Occipital Artery to Middle Cerebral Artery Bypass: Operative Nuances

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■ BACKGROUND: **Superficial temporal artery (STA)—middle cerebral artery (MCA) anastomosis is a common procedure for vascular neurosurgeons, and it is used in a variety of diseases. However, there are cases in which the STA is absent or is too hypoplastic to be used as a donor for revascularization. Occipital artery (OA)—MCA bypass may be a treatment option in these cases.**

■ METHODS: **We encountered 4 cases of symptomatic cerebral ischemia in which the STA was absent or unavailable. These cases were treated by revascularization from the OA to the periphery of the MCA.**

■ RESULTS: **By meticulous dissection of the OA to the level of the superior temporal line, the OA could reach the periphery of the angular artery and be anastomosed to it in the usual fashion. The patency of the donor artery was confirmed by magnetic resonance angiography soon after the operation and 3 years later.**

■ CONCLUSIONS: **OA-MCA bypass may be a surgical option for cerebral revascularization when the STA is not available.**

Superficial temporal artery (STA)—middle cerebral artery (MCA) bypass is an established procedure used to treat a variety of diseases, such as cerebral ischemia, complex cerebral aneurysms, and neoplasms. However, in certain cases, the STA is absent or unavailable because of hypoplasia or a previous operation. In these cases, graft bypass is sometimes adapted using the radial artery, saphenous vein, occipital artery (OA), or other vessel, but graft bypass has several limitations, such as a need for complex procedures and the production of multiple surgical scars. In this article, we report use of the OA in place of the STA for direct anastomosis and describe the technical nuances of this approach.

MATERIALS AND METHODS

Between 2007 and 2015, 187 external-to-internal carotid artery bypasses were performed at our institution to treat moyamoya disease and hemodynamic ischemia because of atherosclerotic steno-occlusive disease of the major cerebral arteries. In ischemic steno-occlusive disease, the surgical indication was determined based on the criteria of the Japanese EC-IC Bypass Trial (JET study),[1] assessing the cerebral blood flow using single-photon emission computed tomography with iodine^{123} N-isopropyl-iodoamphetamine accompanied by acetazolamide challenge when possible.

Among the cases, OA-MCA bypass was performed in 4 cases (**Table 1**). One case involved ischemic moyamoya disease,[2] and the other 3 involved atherosclerotic steno-occlusive disease. In the moyamoya case, the frontal branch of the STA had anastomosis with the anterior cerebral artery; hence, the parietal branch of the STA and OA was anastomosed to the M4 portion of the MCA.

TECHNICAL NOTE

During the operation, the patient was placed in the lateral position, with the head slightly rotated to the contralateral side, and the vertex was slightly elevated to reduce venous pressure. After confirming the course of the OA with Doppler sonography, a curved incision was made along the suboccipital and subgaleal segments of the OA. The OA was dissected from the galea under a microscope, from its periphery to the point where it pierces the splenius capitis muscle (**Figure 1A**). Retraction with a skin hook to open the incision slightly upward is useful to identify small branches of the OA because they exist in the same loose areolar tissue as the main trunk. Along the main trunk, one large branch can be identified in the subgaleal portion, which

Key words
- Cerebral ischemia
- EC-IC bypass
- Moyamoya
- OA-MCA bypass
- Occipital artery

Abbreviations and Acronyms
DSA: Digital subtraction angiography
MCA: Middle cerebral artery
MRA: Magnetic resonance angiography
OA: Occipital artery
STA: Superficial temporal artery

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Table 1. Patient List

Case	Age (years)	Sex	Presentation	Preoperative Condition of STA	Single/Double	Site of First Anastomosis	Site of Second Anastomosis	Follow-Up Period (years)
1	54	M	Cognitive disturbance	Hypoplastic/retrograde via OA	Double	Angular	Post. temporal	5.4
2	30	F	Infarction (moyamoya)	Frontal br. fed cortex	STA parietal br. plus single OA	Posterior temporal		5.0
3	71	F	TIA	Already used	Double	Angular	Post. temporal	4.4
4	69	F	TIA	Cut in previous operation	Double	Angular	Post. temporal	3.1

STA, superficial temporal artery; M, male; OA, occipital artery; F, female; Post. temporal, posterior temporal artery; br., branch; TIA, transient ischemic attack.

should be preserved for use as a conduit for rinsing inside the donor artery and for a second anastomosis (**Figure 1B**). To dissect the suboccipital portion of the OA, the sternocleidomastoid muscle was reflected anteriorly with the skin flap. The splenius capitis muscle was cut along the OA, and the upper part was also reflected anteriorly to make room for the guttering. The descending branches of the OA supplying the suboccipital muscles were dissected and cut after coagulation. Where the main trunk of the OA makes a hairpin curve, the connective tissue between the curve was dissected to stretch the OA during the anastomosis procedure. A concomitant vein was dissected from the OA to enhance the visibility and movability of the OA. By reflecting the longissimus capitis muscle inferiorly, the OA was exposed near the mastoid process.

The incision was then extended anteriorly along the superior temporal line from the upper end of the vertical incision to perform the craniotomy.

To prevent compression of the donor artery while the patient was lying supine, a gutter was made from the bottom of the craniotomy toward the proximal OA (**Figure 1C**). After manipulation of the bone, the OA was transected at the peripheral end, and its lumen was rinsed with heparin saline. Because the OA has few branches between the origin at the external carotid artery and the exposed suboccipital segment, heparin saline was injected to fill the proximal lumen, and the OA was occluded with an aneurysm clip to prevent clot formation. The length of the harvested OA was approximately 7 cm, and it was anastomosed to the periphery of the angular artery with intermittent sutures using 10-0 nylon (**Figure 1D**). Because the recipient artery was a peripheral artery, the diameter was smaller than the usual recipient M4 in STA-MCA bypass. Hence, the arteriotomy had to be a little longer than in the STA-MCA bypass to ensure that the vessel walls met correctly. The other branch of the OA was anastomosed to the posterior temporal artery as well (**Figures 1E** and **1F** and **Video 1**).

RESULTS

The postoperative course was uneventful in all 4 cases. Magnetic resonance angiography (MRA) performed 3–5 years after the operation showed patency of the bypass in all 4 cases (**Table 1**).

Illustrative Cases

Case 1. A 54-year-old man presented with dysarthria and confusion. He had a history of cerebral infarction in the right frontal lobe 9 years previously and had been on low-dose aspirin. Magnetic resonance imaging revealed a new infarction in the left basal ganglia and occlusion of the right internal carotid artery, which had already been noted. On digital subtraction angiography (DSA), there was also severe stenosis at the A1 segment of the left anterior cerebral artery. The right MCA area was perfused through a leptomeningeal anastomosis from a posterior cerebral artery. Single photon emission computed tomography showed decreased blood flow in the right parietal lobe. Acetazolamide challenge revealed a compromised vascular reserve in this area. Therefore, cerebral revascularization was recommended. The patient's right STA was not palpable on physical examination. On DSA, the right OA had developed enough to supply the frontal area (**Figure 2A**); hence, direct OA-MCA bypass was performed. Postoperative DSA showed a patent bypass (**Figure 2B**), and the patient returned to his job 5 months after the operation. MRA performed 3 years later showed patency of the bypass (**Figure 2C**).

Case 3. A 71-year-old woman presented with a transient ischemic attack of motor aphasia and right hemiparesis. She had undergone an STA–anterior cerebral artery bypass for a minor stroke in the anterior cerebral artery region (**Figure 1G**) and had been taking 100 mg of aspirin daily. Because MRA showed severe stenosis at the M1 portion of the MCA, 75 mg of clopidogrel was added. Because the ischemic attack occurred again and because single photon emission computed tomography showed decreased cerebral blood flow, OA-MCA bypass was performed (**Figure 1**). Postoperatively, the ischemic attack stopped, and antiplatelet therapy was reduced to 100 mg aspirin only. MRA performed 1 year later revealed patent OA (**Figure 1H**).

Video

Video available at WORLDNEUROSURGERY.org

DISCUSSION

STA-MCA bypass is a basic procedure for vascular neurosurgeons that is used to treat a variety of diseases such as cerebral ischemia, complex aneurysms,[3] and tumors.[4] However, there are cases in which the STA is hypoplastic or aplastic, and in those cases, a graft bypass is sometimes adapted using the radial artery, saphenous vein,[5] or OA,[6] among others.