 doi: 10.2176/jns-nmc.2022-0028

NMC Case Report Journal 9, 129-133, 2022

A Case of Proximal Posterior Inferior Cerebellar Artery (PICA) Aneurysm Treated with PICA-to-PICA Bypass and Trapping Surgery: Comparison with Occipital Artery-PICA Bypass

Yusuke SAKAMOTO, Kenko MAEDA, Masaya TAKEMOTO,
Jungsu CHOO, Mizuka IKEZAWA, Ohju FUJITA,
Fumihiro SAGO, Daiki SOMIYA, and Akira IKEDA

Department of Neurosurgery, Japan Community Health Care Organization Chukyo Hospital, Nagoya, Aichi, Japan

Abstract

Posterior inferior cerebellar artery (PICA) aneurysms often require cerebral vascular reconstruction for surgical treatment because of their characteristic morphology. Despite its potential complications, the occipital artery-to-posterior inferior cerebellar artery (OA-PICA) bypass is a typical treatment because of its versatility. Although a few cases of intracranial-to-intracranial bypass have been reported, this type of vascular reconstruction is only regarded as an alternative to the OA-PICA bypass because of the uncertainty of bypass feasibility and potential risk of ischemic complications. In this article, we report a case of proximal PICA ruptured aneurysm that was treated with a PICA-to-PICA (PICA-PICA) bypass. A 79-year-old man presented with a chief complaint of sudden, severe headache and disturbances in consciousness. Radiological examination revealed a right proximal PICA fusiform aneurysm. The patient had many systemic disorders such as microscopic polyangiitis and steroid-induced diabetes mellitus that could have caused wound dehiscence and cerebrospinal fluid (CSF) leakage. We performed the PICA-PICA bypass and trapping surgery rather than the OA-PICA bypass to avoid skin problems and CSF leakage. The postoperative course was uneventful, and the patient was discharged on day 64 without any neurological disorders. In comparison with the OA-PICA bypass, the PICA-PICA bypass is less likely to cause CSF leakage and skin complications, although it carries the risk of specific ischemic complications and requires advanced surgical techniques. For some patients with systemic disorders, the PICA-PICA bypass could be an optimal treatment option for proximal fusiform PICA aneurysms rather than as an alternative to the OA-PICA bypass.

Keywords: posterior inferior cerebellar artery, aneurysm, bypass surgery

Introduction

Posterior inferior cerebellar artery (PICA) aneurysms are rare and account for only 3%-4% of all brain aneurysms.[1] Many cases of PICA aneurysms are nonsaccular or fusiform aneurysms in which a simple clipping technique cannot be applied, and trapping surgery with vascular reconstruction is often required. The occipital artery (OA)-PICA bypass is a typical vascular reconstruction surgery for aneurysms in this area. However, the OA-PICA bypass has been reported to cause a few complications.[2] One of them is skin necrosis caused by the harvesting of the OA and reduced blood flow to the skin flap. Intracranial-to-intracranial (IC-IC) bypass, which does not require an extracranial artery, may reduce the risk of skin problems. We encountered a case of ruptured proximal PICA fusiform aneurysm, which was treated with a PICA-PICA bypass and trapping surgery. In this report, we describe the details of this case and compare the OA-PICA bypass and PICA-PICA bypass with a literature review and present the outcomes of bypass surgeries performed at our institute.

Received January 27, 2022; Accepted March 23, 2022

Fig. 1 Three-dimensional digital subtraction angiography showed a proximal posterior inferior cerebellar artery (PICA) fusiform aneurysm (arrowheads).

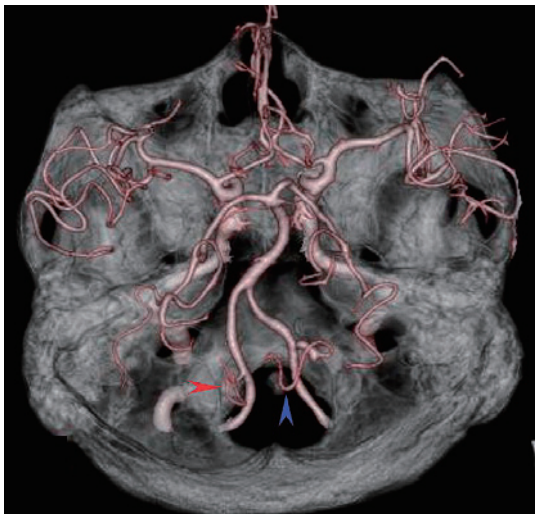

Fig. 2 Three-dimensional computed tomography angiography showed that the caudal loops of the left PICA (red arrowhead) and the right PICA (blue arrowhead) were positioned parallelly at some distance.

Case Report

The authors obtained written informed consent from the patient and his family. No approval from the IRB was sought as this article is a case report.

This 79-year-old man had a sudden onset of consciousness disturbance and headache and was initially admitted to another hospital. His consciousness level on admission was E3V4M6 on the Glasgow Coma Scale. Head computed tomography (CT) revealed a Fisher grade 3 subarachnoid hemorrhage. The patient was subsequently transferred to our facility for surgical treatment. He had microscopic polyangiitis, renal dysfunction, and steroid-induced diabetes mellitus. His medical history also included hyperlipidemia, hypertension, and osteoporosis. Three-dimensional digital subtraction angiography showed a right proximal PICA fusiform aneurysm (Fig. 1). We observed both PICAs, but there was some distance between the bilateral PICA caudal loops (Fig. 2). Fortunately, the origin of the right PICA was sufficiently low to allow securing its proximal location without difficulty.

The patient's comorbidities increased his risk for skin complications. Therefore, we avoided using the OA as a graft. We instead selected an IC-IC bypass instead of an OA-PICA bypass. We assumed that aggressive dissection around the PICA might facilitate PICA-PICA bypass, but the distance between the PICAs made it uncertain whether this surgery could be performed. Our strategy was as follows: we made a midline linear skin incision and performed conventional suboccipital craniotomy to reduce the risk of skin problems. We then marked the short segment of the OA by using sonography and sanitized the skin, without harvesting. If we then found that a PICA-PICA bypass would be difficult to perform during surgery, we would harvest a short segment of the OA graft and perform PICA-OA interposition graft-PICA anastomosis.

We performed a midline linear skin incision and a conventional suboccipital craniotomy. First, we dissected the right cerebromedullary fissure and found the right PICA easily. The right proximal vertebral artery V4 segment was secured without difficulty. Then, we easily identified the right PICA and the aneurysm (Fig. 3a). The proximal and distal PICA locations were secured. At a glance, there was some distance between the PICAs, but aggressive dissection facilitated their mobilization. Finally, we decided to perform a PICA-PICA bypass without using an OA interposition graft. We made two stay sutures and running sutures on the posterior wall and intermittent sutures on the anterior wall (Fig. 3b). The total clamp time was 32 min and 15 s. Indocyanine green showed excellent patency of the PICA-PICA bypass. After anastomosis, the right PICA aneurysm was trapped (Fig. 3c). The total operation time was 5 h and 3 min.

The patient recovered well. On day 2, his level of consciousness was almost of complete alertness, and he was extubated. He did not have any neurological disorders that would indicate damage to the lower cranial nerves. Magnetic resonance imaging on day 8 showed a very small asymptomatic infarction in the left caudate nucleus. CT angiography on day 15 showed excellent bypass patency (Fig. 4). The patient did not show any skin complications or cerebrospinal fluid (CSF) leakage. He had normal pressure hydrocephalus and underwent a ventriculoperitoneal shunt on day 37. He was transferred to a rehabilitation hospital on day 64 (modified Rankin score = 2). At his 6-month outpatient follow-up, the patient was independently per-

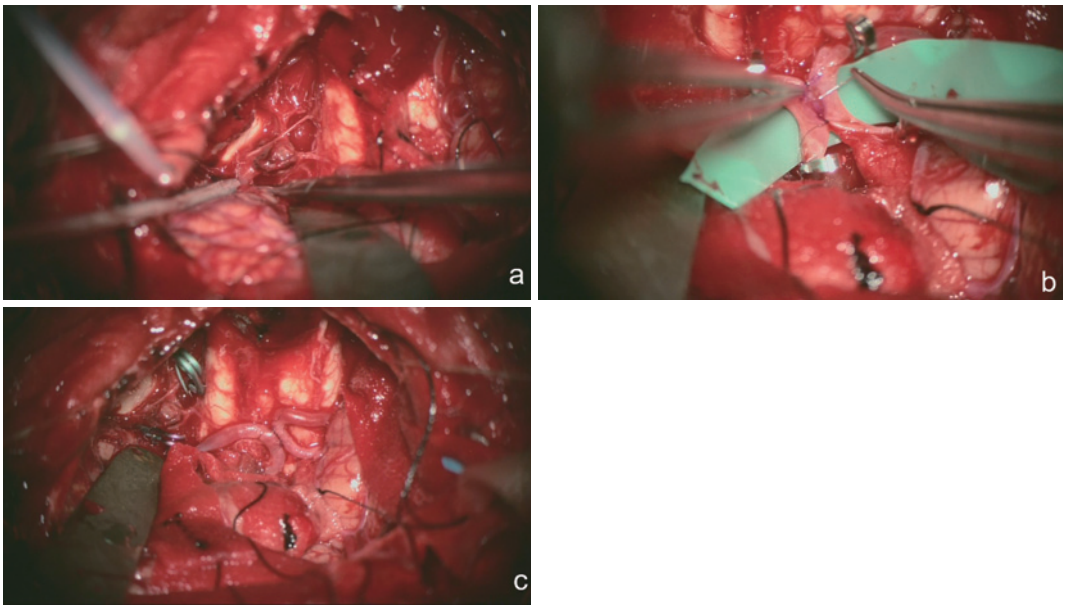

Fig. 3 (a) PICA and its exposed rupture point. (b) PICA-PICA side-to-side anastomosis was performed. (c) After anastomosis, the rupture point was trapped.

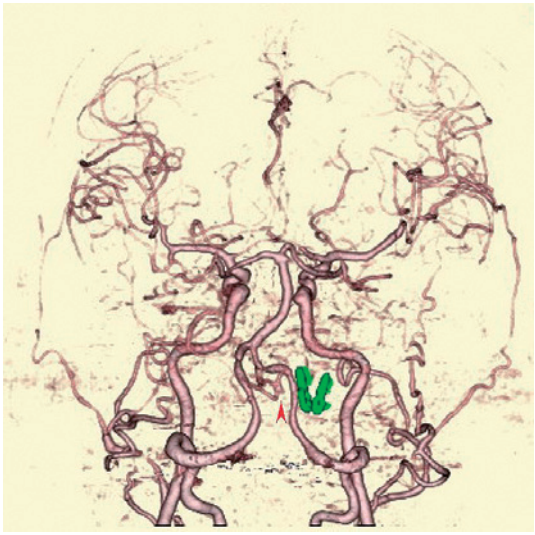

Fig. 4 Three-dimensional computed tomography angiography showed perfect patency of the PICA-PICA bypass and obliteration of the aneurysm (PICA-PICA anastomosed site showed by arrowhead).

forming his activities of daily living.

Discussion

OA-PICA bypass

Nonsaccular PICA aneurysms often require trapping surgery with vascular reconstruction, and many bypass options have been reported for these lesions.[3,4] The OA-PICA bypass appears to be one of the most typical and popular treatment options.[5] One reason for this popularity is the versatility of the OA-PICA bypass, which can be applied in almost all cases of nonsaccular PICA aneurysms, except in those lacking the OA. Although the PICA has many anatomical variations, the OA-PICA bypass is independent of the arrangement of the PICA and can therefore be applied in almost all cases. The use of the OA enables sufficient extracranial blood flow to the recipient area of the lesion, which can help prevent vasospasm and ischemic complications. However, harvesting the OA is complicated because of its tortuous course through the muscular and subcutaneous layers.[6] In addition, the OA has to be harvested from the superior nuchal line to the mastoid groove to avail a sufficient length of graft. This requires the use of nonlinear incisions such as the hockey stick incision or the C-shaped incision to include a long OA graft and far lateral craniotomy.[6] However, such nonlinear skin incisions are unfavorable with respect to blood flow to the skin flap.[7] A reduction in blood supply to the skin flap may cause graft dehiscence and necrosis, necessitating additional plastic surgical treatment, although the frequency of this complication is low. Specifically, the exact frequency of skin complications of OA-PICA bypass has not been well described in previous studies; only one small case series of OA-PICA bypass mentioned the frequency of skin complication to be one among nine cases.[8] Although long and nonlinear skin incisions are unfavorable from the point of view of invasiveness of the skin flap, they are more favorable from the point of view of the surgical approach. For example, the hockey stick skin incision and muscle skin flap can be flipped to the caudal side, after which large far lateral craniotomy can be performed to avail a wide, gently sloped, and relatively shallow surgical field. This wide sur-

gical field allows the OA-PICA bypass to provide an easier anastomosis than other anastomoses in the deep site. In addition, we usually perform end-to-side anastomosis in the OA-PICA bypass, which is familiar to neurosurgeons because an end-to-side anastomosis is a variation of the familiar superficial temporal artery (STA) to middle cerebral artery (MCA) anastomosis. Thus, the OA-PICA bypass can be usually performed without difficulty and with a short clamp time. Moreover, this bypass only requires the use of a single PICA, in contrast to the PICA-PICA bypass. In cases involving bypass occlusion, ischemic complications are therefore limited to the ipsilateral PICA lesions. However, CSF leakage is a potential complication of OA-PICA bypasses in particular.[2] Complete dural closure is impossible because of the OA bypass graft running through the dural incision.

PICA-PICA bypass

The side-to-side bypass of PICA lesions was first reported by Ausman et al. in 1988.[9] Actually, while a few cases of PICA-PICA bypasses have been reported over the past 30 years, this procedure is not as familiar to neurosurgeons as the OA-PICA bypass.[10] We suppose that the PICA-PICA bypass has been mostly regarded as a mere alternative to the OA-PICA bypass when the OA is not available for reasons such as preclusion or injury of the OA during dissection. One of the reasons for the low familiarity of surgeons with the PICA-PICA bypass is its lower versatility, when compared to the OA-PICA bypass. The former technique requires both PICAs to be parallel, closely positioned, and have matching calibers. Thus, the PICA-PICA bypass depends on the anatomical structures of the PICAs. Another disadvantage of the PICA-PICA bypass is the risk of injury to the contralateral PICA. A long cross-clamping time or bypass occlusion can endanger the PICAs and may cause irreversible bilateral ischemic complications in the cerebellum. Lack of surgeon's familiarity with side-to-side anastomosis is also a disadvantage of the PICA-PICA bypass since it requires an utterly different anastomosis procedure in comparison with the STA-MCA bypass, which most neurosurgeons are familiar with. The technique also requires intraluminal suturing in the deep field with maximal care for the endothelial and line brakes. These peculiar difficulties make this anastomosis technically challenging.[3]

Nevertheless, the PICA-PICA bypass also offers some advantages over the OA-PICA bypass. First, it does not require complicated and time-consuming dissection of the OA. Since the OA is not harvested, the blood supply to the skin flap is preserved, which is beneficial for wound healing. Depending on the position of the ruptured PICA point, the PICA-PICA bypass can be performed with a linear midline skin incision and a conventional suboccipital approach.[3,4] Thus, a large muscle skin flap is not required. With respect to extracranial invasiveness, the PICA-PICA bypass appears to be less invasive than the OA-PICA bypass. However, the lower extracranial invasiveness also causes technical difficulties in the PICA-PICA bypass, since linear skin incisions and conventional suboccipital craniotomy provide a much narrower and steeper surgical field than the OA-PICA bypass. Moreover, a wound retractor is required for linear skin incisions, which yields a much deeper surgical field than that obtained with the flipped hockey stick skin flap and far lateral craniotomy. The narrower and less invasive the surgical field, the more difficult the bypass surgery. An advantage of the PICA-PICA bypass in this regard is the lower probability of CSF leakage and skin complications. Unlike the OA-PICA bypass, the PICA-PICA bypass does not require an extracranial bypass skin graft, and the absence of this graft allows watertight dural closure, thereby reducing the risk of CSF leakage, infections, and skin complications.

Comparison between the OA-PICA and PICA-PICA bypasses

The advantages and disadvantages of these two bypass surgeries are summarized in Supplementary Table 1. Versatility can be considered to be one of the biggest advantages of the OA-PICA bypass, since this technique can be performed in almost all cases of PICA lesions. The PICA-PICA bypass is dependent on anatomical PICA morphologies and positioning; thus, it is uncertain whether this bypass can be performed in certain cases. However, the use of a short interposition graft may be of some help in overcoming these anatomical difficulties.[11] A PICA-interposition-PICA bypass may address the anatomical uncertainty associated with the PICA-PICA bypass. In our case, we marked the right OA with Doppler and sanitized the occipital skin to avail the distal OA as a short interposition graft in case the PICA-PICA bypass would not be feasible. This approach aimed to address the risks of the PICA-PICA bypass to some extent.

After the procedure and despite his multiple comorbidities, our patient recovered quickly and was discharged from the hospital without any complications. Although the current evidence has focused primarily on the risks and lack of surgeons' familiarity with the PICA-PICA bypass, it may be an optimal treatment option rather than just an alternative to the OA-PICA bypass.[3] Indeed, while every PICA aneurysm may not be treatable with the PICA-PICA bypass, this could become a potential treatment option for patients who have several comorbidities, including a higher chance of skin complications. However, since this bypass technique does not have widespread use and it is technically difficult, continuous training and increased familiarity with the procedure would be necessary to achieve optimal surgical outcomes. We have described the surgical outcomes of the different types of bypass performed at our institute over a period of 11 years (from January 2011 to December 2021) as supportive data in Supplementary Ta-

ble 2. Although our case series was not large enough to perform statistical analyses, it may nevertheless reflect the pros and cons of PICA-PICA bypass stated in this report. Comparison of surgical outcomes of each bypass type performed at our institute is summarized in Supplementary Table 3. Our data were retrospectively retrieved from our medical records. As per the ethical guidelines of the Japan Neurosurgical Society, we did not seek local IRB approval, as this case series included less than nine cases. Considering the low invasiveness of retrospective data retrieval, an opt-out method of consent was adopted. Notification for opt-out was posted on our institute website; patients could easily opt to decline the use of their data for publication in the report.

Conclusion

We described a case of fusiform proximal PICA aneurysm that was treated with a PICA-PICA bypass. The PICA-PICA bypass has specific advantages over the OA-PICA bypass. In some cases, the PICA-PICA bypass could be an optimal treatment option rather than just an alternative treatment for OA-PICA bypass.

Details of Previous Presentation

The 80th Annual Meeting of the Japan Neurosurgical Society, 2021/10/27-10/30, Yokohama, Japan, poster presentation

Supplementary Material

https://doi.org/10.2176/jns-nmc.2022-0028

Acknowledgments

Funding: This study did not receive any funding or financial support.

Abbreviations

PICA, posterior inferior cerebellar artery; OA, occipital artery; MCA, middle cerebral artery; STA, superficial temporal artery; IC, intracranial; CSF, cerebrospinal fluid; CT, computed tomography

Conflicts of Interest Disclosure

Conflicts of interest: All authors have no conflicts of interest to declare. All authors have registered online self-reported COI disclosure statement forms through the website of the Japan Neurosurgical Society members.

References

1) Miao HL, Zhang DY, Wang T, Jiao XT, Jiao LQ: Clinical importance of the posterior inferior cerebellar artery: a review of the literature. *Int J Med Sci* 17: 3005-3019, 2020
2) Crowley RW, Medel R, Dumont AS: Operative nuances of an occipital artery to posterior inferior cerebellar artery bypass. *Neurosurg Focus* 26: E19, 2009
3) Abla AA, McDougall CM, Breshears JD, Lawton MT: Intracranial-to-intracranial bypass for posterior inferior cerebellar artery aneurysms: options, technical challenges, and results in 35 patients. *J Neurosurg* 124: 1275-1286, 2016
4) Deora H, Nayak N, Dixit P, et al.: Surgical management and outcomes of aneurysms of posterior inferior cerebellar artery: location-based approaches with review of literature. *J Neurosci Rural Pract* 11: 34-43, 2020
5) Sundt TM Jr., Piepgras DG: Occipital to posterior inferior cerebellar artery bypass surgery. *J Neurosurg* 48: 916-928, 1978
6) Fukuda H, Evins AI, Burrell JC, Stieg PE, Bernardo A: A safe and effective technique for harvesting the occipital artery for posterior fossa bypass surgery: a cadaveric study. *World Neurosurg* 82: e459-e465, 2014
7) Katsuta T, Inoue T, Arakawa S, Uda K: Cutaneous necrosis after superficial temporal artery-to-middle cerebral artery anastomosis: is it predictable or avoidable? *Neurosurgery* 49: 879-882; discussion 882, 2001
8) Kitiporn S, Somikiat W, Nasaeng A: Occipital artery-posterior inferior cerebellar artery bypass for the treatment of aneurysm of vertebral artery and posterior inferior cerebellar artery. *Vajira J* 63(Suppl): S1-18, 2019
9) 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* 22: 919-922, 1988
10) Lemole GM Jr., Henn J, Javedan S, Deshmukh V, Spetzler RF: Cerebral revascularization performed using posterior inferior cerebellar artery-posterior inferior cerebellar artery bypass. Report of four cases and literature review. *J Neurosurg* 97: 219-223, 2002
11) Kawashima M, Rhoton AL Jr., Tanriover N, Ulm AJ, Yasuda A, Fujii K: Microsurgical anatomy of cerebral revascularization. Part II: posterior circulation. *J Neurosurg* 102: 132-147, 2005

Corresponding author: Yusuke Sakamoto, M.D., Ph.D.
Department of Neurosurgery, Japan Community Health Care Organization Chukyo Hospital, 1-1-10 Sanjyo, Minami-ku, Nagoya, Aichi 457-8510, Japan.
e-mail: usakamoto420@gmail.com