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Case Report

Occipital artery to extracranial vertebral artery anastomosis for bilateral vertebral artery stenosis at the origin: A case report

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Abstract

Background: Revascularization of posterior circulation is essential in patients with severe bilateral vertebral artery (VA) stenosis despite administering maximal medical treatment, due to the high mortality of posterior circulation stroke.

Case Description: We present a 69-year-old man with bilateral severe VA stenosis at the origins, treated with occipital artery (OA)-distal VA anastomosis.

Conclusion: Endovascular treatment and other surgical treatments, such as bypass grafting, are effective, but OA-VA anastomosis is a safe and effective procedure for revascularization of the posterior circulation.

Key Words: Arterial reconstruction, occipital artery-vertebral artery transposition, vertebral artery stenosis, vertebrobasilar insufficiency

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INTRODUCTION

Bilateral vertebral artery (VA) stenosis can cause posterior circulatory insufficiency when the posterior communicating artery or other collaterals are poorly developed. The proximal portion, especially the origin, of the VA is the most common location (92%) of atherosclerotic occlusive disease in VA.[16] Symptomatic VA stenosis refractory to medical treatment has a 5–11% rate of stroke or death at 1 year[8] and mortality of posterior circulation stroke ranges from 20 to 30%.[8,15,18,20] Therefore, revascularization of the posterior circulation is essential in patients with severe bilateral VA stenosis despite administering maximal medical treatment. Here, we describe a case of successful revascularization that was achieved using occipital artery (OA) to distal extracranial VA anastomosis in a patient with severe bilateral VA stenosis at the origin.

CASE DESCRIPTION

Case Report

A 69-year-old man was admitted to our hospital because of bilateral ataxia and dizziness. He had not been taking any medications and had been smoking 40 cigarettes per day for 49 years. Laboratory tests revealed mild dyslipidemia and impaired glucose tolerance. Blood pressure on admission was 188/92 mmHg. Magnetic resonance imaging (MRI) showed acute brain infarction at the bilateral cerebellar hemispheres and the right thalamus. The lesions in the cerebellum were not perfectly consistent with vessel-dominant regions supplied by the anterior inferior cerebellar artery or posterior inferior cerebellar artery. Head magnetic resonance angiography (MRA) showed bilateral VAs but posterior communicating arteries were not observed

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bilaterally. Neck MRA indicated right VA but did not show left VA [Figure 1]. Contrast-enhanced three-dimensional computed tomographic angiography (3D-CTA) showed right VA severe stenosis at the origin and did not show the left VA from the ostia to the lower edge of the second cervical vertebra [Figure 2, left]. Relatively thick OA was also shown. Cerebral angiography revealed right VA severe stenosis similar to 3D-CTA, but showed near-occlusion of the ostia of the left VA and markedly delayed poststenotic blood flow in the left VA. Stenosis was detected only at the ostia, in contrast to 3D-CTA. Argatroban, antiplatelet medication (aspirin 100 mg and clopidogrel 75 mg daily), rosuvastatin, and omarigliptin were started. After the acute phase, amlodipine and olmesartan treatment were also begun. The patient was discharged home with mild bilateral ataxia.

We planned surgical reconstruction of posterior circulation in order to avoid fatal brain infarction due to posterior circulatory insufficiency, which is related to high morbidity and mortality. In terms of preoperative neurological symptoms, the muscle tones of extremities were intact. The gait on a flat surface was normal without assistance, but the tandem gait was unsteady when attempting to touch the heel of the right foot to the toe of the left foot. Mild dysmetria was seen when finger–nose–finger test was performed with the left forearm. He felt a difficulty to use his left hand as a subjective symptom. Dysarthria was mild to moderate with some slurring of speech so that we asked the patient to repeat sometimes.

Operation

We performed left OA to left distal extracranial VA anastomosis 3 months after the first admission avoiding hemorrhagic infarction [Video 1]. The OA and VA were carefully exposed with maintenance of blood flow by dissecting suboccipital muscles layer-by-layer through the lateral suboccipital approach. Craniotomy was not required because the arteries were extracranial. The VA from the foramen transversarium of C2 to foramen magnum (V3) was temporarily trapped and incised to make a 3.5-mm hole by vessel punch. The OA was cut adequately for end-to-side anastomosis to the VA with 16 sutures using 8-0 monofilament nylon at the occipito-atlantal (C0-C1) level. The temporary occlusion time was 38 min and 40 s [Figure 3].

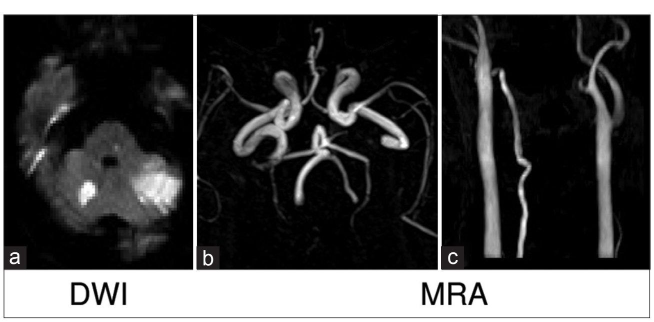

Figure 1: Diffusion weighted magnetic resonance imaging showed acute brain infarction at the bilateral cerebellar hemispheres and the right thalamus (a). Head MRA showed the bilateral VAs but posterior communicating arteries were not observed bilaterally (b). Neck MRA indicated the right VA but not the left VA (c)

Postoperative course

On the day following the operation, the patient walked without assistance but watching and the bilateral ataxia improved. 3D-CTA just after the operation showed that the anastomosis was patent, and the left VA was observed from the ostia to the union [Figure 2, right]. In terms of postoperative neurological symptoms, he was able to walk more swiftly than before the operation and the tandem gait was slightly improved. The mild dysmetria was still seen when finger–nose–finger test was performed with the left forearm, but the subjective symptom that he felt difficult to use his left hand was improved. Dysarthria was improved a little so that what the patient said could be understood easily. Furthermore, the mini mental state examination score and the frontal assessment battery at bedside score were improved from 24 to 29 and from 15 to 17, respectively. The patient was discharged home under his own ambulation. Three months after the operation, MRA indicated that the bypass was widely patent, and OA had developed from 3.0 to 3.6 mm in diameter. The patient remains under observation and has experienced no recurrent symptoms due to posterior circulatory stroke for 6 months. He restarted to work in his farm field.

DISCUSSION

Posterior circulatory insufficiency carries risks of severe morbidity and mortality. Up to 25% of transient ischemic attacks (TIAs) and strokes are associated with posterior

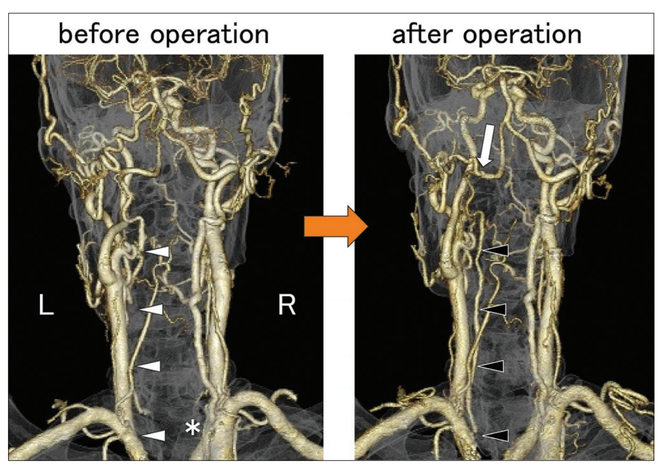

Figure 2: Posterior view of contrast-enhanced 3D-CTA before the operation (left) showed right VA severe stenosis at the origin (*asterisk*) and did not show the left VA from the ostia to the lower edge of the second cervical vertebra (*white arrowheads*). Whereas, 3D-CTA just after the operation (right) showed that the anastomosis was patent (*white arrow*) and the left VA was shown from the ostia to the union (*black arrowheads*)

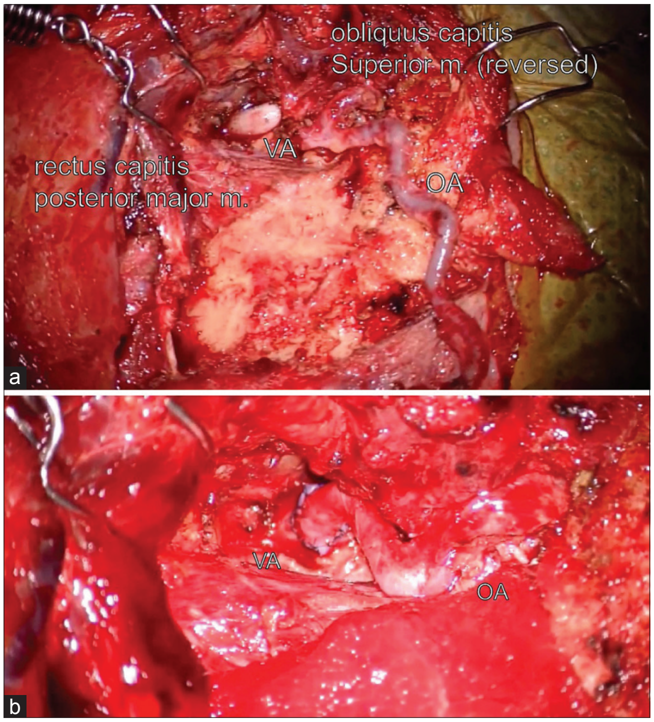

Figure 3: Intraoperative findings of left OA to left extracranial VA anastomosis. After dissecting the OA and the VA (a), the OA was mobilized and anastomosed end-to-side to the VA (b). The VA was observed in the occipito-atlantal (C0-C1) level within the suboccipital triangle bounded by the rectus capitis posterior major muscle, obliquus capitis superior muscle, and obliquus capitis inferior muscle [Video 1]

circulation, and patients with symptomatic VA stenosis have a 30–35% risk of stroke over 5 years and a 5–11% combined risk of stroke and death at 1 year.[12,17,25] Moreover, the mortality rate after a posterior circulation stroke is up to 25%.[18,20] Therefore, we performed vascular reconstruction of posterior circulation to prevent stroke in the vertebrobasilar territory of this patient.

Open surgery and/or endovascular treatment are planned to revascularize VA. In terms of endovascular treatment, previous randomized controlled trials (RCTs), such as The Vertebral Artery Stenting Trial (VAST)[5] and The Vertebral Artery Ischaemia Stenting Trial (VIST),[13] showed no advantages of stenting/angioplasty, compared to best medical treatment alone in patients with extracranial VA stenosis.

In addition, the rates of perioperative stroke and death are comparable for open versus endovascular approaches. The main difference between surgical and endovascular treatment is durability. The perioperative stroke rates of open surgery and endovascular treatment are almost the same (0–4%). However, the patency rate and stroke-free rate of open surgery are both 90% at 10 years.[3] Despite the high rates of technical success, endovascular treatment of VA disease is associated with high rates of restenosis, ranging between 13 and 50% in available reports.[2,11,21,23] Therefore, as described in the Japanese Guidelines for the Management of Stroke 2015, there is insufficient scientific evidence to perform percutaneous angioplasty and stent placement for extracranial and intracranial arterial stenosis except in the cervical internal carotid artery (ICA).[14] However, it should be noted that endovascular treatment is less invasive and relatively easy, and that the procedure can be performed without general anesthesia, enabling continuous neurological monitoring of the patient.[5] In addition, the latest RCT, VIST, suggested that stenting may reduce longer term stroke risk, although this remains to be confirmed in larger trials.[13] The VA in the neck region gives off numerous branches reconstituting the distal VA as collaterals,[4] so there is a possibility that endovascular treatment may be an easy procedure to gain time for collaterals to develop.

Furthermore, in particular cases with severe VA stenosis, it has been reported that hybrid operations combining surgical manipulation of the proximal VA and endovascular techniques can be safe and effective.[26] In addition, although endovascular treatment of VA stenosis is associated with high rates of restenosis, surgical revascularization can be performed after restenosis. With regard to acute stroke, emergent revascularization of VA occlusion has been reported.[1] In patients with such acute stroke, it is useful to perform surgical revascularization after VA stenting in the acute phase as two-stage surgery. Thus, endovascular treatment is a feasible option for treatment of VA stenosis.

On the contrary, open surgery largely consists of two procedures: bypass grafting and transposition. Bypass grafting involves carotid bypass to the VA from the ostia to the transverse foramen of C6 (V1) or V3, or subclavian bypass to the V1, with vein grafting. Transposition involves anastomosing VA to ICA, the external carotid artery (ECA), or OA to VA, or VA to the subclavian artery.[6] Several case series of open surgery for revascularization of symptomatic vertebrobasilar artery stenosis or posterior circulatory lesion have been reported between 1985 and the present [Table 1].[6,7,9,10,22,24,27] The largest series of distal VA reconstruction indicated a patency rate of 89.3% and a significant vertebrobasilar symptom-free rate of 94% at 5 years.[7] In one report, transposition provided a statistically significant improvement in primary patency over bypass grafting for 80 months,[7] but whether bypass grafting or transposition is superior remains controversial.

To our knowledge, there have been only 19 previous case reports of OA-VA transposition, as performed in our case. These previous reports indicated good patency and no complications of OA-VA transposition [Table 2].[6,9,10,22,24,27] Complications of open surgery were mainly observed in patients requiring combined ICA and distal VA reconstruction.[7] So OA-VA transposition is safe by avoiding the risk of ICA treatment.

Table 1: Case series of surgical revascularization of symptomatic vertebrobasilar artery stenosis[6,7,9,10,22,24,27]

Author, year	Period	No.	Bypass graft	Trans-position	Others	Patency, period	Complication, period
Hadley, 1985	1985	1	0	1	0	Patent, postoperative	No new deficit, postoperative
Takeda, 1992	1984-1990	33	0	31	2	91%, 1-84 months	33%, postoperative
Hans, 1998	1992-1996	9	0	4	5	100%, 3-48 months	0%, postoperative
Ramon, 1998	1982-1996	100	72	25	3	84%, postoperative	Not described
Edouard, 2002	1978-2001	352	240	110	2	80.8%, 10 years	2.2%, postoperative
Yong, 2010	2007	1	0	1	0	Not described	Not described
Dawn, 2013	2005-2011	41	32	9	0	89%, 60 months	18%, postoperative
Total		942	391	454	97		

Table 2: Case series of OA-VA anastomosis for symptomatic vertebrobasilar artery stenosis[6,9,10,22,24,27]

Author, year	Period	OA-VA anastomosis	Patency, period	Complications, period
Hadley, 1985	1985	1	Patent, postoperative	No new deficit, postoperative
Takeda, 1992	1984-1990	4 (ECA or OA-VA)	100%, 6-84 months	0% complications, postoperative
Hans, 1998	1992-1996	2	100%, 3-48 months	0% complications, postoperative
Ramon, 1998	1982-1996	5	Not described	Not described
Yong, 2010	2007	1	Patent, 2 years	No new deficit, 2 years
Dawn, 2013	2005-2011	6 (ECA or OA-VA)	Not described	Not described
Our case, 2017	2017	1	Patent, 3 months	No new deficit, 3 months
Total		20		

In our case, we chose OA-VA anastomosis instead of bypass grafting, VA-subclavian transposition, or endovascular treatment. Bypass grafting requires temporary occlusion of the ICA or common carotid artery (CCA), which markedly reduces cerebral blood flow, and therefore the operation must be performed quickly. Although blood flow in the ICA or CCA can be maintained using an internal shunt tube or partial vessel occlusion with a curved clip, the possibility of blood flow decrease is not zero. Furthermore, bypass grafting requires invasive and complicated procedures, such as wide skin incision, harvesting of the venous graft, two anastomoses, and multiple temporary clipping and occlusion procedures.

VA-subclavian transposition can improve the VA stenosis and was recommended by Ogawa[19] because it is less invasive compared to other surgical reconstruction methods. However, it requires skin incision around clavicle or sternocleidomastoid muscle, but this approach is not popular among neurosurgeons as there is a risk of cervical sympathetic nerve injury. In addition, it requires a moderate length of VA, and anastomosis can be difficult when the subclavian artery has many of its important branches. In addition, the right VA is the solitary feeding artery for the brainstem, so it is difficult to anastomose the right VA to the subclavian artery with temporary occlusion of the right VA.

Endovascular treatment also requires transient occlusion, so endovascular angioplasty for the right VA is unsafe for the same reason, and angioplasty itself can cause strokes due to embolization of debris despite using an embolic protection device, such as a filter. Endovascular angioplasty for the left VA is also difficult because insertion of the guidewire cannot be performed easily due to near occlusion of the left VA.

Based on the points discussed earlier, we performed left OA-VA anastomosis. Of course, it required temporary occlusion of the left VA. However, the left VA was almost occluded prior to surgery and the right VA could maintain its flow during temporary left VA occlusion. Therefore, OA-VA anastomosis was a safe procedure in this case [Figure 4]. The diameter of the vessel increased in response to the demands of blood flow, similar to superficial temporal artery (STA)-middle cerebral artery (MCA) bypass. This case suggests a novel surgical indication of OA-VA anastomosis for posterior circulatory insufficiency similar to STA-MCA bypass for MCA stenosis or occlusion and symptomatic ICA stenosis or occlusion.

Furthermore, when transposition of V1 to the subclavian artery is needed as a radical operation or two-stage operation, OA-VA anastomosis before V1-subclavian transposition can maintain flow of the VA for the brainstem via anastomosis at V3 during V1-subclavian transposition with temporary occlusion of the proximal VA. Therefore, OA-VA anastomosis can be a safe procedure and lead to radical operation.

CONCLUSION

OA to distal extracranial VA anastomosis is a good candidate for symptomatic bilateral severe VA stenosis at

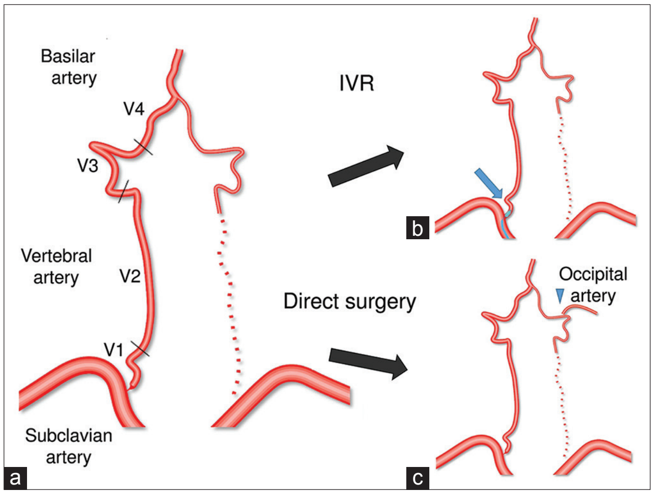

Figure 4: The surgical strategy in this case. Schema of arteries in this case (a). The VA is divided into four segments: V1, origin to transverse foramen of C6; V2, from the transverse foramen of C6 to the transverse foramen of C2; V3, from C2 to the dura; V4, from the dura to their union to form the basilar artery. In our case, the right VA was the solitary feeding artery for the brainstem, so it was difficult to perform procedures requiring temporary occlusion of the right VA, such as anastomosing the right VA to the subclavian artery and endovascular angioplasty for the right VA. In addition, the left VA showed severe stenosis, so anastomosing the left VA to the subclavian artery and endovascular angioplasty for the left VA had no guarantee of success (b). On the contrary, left occipital artery-VA anastomosis was safe. Of course, it required temporary occlusion of the left VA. However, the left VA was almost occluded prior to surgery and the right VA was able to maintain its flow during temporary left VA occlusion (c)

the origin and can be performed more safely and more easily than bypass grafting and endovascular treatment.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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