suspect that we were successful only because the occlusion was probably not of atherosclerotic origin and that the lumen must have been somehow preserved, though not functional. The appearance of the vessel before reopening was that of a typical long-lasting occlusion, i.e., a thick, fibrous band of tissue.

CONCLUSION

In this single case, it was possible to recanalize a long-lasting MCA occlusion by a combination of surgical and in-

terventional approaches. We stress the utmost importance of the cerebrovascular neurosurgeons' and interventional radiologists' collaboration in the treatment of cerebrovascular disorders.

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COMMENTS

The authors report a case of successful endovascular recanalization and balloon angioplasty of long-standing middle cerebral artery occlusion, performed intraoperatively under direct surgical control. The arterial occlusion was documented angiographically when this 39-year-old woman presented 15 years earlier, and moyamoya-like vessels developed subsequently in response to poor collateral circulation to the right hemisphere. The report is interesting because of the unexpected success. However, this approach is potentially risky, with the possibility of arterial perforation with the guide wire or rupture with angioplasty. Without direct visualization at surgery, the procedure would have been even riskier. Therefore, this approach is unlikely to be applicable to the majority of occluded middle cerebral arteries, and instead represents a rare case of a fibrous occlusion in a young patient. The authors demonstrate flexibility intraoperatively, teamwork with their neuroradiologists, and careful planning in preparing for bypass.

Michael T. Lawton
San Francisco, California

This is a truly remarkable case report. Reopening a chronically occluded middle cerebral artery is a unique phenomenon. It is extremely important for the reader to note that the initial stroke occurred in a very young woman during pregnancy and was appar-

ently unassociated with any evidence of atheromatous disease elsewhere. Upon representation fifteen years later this patient met anatomic and hemodynamic criteria for extracranial/intracranial bypass.

The decision to use an endovascular strategy was interesting and highly successful. In this setting, using a combined surgical exposure to assist in the navigation of the catheter may have been extremely helpful as the segment of middle cerebral artery occlusion would have been blind angiographically potentially increasing the risk of perforation. The microsurgical appearance of the occluded segment seemed to preclude success of angioplasty. The fact that it was successful should give us pause. Traditional thinking would hold that chronic venous sinus occlusion is amenable to reopening whereas chronic arterial occlusion is not. Clearly, we need to rethink our strategies in young patients like this one. This patient achieved a spectacular result.

H. Hunt Batjer
Chicago, Illinois

This is a fascinating case of endovascular revascularization of a longstanding middle cerebral artery occlusion. The procedure was performed under direct surgical observation as the original goal was surgical bypass of the occluded vessel. The surgeons decided to perform endovascular exploration with the feeling that any perforation or rupture could be handled immediately, and that revascularization would obviate the need for bypass.

Remarkably, the endovascular treatment was successful as demonstrated by clinical symptomatology and immediate and delayed imaging. Although I would not advocate passing a wire through a 15-year-old intracranial occlusion for obvious reasons, this case is unique with the open surgical view of the procedure. While I believe it is unlikely, this case makes one wonder if other types of intracranial occlusions such as *moya-moya* disease might respond to endovascular treatment under direct surgical control. Certainly, the issue of stents and more powerful antiplatelet agents would be significant if required in open surgical patients.

Sean D. Lavine
New York, New York

This case report describes an unusual maneuver for revascularization in a patient with longstanding middle cerebral artery occlusion, i.e., endovascular balloon dilatation under direct observation after craniotomy. Few people would have thought to treat this by interventional means in the first place, neither have the authors. The fact that superficial temporal artery and middle cerebral artery anastomosis—the procedure of choice—was technically impossible and a high-flow bypass in a situation with *moya-moya*-like collateralization would have been too risky, forced them to find an alternative intraoperatively. Thus they advanced a balloon ‘with a little help from the surgeon’ and reopened the vessel successfully. They are to be commended for finding their way out of a difficult situation by a clever and courageous maneuver. To my knowledge, this is the first time that an interventional procedure is reported under such circumstances. However, I feel that it merely illustrates an option for a very rare situation. A general recommendation ‘to consider intravascular interventions in nonatherosclerotic lesions’ cannot be deduced from a single successful case. So, the relevant message is that, nowadays, a team approach is needed to tackle cerebrovascular diseases.

Bernhard Meyer
Bonn, Germany

The authors have reported a fascinating case in which a middle cerebral artery occlusion of 15 years duration was successfully treated by intraoperative transluminal angioplasty. It is remarkable that this occluded middle cerebral artery had not fibrosed over the years and was able to be successfully reopened, apparently on a permanent basis. Although this therapeutic option is intriguing, I suspect most patients with chronic middle cerebral artery occlusion from atherosclerosis would not likely be suitable candidates for endovascular treatment. This case, however, underscores the importance of using a multidisciplinary approach to cerebrovascular disorders, as well as maintaining an attitude of creativity throughout all cerebrovascular surgical procedures.

Daniel L. Barrow
Atlanta, Georgia