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Superficial temporal artery to middle cerebral artery anastomosis for neovascular glaucoma due to common carotid artery occlusion

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Abstract

Background: Common carotid artery (CCA) occlusion sometimes requires surgical revascularization to resolve persistent cerebral/ocular ischemia. High-flow bypass is often indicated in these cases, using the interposed graft such as saphenous vein and radial artery. However, high-flow bypass surgery is invasive and may provide excessive blood flow to ischemic brain. In this report, we present a case that developed neovascular glaucoma due to CCA occlusion and was successfully treated with superficial temporal artery to middle cerebral artery (STA-MCA) anastomosis.

Case Description: A 61-year-old male complained of left visual disturbance and was admitted to our hospital. He underwent carotid endarterectomy for left internal carotid artery stenosis in previous hospital 1-year before, but he experienced left visual disturbance after surgery. Postoperative examinations revealed that the CCA was occluded. His visual disturbance gradually progressed, and he was diagnosed as neovascular glaucoma. None of ophthalmological therapy could improve his symptoms. Blood flow measurement showed an impaired reactivity to acetazolamide in the left cerebral hemisphere. Cerebral angiography demonstrated that the left STA was opacified through the muscular branches from the left deep cervical artery. Therefore, he successfully underwent left STA-MCA double anastomosis. His visual acuity improved and new blood vessels around the iris markedly decreased 3 months after surgery.

Conclusions: Precise radiological examination may enable standard STA-MCA anastomosis even in patients with CCA occlusion.

Key Words: Common carotid artery occlusion, neovascular glaucoma, superficial temporal artery to middle cerebral artery anastomosis

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INTRODUCTION

Common carotid artery (CCA) occlusion is rare, but sometimes requires surgical revascularization to resolve persistent cerebral ischemia. In patients with CCA occlusion, however, high-flow bypass surgery is often indicated, because the superficial temporal artery (STA), one of the terminal branches of the external carotid

artery (ECA), is not available as the donor graft. Usually, saphenous vein graft is used as an interposed graft in high-flow bypass for CCA occlusion.[1,24] However, high-flow bypass is invasive and excessive blood flow through bypass graft may sometimes provoke postoperative hyperperfusion.[4]

In this report, we present a case that developed neovascular glaucoma due to the ipsilateral CCA occlusion. By maximally utilizing the collateral circulation in the external carotid system, standard STA to middle cerebral artery (STA-MCA) double anastomosis could successfully be performed and dramatically improved glaucoma-related symptoms. Less invasive STA-MCA anastomosis may be indicated in a certain subgroup of patients with CCA occlusion, when the STA still keeps enough collateral circulation.

CASE REPORT

A 61-year-old male complained of left visual disturbance and was admitted to our hospital. He underwent carotid endarterectomy for left internal carotid artery (ICA) stenosis in previous hospital 1-year before, but he experienced left visual disturbance after surgery. Postoperative examinations revealed that the operated CCA was completely occluded. Additional surgery was not performed. His visual disturbance gradually progressed, and he was diagnosed as neovascular glaucoma. None of ophthalmological therapy could improve his symptoms. Neurological examination on admission revealed anisocoria. The size of pupils was 3.5 mm and 5.5 mm in the right and left side, respectively. Light reflex was absent in the left side. Left visual disturbance was severe (20/400 vision). Intraocular pressure was elevated up to 38 mmHg in the left side. No parenchymal lesion was observed on brain magnetic resonance (MR) imaging. However, MR angiography demonstrated that the left CCA and left vertebral artery were completely occluded. ^{123}I-IMP single photon emission computed tomography (SPECT) showed an impaired reactivity to acetazolamide in the territory of the left ICA [Figure 1]. On cerebral angiography, the left CCA was occluded at the origin. Left anterior cerebral artery and MCA were opacified via the anterior communicating artery on right carotid angiogram. Left subclavian angiogram showed the development of collateral circulation to the left ICA through the left ECA. Thus, the deep cervical artery extensively supplied collateral blood flow to the distal part of the left occipital artery. The blood flowed to the proximal part of the left ECA with a retrograde fashion, and then to the left ICA via the left ophthalmic artery [Figure 2]. At the same time, the left STA was opacified without a significant delay [Figure 2]. Ultrasound examination also revealed the reversed blood flow in the left ophthalmic artery. The peak systolic flow

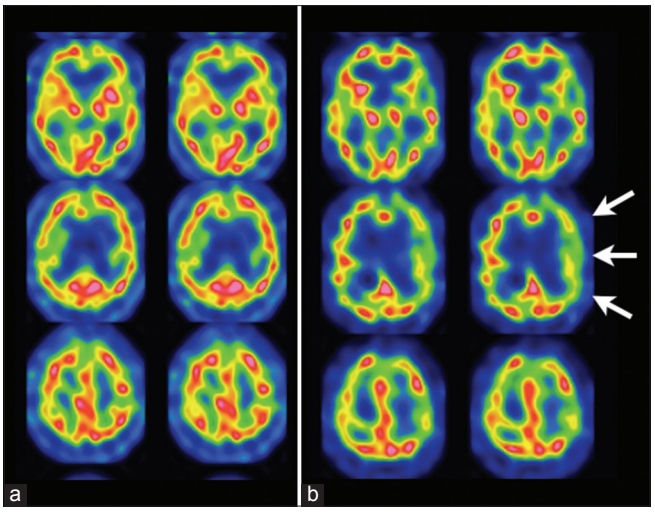

Figure 1: Preoperative single photon emission computed tomography findings of cerebral blood flow before (a) and after intravenous injection of acetazolamide. (b) Cerebral blood flow was kept within normal, but the reactivity to acetazolamide was impaired in the left middle cerebral artery territory (arrows)

velocity was −40 cm/s, suggesting that ocular ischemia was closely related to severe neovascular glaucoma in this case [Figure 3].[7]

Based on these findings, he underwent left STA-MCA double anastomosis to resolve the reversed blood flow in the left ophthalmic artery and improve his glaucoma-related symptoms. The frontal and parietal branches of the STA were carefully dissected under a surgical microscope. We could confirm that the blood flow from the distal end of the ipsilateral STA had enough high-pressure during surgery. The branches of STA were anastomosed to the frontal and temporal branches of the MCA with an end-to-side fashion, respectively. The patency was confirmed during surgery, using indocyanine green videoangiography. Postoperative course was uneventful. Postoperative SPECT study performed 2 weeks after surgery demonstrated that the reactivity to acetazolamide completely recovered in the territory of the left MCA [Figure 4]. Postoperative cerebral angiography demonstrated that STA-MCA anastomosis supplied enough blood flow to the operated hemisphere [Figure 5]. Follow-up ultrasound examination also revealed that the reversed blood flow in the left ophthalmic artery improved from −40 cm/s to −20 cm/s at 6 days after surgery [Figure 3]. His visual disturbance did not deteriorate for these 21 months after surgery. Abnormal blood vessels around the iris gradually decreased and disappeared. Intraocular pressure decreased from 38 to 16 mmHg.

DISCUSSION

Common carotid artery occlusion is rarely recognized in 0.5–5% of total population, which is much less frequent than ICA occlusion.[3,5,12,13,18] Because collateral circulation

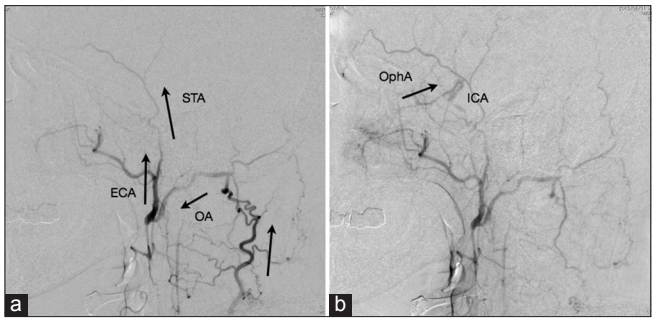

Figure 2: Preoperative cerebral angiography. (a) Early arterial phase of left subclavian angiogram. Lateral view: The occipital artery (OA) was opacified through the deep cervical artery. Then the retrograde blood flow of the OA opacified the main trunk of the external carotid artery and then superficial temporal artery. (b) Late arterial phase of left subclavian angiogram. Lateral view: Note that the internal carotid artery was opacified through the retrograde blood flow of the ophthalmic artery (OphA, arrow)

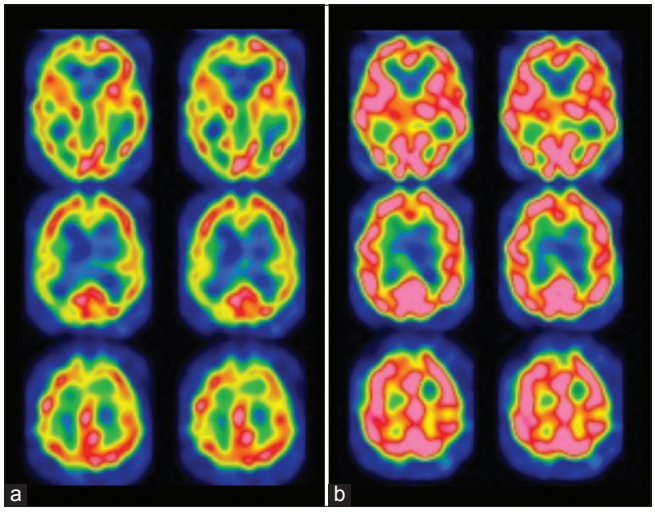

Figure 4: Postoperative single photon emission computed tomography findings of cerebral blood flow before (a) and after intravenous injection of acetazolamide. (b) Note that the reactivity to acetazolamide completely recovered in the left middle cerebral artery territory

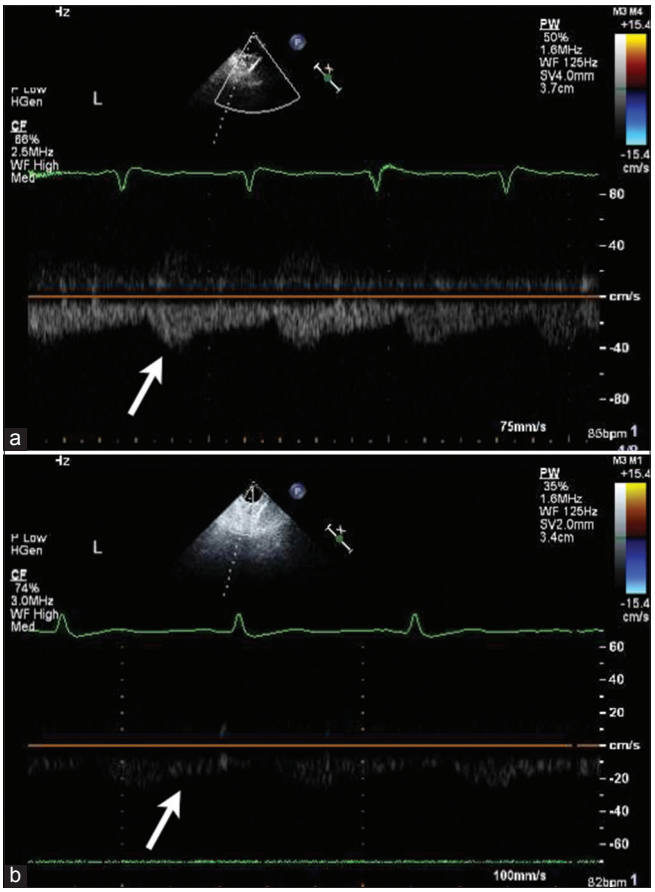

Figure 3: Ultrasound findings of left ophthalmic artery before (a) and after (b) superficial temporal artery to middle cerebral artery (STA-MCA) anastomosis. Note the decrease in systolic velocity of retrograde blood flow in the ophthalmic artery (arrows)

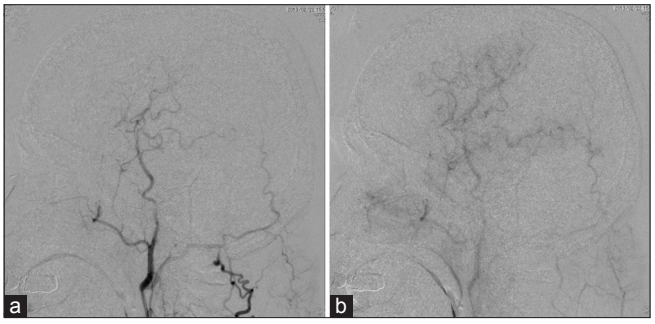

Figure 5: Postoperative angiography. Early (a) and late arterial phase of left subclavian angiogram (b) revealed that superficial temporal artery to middle cerebral artery double anastomosis supplied enough collateral blood flow to the operated hemisphere

extensively develops in most cases, it is further rare to require surgical revascularization for CCA occlusion. However, bypass surgery is necessary in patients who develop ischemic attacks due to hemodynamic compromise.[6] The most common technique performed for CCA occlusion is subclavian artery to carotid artery bypass, using an interposed graft from the saphenous vein.[9]

Riles *et al.* (1984) classified CCA occlusion into four types from surgical viewpoints.[18] They defined CCA occlusion with the patent external and/or internal carotid arteries as Type 1. In Type 1A patients, both the external and internal carotid arteries were patent. In Type 1B patients, only the ECA was patent. In Type 1C patients, only the ICA was patent. On the other hands, they defined CCA occlusion with the occluded external and internal carotid arteries as Type 2. Their classification is quite important to decide the surgical strategy for CCA occlusion. According to their classification, the present case can be classified into Type 1B. In previous reports, a majority of patients with symptomatic CCA occlusion have been classified into Types 1A or 1B.[14,18] The patients with Type 1A CCA occlusion are potentially at high-risk for both artery-to-artery embolism and hemodynamic stroke, which largely depends on

the development of collateral circulation in each case.[18,24] Previously, surgical options for them include aortic arch to ICA bypass, subclavian artery to MCA bypass, axillary artery to ICA bypass, half-collar bypass, transverse cervical artery to ECA bypass, and vertebral artery to ICA.[1,9,16,21] In patients with Type 1B CCA occlusion, persistent reduction of perfusion pressure may induce ischemic attacks due to inappropriately developed collateral circulation.[24] Previously, STA-MCA anastomosis combined with subclavian, transverse cervical, or thyrocervical artery to ECA bypass has been indicated for them. Alternatively, contralateral STA-MCA bypass (Bonnet bypass) is also reported.[15,22] Of course, all of these procedures are rather invasive. However, the natural course of CCA occlusion and benefits of bypass surgery are unclear.[17,18] Therefore, surgical treatment should be limited to selected patients at high-risk of future ischemic events, and the procedure should be as noninvasive as possible. In this case, preoperative cerebral angiography revealed that the extensive formation of collateral circulation maintained the anterograde blood flow of the ipsilateral STA. In addition, we could confirm that the blood flow from the distal end of the ipsilateral STA had enough high-pressure during surgery. Considering these radiological and intraoperative findings, we determined to employ the left STA as a donor. In fact, STA-MCA anastomosis could be performed without any problem safely and less invasively, and provided enough collateral blood flow to the operated hemisphere, improving neovascular glaucoma. In this case, we did not measure the blood pressure of the operated STA during surgery. However, Aso *et al*. previously proposed that the STA is suitable for use as a donor artery when the ratio of STA pressure to systemic blood pressure exceeds 90%.[2] Therefore, it would be better to monitor the blood pressure in the anastomosed STA during surgery to yield enough bypass flow through STA-MCA anastomosis.

Common carotid artery occlusion does not always cause visual disturbance. However, the symptom is the only clinical sign in some patients with CCA occlusion.[11] Beneficial effects of revascularization on visual disturbance is still unclear in patients with carotid occlusion. There are few reports that demonstrate a significant improvement of visual acuity after STA-MCA anastomosis for ICA stenosis or occlusion.[7,10,19,20,23,25] However, STA-MCA anastomosis may be useful to inhibit the progression of visual disturbance by improving retinal circulation.[7,8,10,19,20,23] In fact, surgical revascularization attenuated retrograde blood flow in the ophthalmic artery and could improve the signs of neovascular glaucoma in our case, although visual acuity did not improve probably because of long-term ischemia of retina.[11] Therefore, early appropriate diagnosis and treatment would be essential to improve the visual acuity in patients with carotid occlusive diseases.

CONCLUSION

The authors present a case with neovascular glaucoma due to CCA occlusion. Extensive formation of collateral circulation enabled us to perform standard STA-MCA anastomosis safely and less invasively. Enough blood flow through bypass graft ceased the deterioration of visual acuity and resolve abnormal blood vessels around the iris. Less invasive STA-MCA anastomosis should be considered as one of the surgical options for the certain patients with CCA occlusion.

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