Emergency In Situ Bypass during Middle Cerebral Artery Aneurysm Surgery: Middle Cerebral Artery-Superficial Temporal Artery Interposition Graft-Middle Cerebral Artery Anastomosis

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Many reports have been published on complications related to middle cerebral artery (MCA) aneurysm surgical clipping procedures. We report an emergency intracranial in situ bypass surgery case which was performed as a rescue procedure after aneurysmal neck laceration during clipping of an MCA large aneurysm. In this case, we performed in situ M3-superficial temporal artery (STA) interposition graft-M3 bypass procedure. If a STA-MCA anastomosis is not available under MCA flow obstruction, we can consider an emergency in situ MCA-MCA bypass procedure with or without an STA interposition graft.

Key Words: Middle cerebral artery aneurysm · Clipping · In situ bypass.
pass pedicle was detected (Fig. 3). At postoperative day three, she was awakened, but the motor power of her left upper arm was grade II. However, to our surprise, her left side weakness improved very rapidly, and nearly complete recovery was achieved at postoperative two weeks. Follow-up CT and TFCA at postoperative two weeks revealed much decreased low density in the M2 inferior trunk territory and complete recanalization of the M2 inferior trunk with an intact STA interposition graft (Fig. 4). The patient was discharged with no focal neurological deficits at postoperative three weeks.

**DISCUSSION**

Generally, in MCA aneurysm surgery clipping, aneurismal ficed when the skin incision was made. But, it was not possible to perform in situ M2-M2 bypass, because of limited mobility (cannot be fully pulled to be sutured). In addition, limited vessel mobility also disturbed in situ M3-M3 bypass, so we planned to do M3-STA interposition graft-M3 anastomosis with harvesting the short pedicle of the STA frontal branch.

After harvesting the frontal branch of the STA, the first anastomosis between the M3 of the inferior M2 trunk and the STA interposition graft was made. A little back-flow from the M3 was detected when an incision was made in it. A second anastomosis between the M3 of the superior M2 trunk and the STA interposition graft was made. After performing the in situ M3-STA interposition graft-M3 bypass procedure, the inferior M2 trunk flow resumed, and the flattened wave on the SEP changed into a normal wave pattern (Fig. 2). The total time for the bypass procedure was 65 minutes. Immediate postoperative computed tomography angiography demonstrated good flow of the inferior M2 trunk with good patency of the bypass graft (Fig. 3). However, she was not awakened well, and additional CT on postoperative day one revealed some low density around the inferior M2 trunk territory. Emergency TFCA demonstrated occlusion of the inferior M2 trunk, and no visible bypass pedicle was detected (Fig. 3). At postoperative day three, she was awakened, but the motor power of her left upper arm was grade II. However, to our surprise, her left side weakness improved very rapidly, and nearly complete recovery was achieved at postoperative two weeks. Follow-up CT and TFCA at postoperative two weeks revealed much decreased low density in the M2 inferior trunk territory and complete recanalization of the M2 inferior trunk with an intact STA interposition graft (Fig. 4). The patient was discharged with no focal neurological deficits at postoperative three weeks.

**DISCUSSION**

Generally, in MCA aneurysm surgery clipping, aneurismal
Fig. 4. Follow-up TFCA at postoperative two weeks reveals complete recanalization of the M2 inferior trunk (A) with intact STA interposition graft (B, white arrow). STA : superficial temporal artery, TFCA : transfemoral carotid angiography.

Fig. 5. The mimetic diagram of M3-STA-M3 anastomosis. A : In this case, we performed an anastomosis with an acute angle between the M3 of superior M2 trunk and the STA graft with an obtuse angle between the STA graft and the M3 of M2 inferior trunk. So, the flow direction is not “natural,” and the flow burden of the M2 superior trunk might have increased. B : We believe that ideal and natural M3-STA-M3 anastomosis should be as diagrammed, with the natural flow direction from the M3 of superior M2 trunk toward the STA interposition graft with an obtuse angle. STA : superficial temporal artery.

Neck laceration is a well known complication, and its result usually has catastrophic cerebral ischemia in many cases. So, bypass procedures have been reported to be helpful in clipping of complex middle cerebral artery aneurysms. In our case, an aneurismal neck laceration happened during the clipping procedure due to severe atherosclerotic change in the aneurysm, and emergency suture of aneurismal neck was performed. However, flow resumption of the M2 inferior trunk was not achieved. Finally, we performed an M3-STA interposition graft-M3 anastomosis, and the flow of the M2 inferior trunk and MEP/SSEP were recovered.

Intracranial-intracranial (IC-IC) bypass is known as third-generation bypass surgery and has some benefits over extracranial-intracranial (EC-IC) bypass surgery, such as similar caliber of donor and recipient arteries, no need to harvest EC donor vessels, and less vulnerability to neck torsion or trauma. However, in situ bypass between two MCA branches requires a more challenging side-to-side anastomosis between M3 with limited morbidity and has the co-sacrifice risk involving two MCA branches.

In this case, we used the frontal branch of the STA as an interposition graft because the parietal branch of the STA was sacrificed when the initial skin incision was made. The MEP change was recovered, and the normal wave patterns had been preserved until the end of surgery. Additionally, immediate postoperative CT angiography demonstrated good M2 trunk flow with good patency of the bypass graft. However, the patient was not easily roused, and acute cerebral infarction due to occlusion of the inferior M2 trunk developed. However, the occluded M2 inferior trunk was recanalized, and the low density at basal ganglia on CT disappeared almost at postoperative two weeks.

We suggest two important points. First, we think that the cause of delayed occlusion of the M2 inferior trunk after surgery is probably due to the direction of the free STA graft. This is demonstrated in the mimetic diagram (Fig. 5). Namely, the direction of flow is M3 of superior M2 trunk-STA interposition graft-M3 of inferior M2 trunk, but we performed an anastomosis with an acute angle between the M3 of superior M2 trunk and the STA graft with an obtuse angle between the STA graft and the M3 of M2 inferior trunk. Thus, the flow direction is not “natural”, and the flow burden of the M2 superior trunk might have increased. If in this situation a small M2 inferior trunk flow around the MCA bifurcation resumed, flow “collision” might have occurred, and transient occlusion or low flow would have been sustained, leading to cerebral infarction. Second, we think that the small amount of flow through the M3-STA graft-M3 might have been sustained, and delayed spontaneous thrombolysis might have occurred. Finally, the origin of the MCA inferior trunk around the MCA bifurcation might have been open.

In any event, we obtained a final good result in this case with an emergency IC-IC bypass method; thus, if a STA-MCA anastomosis is not available under MCA flow obstruction, we can consider an emergency in situ MCA-MCA bypass procedure with or without an STA interposition graft. In addition, we must consider the “anastomosis angle” between the parent artery and free graft to get the natural flow direction.

**CONCLUSION**

We report an emergency in situ M3-M3 bypass procedure using an STA interposition graft as a rescue procedure in the case of an M2 trunk flow obstruction during clipping of an MCA aneurysm. If an STA-MCA anastomosis is not available under MCA flow obstruction, we can consider an emergency in situ MCA-MCA bypass procedure with or without an STA interposition graft.
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