

“Isolated Carotid Bifurcation” and Vertebral-Carotid Artery Bypass for Common Carotid Artery Occlusion

—Case Report—

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Abstract

Symptomatic common carotid artery (CCA) occlusion is relatively rare, and requires an elaborate vascular reconstruction procedure with which many neurosurgeons are unfamiliar. We describe a case of CCA occlusion managed by vertebral artery (VA)-internal carotid artery (ICA) saphenous vein interposition graft. An 80-year-old man presented with deterioration of consciousness, transient aphasia, and severe right hemiparesis. Angiography revealed proximal occlusion of the left CCA with concomitant patent ICA. Cerebral blood flow measurement using iodine-123 N-isopropyl-p-iodoamphetamine and single photon emission computed tomography showed corresponding hemodynamic insufficiency of the left hemisphere. The patient underwent a novel revascularization procedure, in which the saphenous vein was used as an interposition graft between the V₃ segment of the VA and the left proximal ICA. Postoperative course was uneventful, and patency of the bypass graft was confirmed. VA-ICA bypass with interposition graft is an alternative treatment option for symptomatic proximal CCA occlusion.

Key words: cerebral revascularization, carotid artery occlusion, saphenous vein graft, vertebral artery, cerebral infarction

Introduction

Symptomatic common carotid artery (CCA) occlusion is relatively rare compared to internal carotid artery (ICA) occlusion.^{2,7,8)} Vascular reconstruction surgery for CCA occlusion has no established benefit, and generally requires a technique with which many neurosurgeons are unfamiliar.^{2,9)} Subclavian-carotid artery bypass using a saphenous vein graft (SVG) is the most commonly used procedure in this situation.¹²⁾ This procedure can be modified in terms of the selection of donor arteries, type of interposition graft, and requirement for upper thoracic exposure, depending on the lesion involved.^{1,3-6,10,11)} We describe a case in which vertebral artery (VA)-ICA bypass was the preferred choice, on the basis of the operative approach and the relatively short length of the graft.

Case Report

An 80-year-old man with approximately 50% stenosis of the left ICA had been receiving antiplatelet medication and was followed up every 3 months in our outpatient clinic. Although we had noticed moderate plaque forma-

tion at the ICA origin during the follow-up period, surgical treatment including carotid stenting was not an option considering his age. However, he was admitted to our emergency department with sudden deterioration of consciousness, aphasia, and severe right hemiparesis. These symptoms resolved within 30 minutes of arrival. Magnetic resonance angiography suggested CCA occlusion. Cerebral angiography confirmed occlusion of the left proximal CCA. The ipsilateral ICA was patent and was perfused via retrograde flow through the external carotid artery (ECA) (Fig. 1). Regional cerebral blood flow (rCBF) measurements using iodine-123 N-isopropyl-p-iodoamphetamine (¹²³I-IMP) and single photon emission computed tomography (SPECT) revealed reduced rCBF of the left hemisphere (Fig. 2A).

Vascular reconstructive surgery was performed 1 week after the ischemic event (Fig. 3). The patient was placed in the supine position and a T-shaped skin incision was made along the anterior border of the left sternocleidomastoid muscle (SCM). A retromastoid skin flap was reflected medially to expose the posterior edge of the SCM. The splenius capitis was disconnected from the posterior surface of the mastoid process and reflected medially. The

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longissimus capitis was identified and dissection carried out medial to this muscle until the fibrofatty tissue surrounding the VA was exposed. The suboccipital muscles were detached from the occipital bone and part of the superior oblique muscle was detached from the transverse process of C2 to facilitate exposure. The V₃ segment of the VA was exposed in the fibrofatty tissue caudal to the occipital condyle and prepared for anastomosis. The high cerebral region of the ICA was also exposed. A ring-rein-

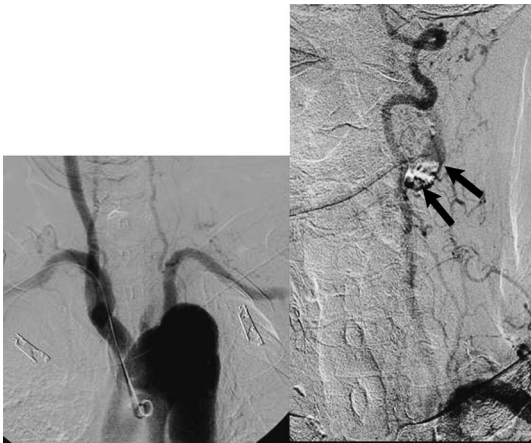


Fig. 1 Preoperative left vertebral angiograms revealing occlusion of the left common carotid artery as well as the patent ipsilateral external carotid artery and internal carotid artery presenting as “isolated carotid bifurcation” (arrows).

forced 5-mm polytetrafluoroethylene (PTFE) vascular graft was used as the conduit of an interposition graft passing underneath the SCM. A portion of the greater saphenous vein approximately 10 cm in length was harvested and introduced through the conduit, and an end-to-side VA-SVG bypass was performed. Subsequently an end-to-side SVG-ICA anastomosis was performed. After confirming patency of the graft, the ICA was ligated at the proximal segment of the bypass.

Postoperative angiography revealed patency of the VA-SVG-ICA bypass (Fig. 4). ¹²³I-IMP SPECT confirmed improvement of the rCBF of the left hemisphere (Fig. 2B).

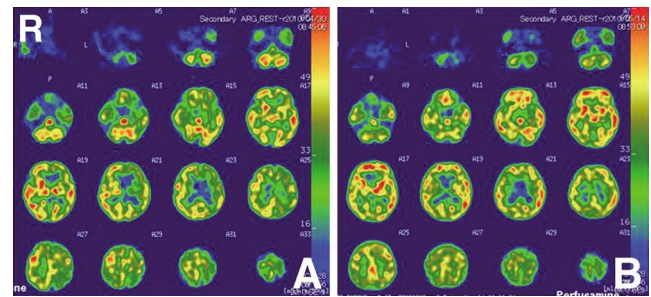


Fig. 2 **A:** Preoperative iodine-123 N-isopropyl-p-iodoamphetamine (¹²³I-IMP) single photon emission computed tomography (SPECT) scans revealing reduced regional cerebral blood flow (rCBF) in the left middle cerebral artery territory. **B:** Postoperative ¹²³I-IMP SPECT scans confirming improvement of the rCBF in the left middle cerebral artery territory.

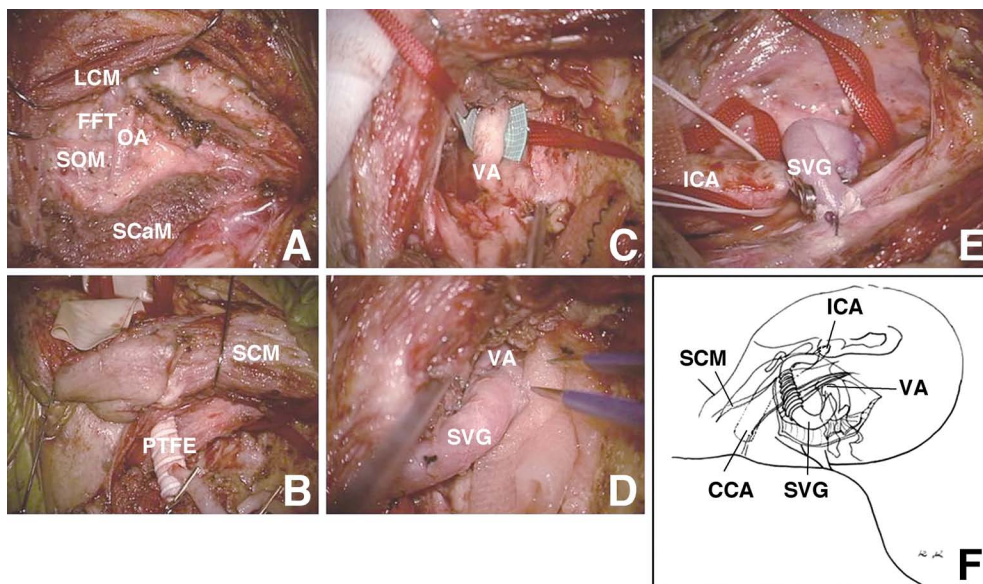


Fig. 3 **A:** Preparation for anastomosis between the extracranial vertebral artery (VA) and the saphenous vein graft (SVG). The landmark structures in the suboccipital region are the splenius capitis muscle (SCaM), longissimus capitis muscle (LCM), superior oblique muscle (SOM), and fibrofatty tissue (FFT) covering the VA. OA: occipital artery. **B:** A ring-reinforced polytetrafluoroethylene (PTFE) graft was introduced underneath sternocleidomastoid muscle (SCM). **C:** The SVG was introduced through this conduit to avoid kinking and compression during neck rotation. **D:** The anastomosis between the SVG and VA was completed. **E:** The anastomosis between the SVG and internal carotid artery (ICA) was completed. **F:** Illustration demonstrating VA-SVG-ICA bypass. CCA: common carotid artery.



Fig. 4 Postoperative left vertebral angiograms confirming patency of the vertebral-carotid artery saphenous vein interposition bypass (arrow).

The patient recovered well after surgery, and was able to resume his usual activities.

Discussion

Subclavian-carotid artery bypass using an interposition SVG is the most common technique performed for symptomatic CCA occlusion.¹²⁾ The transverse cervical artery and the thyrocervical trunk have been employed as alternative donor sites, because their exposure is relatively safe and easy.^{3,5)} However, questions remain regarding whether these small-caliber donor sites can immediately provide sufficient cerebral blood flow to the hemisphere. Using the V₃ segment as a donor vessel theoretically shortens the graft length and increases the flow. The technique required is comparable to that of the extracranial procedure in the suboccipital approach.

CCA occlusion in the presence of patent ECA and occluded ICA (type 1B in Riles' classification) can induce cerebral hypoperfusion.⁸⁾ The treatment options are subclavian, transverse cervical, or thyrocervical artery to ECA bypass combined with superficial temporal artery (STA)-middle cerebral artery (MCA) bypass and contralateral STA to ipsilateral MCA bypass (Bonnet bypass).^{5,11)} Proximal CCA occlusion with patent ECA and ICA (type 1A in Riles' classification) is termed isolated carotid bifurcation, and can potentially induce both cerebral embolism and hypoperfusion depending on the development of the collateral network.^{8,12)} The treatment options previously reported are aortic arch to carotid interposition graft bypass, subclavian to MCA SVG bypass, axillary to carotid artery bypass, half-collar bypass, and transverse cervical to ECA bypass.^{1,6,10)} In the present case, we observed moderate plaque formation at the ICA origin during the follow-up period, and speculate that the plaque induced retrograde thrombus propagation. Treatments using either interventional neuroradiology or carotid endarterectomy were also considered for the acute phase. However, the neurological symptoms were resolved soon after admission, indicating aggressive revascularization may not be beneficial considering the potential embolic complications. More severe plaque formation could have eliminated the source of the collateral circulation, and the

episode had suggested poor outcome in the event of ICA occlusion.

The natural course of CCA occlusion and the benefits of surgery are unclear.^{7,8)} Surgical intervention should be limited to selected patients with a high likelihood of future ischemic events, and the procedure should be as non-invasive as possible. The VA-SVG-ICA bypass is a relatively straightforward procedure, does not require exposure of the upper thoracic region, and shortens the graft length. A potential drawback of this bypass may be compression and kinking of the SVG by SCM when the neck is rotated. We attempted to mitigate this problem by using a ring-reinforced PTFE graft as a conduit. Radial artery graft may be less susceptible to kinking and compression. SVG is also susceptible to occlusion because intimal hyperplasia develops more often than in radial artery graft. However, if the pressure in the graft vessels increases, SVG is more expandable than radial artery graft, so is a more practical choice for extracranial artery reconstruction. In conclusion, VA-SVG-ICA bypass is a relatively simple vascular reconstruction for the treatment of "isolated carotid bifurcation."

Conflicts of Interest Disclosure

The authors did not receive any funding for this work. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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