Surgical Neurology International

OPEN ACCESS

For entire Editorial Board visit : http://www.surgicalneurologyint.com

Editor-in-Chief: **James I. Ausman,** MD, PhD University of California, Los Angeles, CA, USA

Technical Note

Occipital-posterior cerebral artery bypass via the occipital interhemispheric approach

Ken Kazumata, Yuka Yokoyama[1], Taku Sugiyama[1], Katsuyuki Asaoka[1]

Department of Neurosurgery, Hokkaido University Graduate School of Medicine, [1]Department of Neurosurgery, Teine Keijinkai Hospital, Sapporo, Japan

E-mail: *Ken Kazumata - kazumata@med.hokudai.ac.jp; Yuka Yokoyama - yukaj77@gmail.com; Taku Sugiyama - taku-s@yk9.so-net.ne.jp; Katsuyuki Asaoka - asaoka@tkeijinkai.gr.jp
*Corresponding author

Received: 23 April 13 Accepted: 31 May 13 Published: 12 July 13

This article may be cited as:
Kazumata K, Yokoyama Y, Sugiyama T, Asaoka K. Occipital-posterior cerebral artery bypass via the occipital interhemispheric approach. Surg Neurol Int 2013;4:90.
Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2013/4/1/90/114975

Abstract

Background: The unavailability of the superficial temporal artery (STA) and the location of lesions pose a more technically demanding challenge when compared with conventional STA-superior cerebellar or posterior cerebral artery (PCA) bypass in vascular reconstruction procedures. To describe a case series of patients with cerebrovascular lesions who were treated using an occipital artery (OA) to PCA bypass via the occipital interhemispheric approach.

Methods: We retrospectively reviewed three consecutive cases of patients with cerebrovascular lesions who were treated using OA-PCA bypass.

Results: OA-PCA bypass was performed via the occipital interhemispheric approach. This procedure included: (1) OA-PCA bypass (n = 1), and combined OA-posterior inferior cerebellar artery and OA-PCA saphenous vein interposition graft bypass (n = 1) in patients with vertebrobasilar ischemia; (2) OA-PCA radial artery interposition graft bypass in one patient with residual PCA aneurysm.

Conclusions: OA-PCA bypass represents a useful alternative to conventional STA-SCA or PCA bypass.

Key Words: Extracranial – intracranial bypass, occipital artery – posterior cerebral artery bypass, occipital interhemispheric approach, superficial temporal artery – superior cerebellar artery bypass, superficial temporal artery – posterior cerebral artery bypass

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.114975

Quick Response Code:

INTRODUCTION

Superficial temporal artery (STA)-middle cerebral artery (MCA), STA-superior cerebellar artery (SCA), STA-posterior cerebral artery (PCA), and occipital artery (OA)-posterior inferior cerebellar artery (PICA) bypasses represent the mainstays for cerebral revascularization for supra- and infratentorial cerebral ischemia and aneurysms.[2,3,9,11,13,15] An incompetent donor artery and inability to access the recipient artery poses challenges during revascularization procedures.[1] This is particularly true for patients who have undergone previous craniotomy in which the STA is diminutive or in which aneurysm and/or scar tissue overlie the recipient artery. This report describes three consecutive cases of vascular reconstruction surgery using OA-PCA bypass via the occipital interhemispheric approach.

MATERIALS AND METHODS

Clinical data, radiographic findings, bypass procedures, and outcomes for the three patients who underwent OA-PCA bypass in 2011 are presented in Table 1.

Surgical technique

OA-PCA bypass

The patient was placed in a semiquarter prone position (park bench position). To harvest grsaphenous vein, a leg contralateral side of the craniotomy was disinfected and prepared in the operative field. To harvest radial artery (RA), a forearm ipsilateral to the craniotomy was placed on the armrest. A skin incision was made along the OA with its limb extended along the midline to create a horseshoe shape [Figure 1a]. In Case 1, the ipsilateral OA was hypertrophied, and sufficient length (10 cm) of the arterial pedicle was dissected from the scalp8. In Case 2, a left retromastoid C-shaped skin incision was made to connect with the occipital horseshoe-shaped incision on the right side [Figure 2a]. A relatively large craniotomy is preferable because it reduces the brain

Table 1: Clinical characteristics 3 patients underwent OA –PCA bypass

Age/sex	Symptoms	Lesion	Preceded treatment	Bypass procedure	Interposition graft	mRS
68/M	brainstem, cerebellar infarction	bilateral MCA, VA occlusion	biteral STA-MCA bypass	left OA-PCA	none	3
67/M	brainstem, cerebellum, thalamus, occpital infarction	bilateral VA occlusion	none	left OA-PICA, right OA-PCA	SVG	3
51/M	SAH	left PCA aneurysm	endovascular coil embolization	left OA-PCA	RA	1

Figure 1: Imaging results for a 70-year-old male (Case 1) with right VA occlusion who underwent OA-PCA anastomosis via the right occipital interhemispheric approach. Illustration showing OA-PCA bypass (a). Preoperative angiography demonstrated occlusion of the right VA (b) and that the left VA terminated at the posterior inferior cerebellar artery. Collateral circulation was demonstrated in the right posterior communicating artery through the diminutive internal carotid artery to upper basilar artery on angiography (c). Postoperative angiography demonstrates patency of the bypass (d; arrow). VA, vertebral artery; OA, occipital artery; PCA, posterior cerebral artery

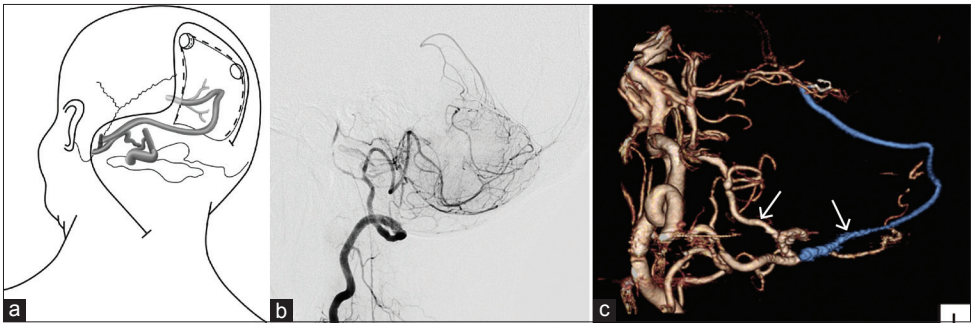

Figure 2: Imaging results for a 65-year-old male (Case 2) with occlusion of the BA who underwent OA-PICA and OA-SVG-PCA anastomosis in the same operating sequence. Illustration showing OA-PICA and OA-SVG-PCA bypass (a). Preoperative angiography demonstrated occlusion of the midbasilar artery and severe stenosis of the left VA and PICA (b). MCA-to-PCA leptomeningeal collateral circulation was demonstrated in the PCA territory on angiography. The OA-PICA anastomosis was performed using a left transcondylar approach (arrow). We subsequently performed right OA-SVG bypass in the same position through an occipital interhemispheric approach (arrow). Proximal anastomosis was made in a side-to-end fashion using the side branch of the OA (a, c). Postoperative angiography demonstrates antegrade flow of the distal VA to the BA through the OA-PICA bypass (c). OA-SVG-PCA bypass was also patent and may function as a double insurance (c). BA, basilar artery; OA, occipital artery; PCA, posterior cerebral artery. PICA, posterior inferior cerebellar artery; SVG, saphenous vein; VA, vertebral artery; MCA, middle cerebral artery

retraction as well as eliminating the need to sacrificing cerebral veins to approach posterior interhemispheric fissure. Ventricular drainage may also be considered as an option to reduce brain retraction. We identified the parieto-occipital, calcarine, and anterior calcarine sulci through a unilateral occipital craniotomy. Because cortical segment of the PCA does not seem as competent recipient artery, we select more proximal segment of the PCA as a donor. The P3 segment of the PCA immediately proximal to a branching parieto-occipital and calcarine artery was selected as a recipient artery. In Cases 2 and 3, we harvested either the saphenous vein or the RA, respectively, and distal anastomosis of RA (or SVG)-PCA bypass and proximal anastomosis of OA-RA (SVG) was performed in that order. The proximal portion where both parieto-occipital and calcarine artery are branching is optimum for the anastomosis. Five fr. silastic feeding tube is placed on the bottom of the operative field to avoid blood contamination during the anastomosis. Special care should be taken to avoid kinking or twisting in the vein graft when saphenous vein is used.

RESULTS

OA-PCA bypass was employed in three patients. The underlying pathology was unilateral vertebral artery (VA) occlusion with contralateral VA terminating in the PICA in two patients and PCA aneurysm treated previously by endovascular coil embolization in one patient. The reason for use of OA-PCA bypass was the unavailability of STA due to previous bilateral STA-MCA bypass in one patient and the inability to access the recipient artery in one patient. In the remaining case with VA occlusion, other options, such as STA-SCA or STA-PCA bypass were available, but we opted to perform OA-PCA bypass in the hope of minimizing the risk of temporal lobe contusion that is otherwise inherent with a subtemporal approach.

Graft patency was confirmed on postoperative magnetic resonance angiography (MRA) or cerebral angiography in all cases.

ILLUSTRATIVE CASES

Patient 1

A 70-year-old male with a previous history of bilateral MCA occlusion treated with STA-MCA bypass 20 years ago presented to the emergency room with 3 days of vertigo and nausea. Significant neurological examination findings on admission included horizontal nystagmus and right extremity ataxia. Magnetic resonance imaging (MRI) revealed infarction on the right middle cerebellar peduncle on diffusion-weighted imaging (DWI) as well as poor visualization of the basilar artery. Angiography revealed right VA occlusion and a left VA terminating in a PICA [Figure 1b]. Collateral circulation was identified in the distal basilar artery via the diminutive posterior communicating artery of the stenotic right internal carotid artery [Figure 1c]. The patient's level of consciousness decreased to semicoma, and the area of infarction in the cerebellar peduncle and left occipital lobe was noted to have increased. There was a reduction in regional cerebral blood flow (rCBF) in the posterior fossa on N-isopropyl-123I-p-iodoamphetamine (IMP) and single photon emission computed tomography (SPECT). The patient underwent right OA-PCA bypass at 26 days after hospital admission [Figure 1a]. His consciousness improved postoperatively, and no further deterioration was observed either in clinical status or on imaging studies. Postoperative angiography revealed patency of the bypass [Figure 1d]. He was transferred to a rehabilitation hospital 2 months later with a modified Rankin Scale (mRS) score of 3.

Patient 2

A 65-year-old male was admitted to our hospital due to a decreased level of consciousness, nausea, and cerebellar ataxia. Symptoms progressed along with an increase in the size of ischemic lesions in the pons, cerebellum, thalamus, and occipital lobe on DWI, despite intensive medical treatment. Angiography revealed severe stenosis of the left VA, occlusion of the mid-basilar artery, and leptomeningeal anastomosis from the MCA to the PCA [Figure 2b]. IMP and SPECT revealed reduced rCBF in the bilateral cerebellar hemispheres and bilateral PCA territory. The patient underwent successful left OA-PICA bypass and right OA-SVG-PCA bypass [Figure 2a]. Postoperative angiography revealed opacification of the left distal VA through the OA-PICA bypass and opacification of the upper basilar artery via the OA-PCA bypass [Figure 2c]. No neurological deterioration was observed postoperatively. Angiography obtained 1 month postoperatively and MRA obtained 2 months postoperatively both revealed bypass patency.

Patient 3

A 51-year-old male presented with subarachnoid hemorrhage due to rupture of a PCA aneurysm. The lesion was treated by endovascular coil embolization twice because of coil compaction. Follow-up examination by cerebral angiography at 1 month demonstrated recurrence of coil compaction [Figure 3a]. We therefore performed OA-RA-PCA bypass using an occipital interhemispheric approach. The patient subsequently underwent endovascular embolization of the parent artery. The patient experienced upper quadrant hemianopsia due to infarction in the posterior temporal region after the endovascular procedure, which was associated with occlusion of the posterior temporal artery branching at the base of the aneurysm. Three-dimensional CT revealed bypass patency [Figure 3b].

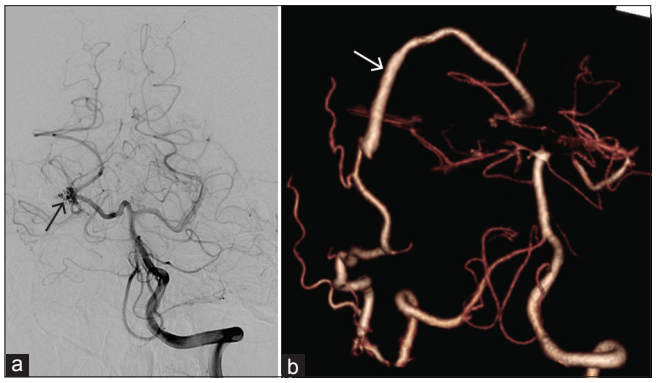

Figure 3: Imaging results for a 51-year-old male (Case 3) with right posterior cerebral aneurysm who underwent OA-STA-PCA anastomosis through an occipital interhemispheric approach prior to trapping of the aneurysm using an intravascular procedure. Left vertebral angiography showing coil compaction of the posterior cerebral artery aneurysm (a; black arrow). Postoperative angiography showing complete obliteration of the aneurysm and patency of the OA-RA-PCA bypass (b; white arrow). OA, occipital artery; STA, superficial temporal artery; PCA, posterior cerebral artery; RA, radial artery

DISCUSSION

The present report describes the use of OA-PCA bypass as an alternative to conventional STA-SCA or in the event that PCA bypasses are unavailable. Few cases of OA-PCA interposition graft bypass via the occipital interhemispheric approach have been reported for VA occlusion and PCA aneurysms.[10,16,17] We prefer this technique, which provides a relatively wide working space and avoids the temporobasal bridging veins encountered during conventional STA-SCA or STA-PCA bypass through the conventional subtemporal or transpetrosal approaches.[14,18] Indeed, no postoperative brain contusions were observed in the three patients who underwent OA-PCA bypass.

The first case presents an example in which the OA was sufficient in size and length to perform OA-PCA bypass in the occipital interhemispheric fissure. The second case could have been treated by STA-SCA bypass alone via the subtemporal approach. However, because of ischemia in the bilateral anterior inferior cerebellar artery (AICA) and distal VA territories, we preferred to perform left OA-PICA bypass in adjunct with reconstruction of upper basilar artery territory. Right OA-PCA bypass via the right occipital interhemispheric approach was considered a better option, and this strategy was performed in the same session as left OA-PICA bypass. The third case represents a typical case in which OA-PCA bypass was performed to reconstruct the distal PCA in multimodality management of complex PCA aneurysms.

A recipient artery may be found on either the lateral surface of the occipital lobe or in the interhemispheric fissure. The latter entails a deeper and more technically difficult anastomosis, which usually requires an interposition graft. Either a saphenous vein graft (SVG) or the RA can be used as an interposition graft with comparable graft patency.[7,8] However, an SVG is more susceptible to graft kinking and compression. The PCA in the anterior calcarine sulcus is matched in size for the anastomosis with the interposition graft and is expected to carry a larger amount of flow than the one in the lateral surface. Proximal bypass was selected because a larger amount of flow was expected to irrigate the entire upper basilar arterial territory in patients with ischemia and to secure the patency of the bypass for any subsequent endovascular procedure in a patient with a PCA aneurysm.

An attempt to avoid ischemic complications during the surgery of the complex PCA aneurysm were investigated in a large cohort previously.[5] This study indicated that the ischemic complications were not well circumvented by the vascular reconstruction. This is particularly true when a thick middle temporal artery is branching at the site of aneurysm, because it is usually difficult to reconstruct efferent arteries in a same session. It should also be emphasized that the vascular reconstructive surgery to prevent future ischemic stroke would have no beneficial effect on the outcome in internal carotid occlusion.[4,6,12] Therefore, a conservative approach is considered as a first choice of treatment even if severe ischemia was observed in the posterior fossa territory. We concluded that the OA-PCA bypass is a suitable and safe alternative for the reconstruction of blood flow to the PCA and basilar artery territories.

REFERENCES

1. Alaraj A, Ashley WW Jr, Charbel FT, Amin-Hanjani S. The superficial temporal artery trunk as a donor vessel in cerebral revascularization: Benefits and pitfalls. Neurosurg Focus 2008;24:E7.
2. Ausman JI, Diaz FG, Vacca DF, Sadasivan B. Superficial temporal and occipital artery bypass pedicles to superior, anterior inferior, and posterior inferior cerebellar arteries for vertebrobasilar insufficiency. J Neurosurg 1990;72:554-8.
3. Ausman JI, Pearce JE, Vacca DF, Diaz FG, Shrontz CE, Patel S. Tandem bypass: Occipital artery to posterior inferior cerebellar artery side-to-side anastomosis and occipital artery to anterior inferior cerebellar artery end-to-side anastomosis: A case report. Neurosurgery 1988;22:919-22.
4. Carlson AP, Yonas H, Chang YF, Nemoto EM. Failure of cerebral hemodynamic selection in general or of specific positron emission tomography methodology? Carotid Occlusion Surgery Study (COSS). Stroke 2011;42:3637-9.
5. Chang SW, Abla AA, Kakarla UK, Sauvageau E, Dashti SR, Nakaji P, *et al*. Treatment of distal posterior cerebral artery aneurysms: A critical appraisal of the occipital artery-to-posterior cerebral artery bypass. Neurosurgery 2010;67:16-25.
6. Grubb RL Jr, Powers WJ, Clarke WR, Videen TO, Adams HP Jr, Derdeyn CP: Carotid Occlusion Surgery Study Investigators. Surgical results of the Carotid Occlusion Surgery Study. J Neurosurg 2013;118:25-33.
7. Hayward PA, Gordon IR, Hare DL, Matalanis G, Horrigan ML, Rosalion A, *et al*. Comparable patencies of the radial artery and right internal thoracic artery or saphenous vein beyond 5 years: Results from the Radial Artery Patency and Clinical Outcomes trial. J Thorac Cardiovasc Surg 2010;139:60-7.
8. Houkin K, Kamiyama H, Kuroda S, Ishikawa T, Takahashi A, Abe H. Long-term

patency of radial artery graft bypass for reconstruction of the internal carotid artery. Technical note. J Neurosurg 1999;90:786-90.
9. Khodadad G. Occipital artery-posterior inferior cerebellar artery anastomosis. Surg Neurol 1976;5:225-7.
10. Korinth MC, Thron A, Bertalanffy H, Gilsbach JM. Coil embolization of an incidental posterior cerebral artery aneurysm after initial OA-PCA bypass surgery. Zentralbl Neurochir 2000;61:158-61.
11. Peerless SJ, Ferguson GG, Drake CG. Extracranial-intracranial (EC/IC) bypass in the treatment of giant intracranial aneurysms. Neurosurg Rev 1982;5:77-81.
12. Powers WJ, Clarke WR, Grubb RL Jr, Videen TO, Adams HP Jr, Derdeyn CP; COSS Investigators. Extracranial-intracranial bypass surgery for stroke prevention in hemodynamic cerebral ischemia: The Carotid Occlusion Surgery Study randomized trial. JAMA 2011;306:1983-92.
13. Roski RA, Spetzler RF, Hopkins LN. Occipital artery to posterior inferior cerebellar artery bypass for vertebrobasilar ischemia. Neurosurgery 1982;10:44-9.
14. Sakata K, Al-Mefty O, Yamamoto I. Venous consideration in petrosal approach: Microsurgical anatomy of the temporal bridging vein. Neurosurgery 2000;47:153-60.
15. Sundt TM, Jr., Piepgras DG. Occipital to posterior inferior cerebellar artery bypass surgery. J Neurosurg 1978;48:916-28.
16. Touho H, Karasawa J, Ohnishi H, Kobitsu K. Anastomosis of occipital artery to posterior cerebral artery with interposition of superficial temporal artery using occipital interhemispheric transtentorial approach: Case report. Surg Neurol 1995;44:245-50.
17. Vishteh AG, Smith KA, McDougall CG, Spetzler RF. Distal posterior cerebral artery revascularization in multimodality management of complex peripheral posterior cerebral artery aneurysms: Technical case report. Neurosurgery 1998;43:166-70.
18. Yonekawa Y, Imhof HG, Taub E, Curcic M, Kaku Y, Roth P, *et al*. Supracerebellar transtentorial approach to posterior temporomedial structures. J Neurosurg 2001;94:339-45.