Revascularization of the anterior cerebral artery

Report of two cases

AKIRA IKEDA, M.D., TOMOHISA OKADA, M.D., MASATO SHIBUYA, M.D., SATOSHI NODA, M.D., MASAKAZU SUGIURA, M.D., IKUZO IGUCHI, M.D., TAKAMI GONDA, M.D., AND NAOKI KAGEYAMA, M.D.

Department of Neurosurgery, Nagoya University, School of Medicine, Nagoya, Japan

There have been few reports of revascularization of an anterior cerebral artery (ACA). This operation is rare because isolated occlusion of the ACA seldom occurs, the ACA lies deep in the interhemispheric fissure, and there is no suitable donor artery nearby. This paper reports on two successful attempts to revascularize the ACA using inter-ACA anastomosis.

Case Reports

Case 1

This 50-year-old man had been healthy and fully employed until February 2, 1984, when he had the onset of a gait disturbance due to weakness in his right leg.

Examination. Computerized tomography (CT) on admission was normal. Angiography revealed occlusion of the left ACA at the A2 segment. There was no retrograde filling of the distal ACA from the middle cerebral artery (MCA) or posterior cerebral artery (PCA). Additionally, the posterior pericallosal artery was not opacified. In spite of medical treatment with anticoagulant and antiplatelet agents, a second attack occurred on March 5, 1984. This time, the weakness in the right leg was more severe and of longer duration. Although the patient did not experience weakness in his hand or arm, he did have some difficulty in writing. A CT scan showed a small infarcted area in the left corona radiata. Administration of anticoagulant and antiplatelet medications for another month did not affect the patient’s weakness or gait disturbance.

Operation. On April 16, 1984, he underwent surgery. After a right frontal paramedian craniotomy, the frontal lobe was retracted laterally and the A1 to A2 portion of the ACA was approached interhemispherically. The left pericallosal artery was found to be without pulsation, poorly filled with blood, and with a diameter of only 1.7 mm, whereas the right pericallosal artery was pulsatile with a diameter of 2 mm. The left distal pericallosal artery was yellow-colored and rigid, probably due to an occlusion (Fig. 1 left). After temporary occlusion of the anterior communicating arteries and their branches, arteriotomies 4 mm in length were made on each of the pericallosal arteries. Side-to-side anastomosis was completed between these arteries. After two stay-sutures were placed, the back wall was sutured in running fashion from the intravascular side and then the anterior wall was closed with interrupted sutures (Fig. 1 right). After the temporary clips were released, the left pericallosal artery and its branches enlarged with good pulsation. The ACA was occluded for 40 minutes.

Postoperative Course. Immediately after the operation, the weakness in the patient’s right leg resolved. Four days after the operation, he could walk alone...
Fig. 1. Diagrams of the operative procedure in Case 1. **Left:** Right frontal paramedian craniotomy showing occlusion of the left pericallosal artery at the A4 segment (arrow). **Right:** Anastomotic procedure showing completion of the back wall with a running suture and first insertion of the interrupted suture in the anterior wall.

without difficulty and had recovered full writing ability. Angiography 10 days after the operation confirmed patent anastomosis and good filling of the left pericallosal artery and its branches. Neurological examination at the time of discharge revealed only minimal weakness in the right leg.

**Case 2**

This 52-year-old man had suffered multiple transient ischemic attacks manifesting as left hemiparesis. The last attack, a minor completed stroke, was the most severe and he was admitted to the hospital on August 20, 1983. The left hemiparesis was not reversible by medication.

**Examination.** Angiography revealed occlusion of the right internal carotid artery with poor collateral flow. A CT scan showed a small low-density area adjacent to the right caudate nucleus, which was thought to be the territory of Heubner's artery; a small cortical infarction was also visible in the right superior frontal gyrus.

**First Operation.** A double anastomosis of the right superficial temporal artery (STA)-MCA was performed on September 18, 1983, as a result of which the upper extremity returned to normal strength; however, the weakness in the left leg remained unchanged. Postoperative angiography showed good filling of the MCA branches but poor flow through the right ACA (Fig. 2). Collateral circulation from the left ACA through the anterior communicating artery was also poor. Administration of antiplatelet and antithrombotic agents and physical therapy for 6 months provided no improvement of the paresis in the left leg. The patient could walk with a cane more easily on days when his blood pressure was elevated.

**Second Operation.** A second operation was performed on May 15, 1984, to revascularize the right ACA territory. The operative procedure was almost the same as in Case 1. The right ACA and its branches were smaller than those on the left side and no pulsation was observed. Inter-ACA anastomosis was performed between the bilateral posterior internal frontal arteries. The ACA occlusion time was 29 minutes. After the temporary clips were released, the right ACA pulsated and dilated to normal size.

**Postoperative Course.** The postoperative course was smooth. The weakness in the left leg improved, but not completely. Postoperative angiography showed a patent anastomosis and good filling of the right ACA and its branches. Normograde filling of the M1 portion of the right MCA was also observed (Fig. 3). Postoperatively, the patient could easily go up or down stairs without the help of a cane.

**Discussion**

Since Yaşargil first described microvascularization of a distal MCA, many modifications of the technique have been reported. Most of these reports are primarily concerned with either the MCA or the posterior circulation, while only a few discuss the ACA territory. Cerebral ischemia as a result of hypodynamic effect usually occurs in the MCA territory in patients with internal carotid artery stenosis or occlusion and/or with MCA occlusion. Occlusion involving the ACA alone occurs very infrequently. Moreover, the midline motor cortex for the legs receives its blood supply from many sources, including the ipsilateral ACA, the contralateral ACA through the anterior communicating artery, a leptomeningeal anastomosis between the ACA and the MCA or PCA, and also the posterior pericallosal artery.

In Case 1, ACA occlusion was present not only at the A2 portion but also at the A4 portion, as confirmed during the operation. The blood supply to the distal ACA was thought to come from the MCA through a leptomeningeal anastomosis which might have caused a blood steal from the MCA to the ACA territory. This may be why the patient's handwriting became poor after the attack and improved postoperatively. Another explanation might be that Heubner's artery was in-
Revascularization of anterior cerebral artery

FIG. 2. Preoperative angiograms in Case 2. Left: Right retrograde transbrachial angiogram showing good filling of the middle cerebral artery (MCA) through a superficial temporal artery-MCA double anastomosis (arrowhead). There is poor filling of the internal carotid artery (ICA) and the anterior cerebral artery (ACA) (arrows). Right: Left carotid angiogram showing a normal left ACA and ICA, but poor filling of the right ACA (arrow) through the anterior communicating artery.

...volved, which would cause ischemia in the anterior limb of the internal capsule. In Case 2, the ACA territory did not receive a sufficient blood supply from the contralateral A1 segment, through the anterior communicating artery from the ipsilateral A1 and M1 portions, in spite of good filling of the STA-MCA anastomosis.

Variations of the course of the ACA and its branches are commonly seen. To improve the motor function of the leg in cases of stenosis or occlusion of the

FIG. 3. Postoperative left carotid angiograms in Case 2. Left: Anteroposterior view showing good filling of the right anterior cerebral artery (ACA) through the inter-ACA anastomosis (arrow). The right A1 and M1 segments are also opacified. Right: Lateral view showing fusiform dilatation of the anastomotic orifice (arrowhead) and good filling of the right ACA (arrows).
proximal ACA, revascularization of the contralateral paracentral region is required. It would be less effective to revascularize the callosomarginal artery or the frontopolar artery when they do not supply the paracentral region directly. In Case 1, the pericallosal arteries (proximal A3 portions) were selected as the donor and the recipient arteries and, in Case 2, the posterior internal frontal arteries were chosen since they supplied the paracentral region and were less deep than the pericallosal arteries.

Computerized tomography plays an important role in estimating the reversibility of a neurological deficit. In Case 1, only a small coronal area of low density was observed in the preoperative CT scan, and the weakness in the lower extremity almost completely improved postoperatively. In Case 2, a cortical infarced area, including most of the motor cortex for the leg, was obvious preoperatively, so postoperative improvement was not complete.

Ito described a new technique of intracranial interarterial anastomosis between the distal ACA's for treating ACA occlusion. He described four variations of the technique: A2-A2 end-to-side anastomosis, A2-A3 end-to-side anastomosis, and A3-A3 side-to-side anastomosis; he recommended the last procedure. Ishii, et al., reported on revascularization of the ACA territory using a vein graft in a patient with moyamoya disease.

Side-to-side anastomosis is rarely performed by neurosurgeons, while this is a routine procedure in cardiovascular surgery. Usually a running suture is used for both far and near suture lines. Before the operation, we studied side-to-side anastomosis in the carotid arteries of rats to discover which technique maximizes blood flow through the anastomosis. The conclusion was that the size of the orifice should be larger than twice the vessel diameter and the near wall should be sutured in an interrupted fashion.

Patients with isolated ACA occlusion with either no or small infarction are rare, but in the future more patients may be found with intracranial occlusion who have a poor anterior communicating artery channel as in Case 2, or who have iatrogenic A2 segment occlusion as in aneurysmal surgery. These patients may benefit from the procedure described here. This inter-ACA anastomosis has many associated problems, however. First, many patients with cerebral ischemia have multiple lesions, not only on the ipsilateral side but also on the contralateral side; for this procedure to be successful, the contralateral ACA should be completely normal. Second, if occlusion of the anastomotic site occurs, the contralateral ACA might be occluded as well, resulting in paraparesis. Moreover, even if the patency of the anastomosis is preserved, blood flow distal to the anastomosed site on the normal side will nearly always decrease due to the steal phenomenon to the lesion side. Therefore, the criteria for use of this procedure should be strict and completely justifiable. Also, the operative procedure must be meticulously performed.

References


Manuscript received September 13, 1984.
Address for Drs. Noda and Sugiiura: Department of Neurosurgery, Nishio Municipal Hospital, Nishio, Japan.
Address for Drs. Iguchi and Gonda: Department of Neurosurgery, Ogaki Municipal Hospital, Ogaki, Japan.
Address reprint requests to: Akira Ikeda, M.D., Department of Neurosurgery, School of Medicine, Nagoya University, 65 Tsuruma-cho, Showa-ku, Nagoya 466, Japan.