

Natural Y-shaped radial artery graft bypass for a complex middle cerebral artery aneurysm: A case report

Ryota Sato, MD,* Takeshi Mikami, MD,* Hime Suzuki, MD,*
Akinori Yamamura, MD,*† Yusuke Kimura, MD,* Ryo Ukai, MD,*
Tomoaki Tamada, MD,* Yuka Kawata, MD,* Yukinori Akiyama, MD,* and
Nobuhiro Mikuni, MD, PhD*

Giant thrombosed middle cerebral artery (MCA) aneurysms are difficult to treat and sometimes require complex revascularization using allografts. We describe a technical method using revascularization with a natural Y-shaped graft that provides a normal variation for a complex MCA aneurysm. A 65-year-old man with a giant thrombosed MCA aneurysm presented with right hemiparesis and aphasia. The patient had a history of clipping surgery for the ipsilateral side of the MCA aneurysm 25 years before, and a de novo aneurysm developed over the previous 18 years. For the giant thrombosed aneurysm, trapping and revascularization were performed. A natural radial artery Y-graft was used as the graft and anastomosed to both M2 trunks. The symptoms improved after surgery, and the patient was discharged 3 weeks later. This is the first report of a double-barrel bypass using a natural Y-graft. This method attained a normal variation, and the flow of the Y-graft was physiological. For the radical cure of giant thrombosed MCA aneurysms, multiple revascularizations might be required. With this natural Y-graft, complex transpositions could be avoided.

Key Words: Thrombosed aneurysm—Y-shaped graft—High-flow bypass—Cerebral aneurysm

© 2020 Elsevier Inc. All rights reserved.

Introduction

According to the Unruptured Cerebral Aneurysm Study of Japan, the annual rate of rupture of giant middle cerebral artery (MCA) aneurysms was 16.87%.¹ However, the surgical treatment of giant MCA thrombosed aneurysms is complex and requires tremendous effort to complete a radical cure despite advancements of surgical and endovascular treatments. Owing to multiple perforators along the M1 segment, accessibility to the parent artery (M1 segment) or distal artery (M2 segment) is limited,

and aneurysms sometimes involve the M2 segment.² Consequently, multiple revascularizations are needed for trapping the aneurysms.^{2–4} For the reconstruction of the MCA, a superficial temporal artery (STA)-MCA double-barrel bypass is essential,⁵ although radial artery (RA) or saphenous vein grafts are needed in some limited cases.^{6,7} We report a technical method of revascularization using a natural RA Y-graft that provides a normal variation for the treatment of giant thrombosed MCA aneurysms.

Case report

A 65-year-old man underwent clipping surgery for a left middle cerebral aneurysm 25 years before in our affiliated hospital. Over the past 18 years, a de novo aneurysm was observed in the left M1 segment, which gradually developed. Four months before admission to our hospital, left hemiplegia and sensory aphasia appeared; he was then transferred to our department for treatment. T2-weighted magnetic resonance imaging revealed a multi-layered mixed intensity signal lesion with a maximum

From the *Department of Neurosurgery, Sapporo Medical University, South 1 West 16, Chuo-ku, Sapporo 060-8543, Japan; and †Department of Neurosurgery, Shinsapporo Neurosurgical Hospital, Sapporo, Japan.

Received January 9, 2020; revision received March 25, 2020; accepted March 29, 2020.

Corresponding author. E-mail: tmikami@sapmed.ac.jp.

1052-3057/\$ - see front matter

© 2020 Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.104853>

diameter of 65 mm (Fig. 1A) and a midline shift with edema. Consequently, we made a diagnosis of giant thrombosed aneurysm. A flow void in the MCA was present within the thrombosed aneurysm. Digital subtraction angiography and computed tomography angiography (CTA) images indicated that the aneurysm originated from the distal M1, which was distal to the previous clip, involving the M2 superior trunk, M2 inferior trunk, and angular artery (Fig. 1B, C). Therefore, we intended to

perform trapping and revascularization of this lesion. In the graft assessment, only a scanty frontal branch of the STA was found owing to the previous surgery. The CTA of the RA assessment confirmed that the branch of the superficial and deep palmar branches of the radial artery was located more proximally than normal. Therefore, we intended to use a natural RA Y-graft for reconstructing both distal M2 trunks. The result of Allen's test, which compresses the radial artery, including the superficial

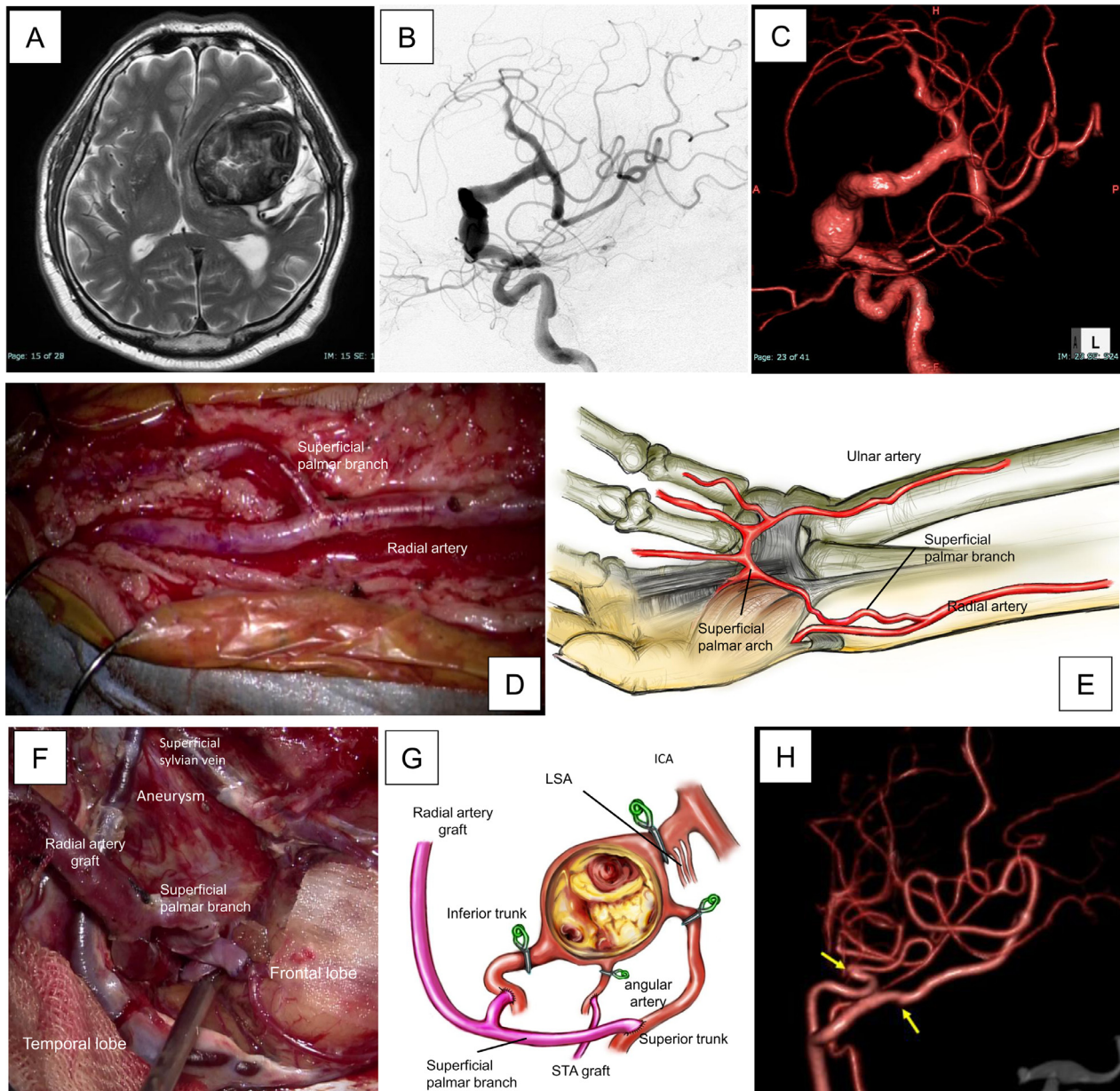


Fig. 1. (A) T2-weighted image showing a multilayered thrombosed mass that caused a midline shift with an edema. (B) Cerebral angiogram showing an aneurysm originating from the previous clip and involving the M2 segment. The yellow arrow indicates the three anastomotic sites. (C) Computed tomography angiography (CTA) image demonstrating tortuous and ectatic vessels in the aneurysm. (D) Intraoperative photograph of the radial artery. The superficial palmar branch arises from the proximal portion of the transverse carpal ligament. (E) Schematic drawings of the variation of the superficial palmar branch of the radial artery. (F) Intraoperative photograph of the revascularization. (G) Schematic drawings of the surgery. The two distal branches are anastomosed to the bilateral M2 trunks. The STA frontal branch is anastomosed to the angular artery. (H) Postoperative CTA image demonstrating the disappearance of the aneurysm and patency of the bypass.

palmar branch, was positive, and the patient's hand returned to its normal color quickly. The operation was performed using a left frontotemporal craniotomy. Both branches of the RA were peeled off, and a natural Y-shaped graft was harvested (Fig. 1D, E). The proximal side of the Y-shaped graft was anastomosed to the left external carotid artery (ECA), and the two distal branches were anastomosed to the inferior trunk and precentral artery, which is a branch of the MCA superior trunk (Fig. 1F). The STA frontal branch was anastomosed to the angular artery that branched directly from the aneurysm. After completing revascularization of the MCA, a clip was placed on the proximal side of the anastomosis, and thrombectomy of the aneurysm was performed. Finally, clipping of the proximal side of the aneurysm was performed (Fig. 1G). The clip on the proximal side was placed distal to the lateral lenticulostriate artery (LSA). The method is shown in the supplemental material. A favorable bypass patency was confirmed on postoperative images (Fig. 1H). After surgery, the right hemiplegia and sensory aphasia caused by the mass effect improved, although the parenchymal edema around the aneurysm persisted for several weeks. The patient was discharged 3 weeks after the operation.

Discussion

In this case, the aneurysm involved three distal arteries, including the superior trunk, inferior trunk, and angular artery. The STA was not suitable for these reconstructions because the STA could not guarantee sufficient flow, and the reconstructive surgery required complex graft placement. Recently, reconstruction using a composite Y-graft constructed using anastomosis has been reported for complex MCA aneurysms.³ This composite Y-graft technique could adjust the length of the graft, although this method is a complicated technique. On the other hand, our natural RA Y-graft-acquired arterial variation is simple, graft flow is physiological, and the number of anastomoses is minimal.

The RA runs distally on the radial side of the forearm and turns to the dorsal side at the level of the wrist joint. The superficial palmar branch arises from the main trunk at the proximal portion of the transverse carpal ligament. In this case, a natural Y-graft could be obtained because the location of the bifurcation was more proximal. This anatomical variation exists in approximately 30–40% of healthy adults and is not a rare variation. Otherwise, a composite Y-graft has to be prepared as a substitute technique. The use of the saphenous vein to prepare a natural Y-graft has been reported; however, venous valves should be removed from the graft for arterial reconstruction.

Essentially, preservation of the LSA might be essential for favorable outcome after such surgical procedures. Then, enough decompression of thrombus for recognizing the LSA is a key procedure to place a clip at the proximal side of the aneurysm. When the MCA aneurysm involves

LSAs, proximal or distal occlusion might be performed instead of trapping.⁸ Bypass surgery with a Y-graft procedure is effective for distal artery revascularization. Consequently, this is the first report of cerebral revascularization performed using a natural RA Y-graft. Understandably, this method might not be possible in all cases. However, a complicated transposition surgery for trapping an aneurysm could be avoided using a natural RA Y-graft in our case.

Declaration of Competing Interest

None.

Acknowledgments

No other persons have made substantial contributions to this manuscript.

Sources of Funding

None.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:[10.1016/j.jstrokecerebrovasdis.2020.104853](https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.104853).

References

1. Morita A, Kirino T, Hashi K, Aoki N, Fukuhara S, Hashimoto N, et al. The natural course of unruptured cerebral aneurysms in a Japanese Cohort. *New England J Med* 2012;366:2474-2482.
2. Wessels L, Fekonja LS, Vajkoczy P. Bypass surgery of complex middle cerebral artery aneurysms-technical aspects and outcomes. *Acta neurochirurgica* 2019;161:1981-1991.
3. Natarajan SK, Zeeshan Q, Ghodke BV, Sekhar LN. Brain bypass surgery for complex middle cerebral artery aneurysms: evolving techniques, results, and lessons learned. *World Neurosurg* 2019;130:e272-ee93.
4. Kivipelto L, Niemela M, Meling T, Lehecka M, Lehto H, Hernesniemi J. Bypass surgery for complex middle cerebral artery aneurysms: impact of the exact location in the MCA tree. *J Neurosurg* 2014;120:398-408.
5. Gandhi S, Rodriguez RL, Tabani H, Burkhardt JK, Benet A, Lawton MT. Double-barrel extracranial-intracranial bypass and trapping of dolichoectatic middle cerebral artery aneurysms: 3-dimensional operative video. *Oper Neurosurg (Hagerstown, Md)* 2019;17:E14-Ee5.
6. Seo BR, Kim TS, Joo SP, Lee JM, Jang JW, Lee JK, et al. Surgical strategies using cerebral revascularization in complex middle cerebral artery aneurysms. *Clin Neurol Neurosurg* 2009;111:670-675.
7. Park W, Chung J, Ahn JS, Park JC, Kwun BD. Treatment of large and giant middle cerebral artery aneurysms: risk factors for unfavorable outcomes. *World Neurosurg* 2017;102:301-312.
8. Tayebi Meybodi A, Huang W, Benet A, Kola O, Lawton MT. Bypass surgery for complex middle cerebral artery aneurysms: an algorithmic approach to revascularization. *J Neurosurg* 2017;127:463-479.