9 Anterior Cerebral Artery-Radial Artery-Anterior Cerebral Artery Bypass

Jianping Song and Wei Zhu

Abstract

For a complex intracranial aneurysm originating from the A2 and beyond, in situ side-to-side bypass may be sufficient for cerebral revascularization with aneurysm trapping. Reanastomosis and reimplantation may also be considered alternative treatment modalities. However, in some specific cases with contradictions to all abovementioned bypass techniques, bypass with interposition grafts may be the last resort for treatment. A short radial artery (RA) was usually harvested as the interpositional graft.

Here, we present a case of a recurrent aneurysm in the A2 segment of the anterior cerebral artery (ACA) that was treated by ACA-RA-ACA bypass with proximal trapping.

Keywords

Anterior cerebral artery · Intracranial aneurysm · Intracranial-intracranial bypass Radial artery · Reanastomosis Revascularization

J. Song · W. Zhu (✉)
Huashan Hospital, Shanghai Medical College, Fudan University, Shanghai, China
e-mail: drzhuwei@fudan.edu.cn

9.1 Introduction

For a complex intracranial aneurysm originating from the A2 and beyond, in situ side-to-side bypass may be sufficient for cerebral revascularization with aneurysm trapping. Reanastomosis and reimplantation may also be considered alternative treatment modalities. However, in some specific cases with contradictions to all abovementioned bypass techniques, bypass with interposition grafts may be the last resort for treatment. A short radial artery (RA) was usually harvested as the interpositional graft.

Here, we present a case of a recurrent aneurysm in the A2 segment of the anterior cerebral artery (ACA) that was treated by ACA-RA-ACA bypass with proximal trapping.

9.2 Case

A 62-year-old woman was diagnosed with a fusion aneurysm in the A2 segment of the ACA 6 months prior. The aneurysm was treated with stenting at that time; however, follow-up digital subtraction angiography (DSA) showed aneurysm recurrence on both the proximal and the distal ends of the stent (Fig. 9.1). No neurological deficits were present. A side-to-side A3-A3 bypass with aneurysm trapping was first planned for this patient. However, angiography of her left internal carotid artery (ICA) showed that the left

© The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd. 2021
Y. Mao et al. (eds.), *Surgical Atlas of Cerebral Revascularization*,
https://doi.org/10.1007/978-981-16-0374-7_9

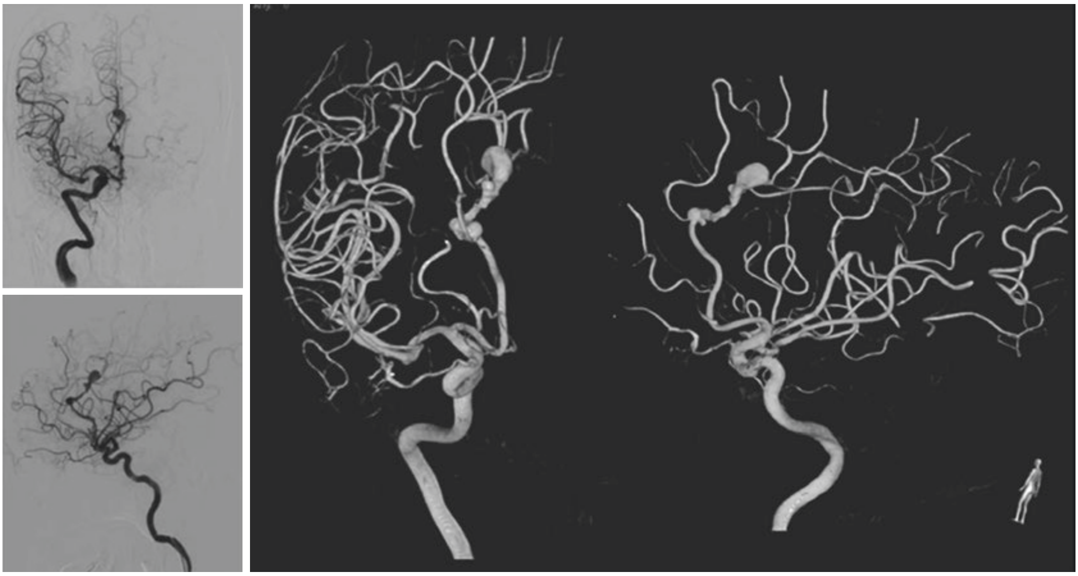

Fig. 9.1 At the 6-month follow-up, DSA (right ICA) showed aneurysm recurrence on both the proximal and the distal ends of the stent

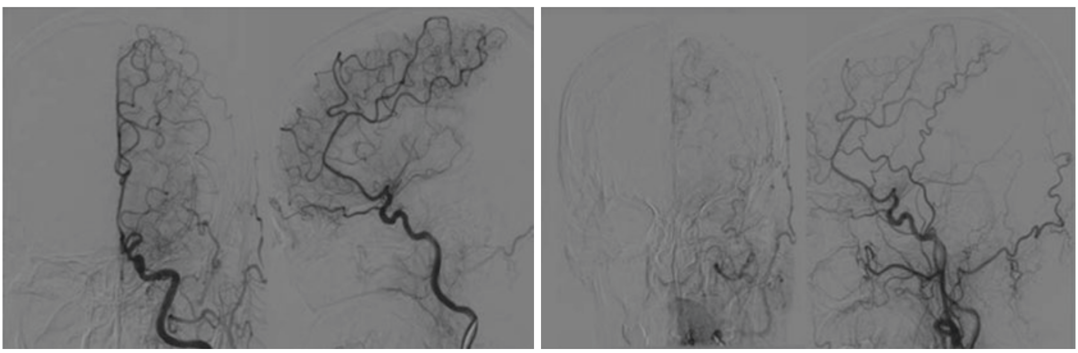

Fig. 9.2 At the 6-month follow-up, DSA (left ICA) showed that the left middle cerebral artery was occluded, and its dominating area was compensated by the left ACA

middle cerebral artery was occluded, and its dominating area was compensated by the left ACA (Fig. 9.2). Therefore, temporary occlusion of the left ACA during A3-A3 bypass would lead to a significant risk of ischemia in the left hemisphere.

Considering that A3-A3 bypass was not applicable for this patient and that end-to-end bypass after aneurysm resection is also difficult, we decided to use the RA as a short graft for proximal ACA and distal ACA bypass and then trap the aneurysm. Because the paracentral artery seemed to originate from the aneurysm body, so only proximal trapping could be achieved to allow for some backflow into this important branch (Fig. 9.3).

9.3 Details of the Procedure

During the operation, the patient was placed supine in a headholder, with the head turned 70° to the right and angled 45° upwards, allowing gravity to naturally retract the right frontal lobe for aneurysm exposure. A 6 cm × 6 cm bone window crossing the midline was made. After opening the dura and performing meticulous dissection under a microscope, the fusiform aneurysm was

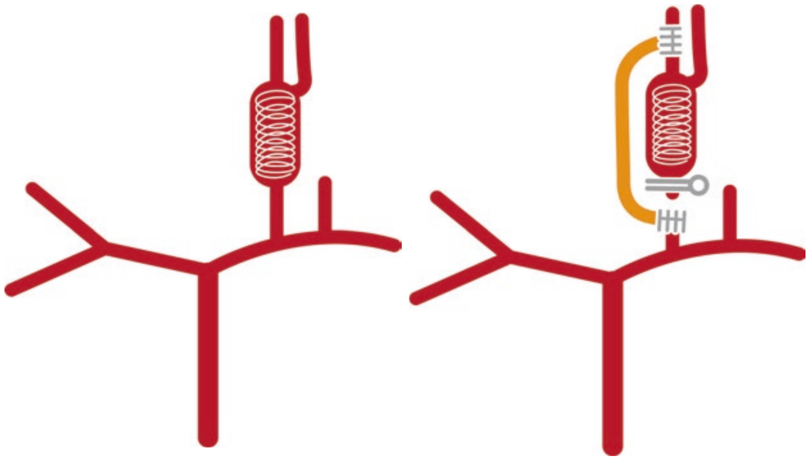

Fig. 9.3 Surgical plan: A3-RA-A3 bypass and proximal aneurysm trapping

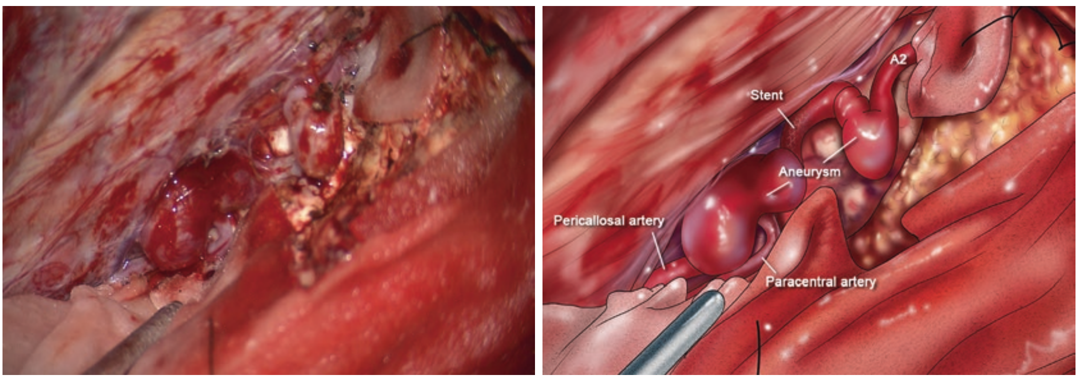

Fig. 9.4 After opening the dura and performing meticulous dissection under a microscope, the fusiform aneurysm was exposed, and a stent could be seen inside. The ACA was enlarged on each side of the stent because of the recurrent aneurysm. The paracentral artery originated from the aneurysm body

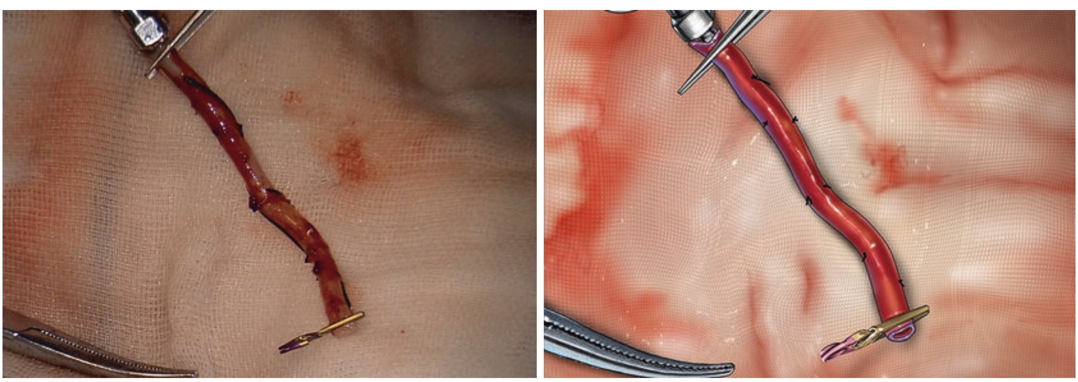

Fig. 9.5 The RA was harvested as an interpositional graft. The pressure dilation technique was used to prevent graft vasospasm

exposed, and a stent could be seen inside. The ACA was enlarged on each side of the stent because of the recurrent aneurysm. The paracentral artery originated from the aneurysm body (Fig. 9.4).

The RA was harvested as an interpositional graft. The pressure dilation technique was used to prevent graft vasospasm (Fig. 9.5).

A healthy segment of the pericallosal artery beyond the aneurysm was selected as the recipient artery and was temporarily occluded, and a rubber stripe was inserted beneath the vessel in preparation for the anastomosis (Fig. 9.6). The arteriotomy on the recipient artery was marked with methylene blue and then cut open in a linear fashion with microsurgical scissors (Fig. 9.7). The distal end of the graft was sutured to the recipient artery in an end-to-side fashion. Anchor stitches were first made on the toe and heel of the anastomosis using 9–0 Prolene sutures (Fig. 9.8).

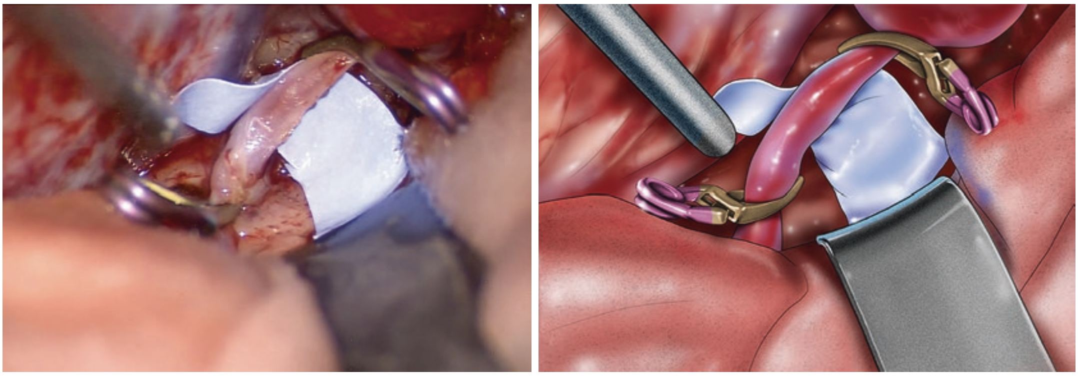

Fig. 9.6 A healthy segment of the pericallosal artery beyond the aneurysm was selected as the recipient artery and was temporarily occluded, and a rubber stripe was inserted beneath the vessel in preparation for anastomosis

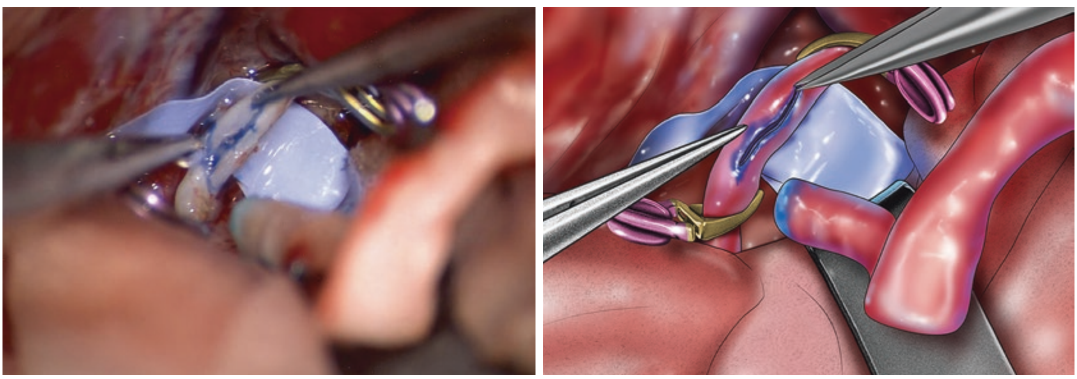

Fig. 9.7 The arteriotomy on the recipient artery was marked with methylene blue and then cut open in a linear fashion with microsurgical scissors

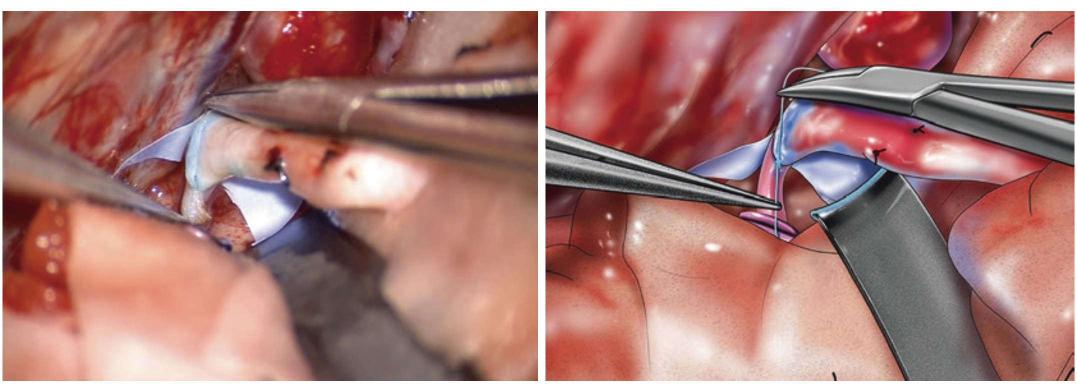

Fig. 9.8 The distal end of the graft was sutured to the recipient artery in an end-to-side fashion. Anchor stitches were first made on the toe and heel of the anastomosis using 9–0 Prolene sutures

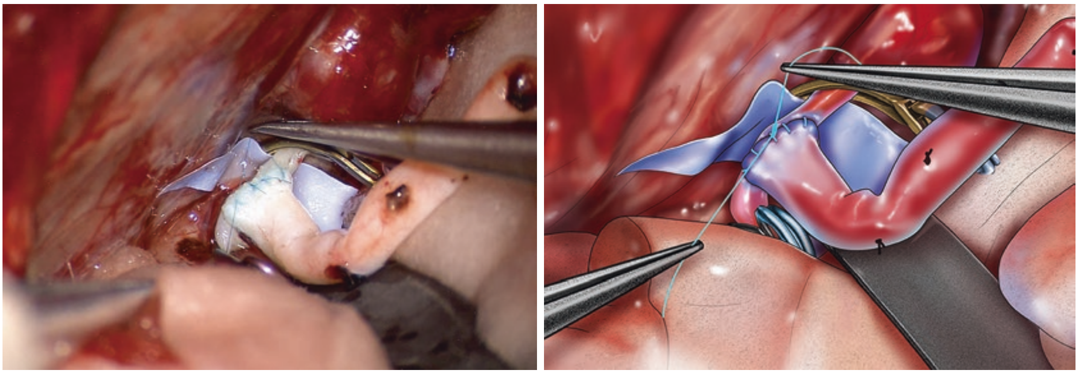

Fig. 9.9 The sidewalls of the anastomosis were sutured in an interrupted fashion. The back wall was sutured first

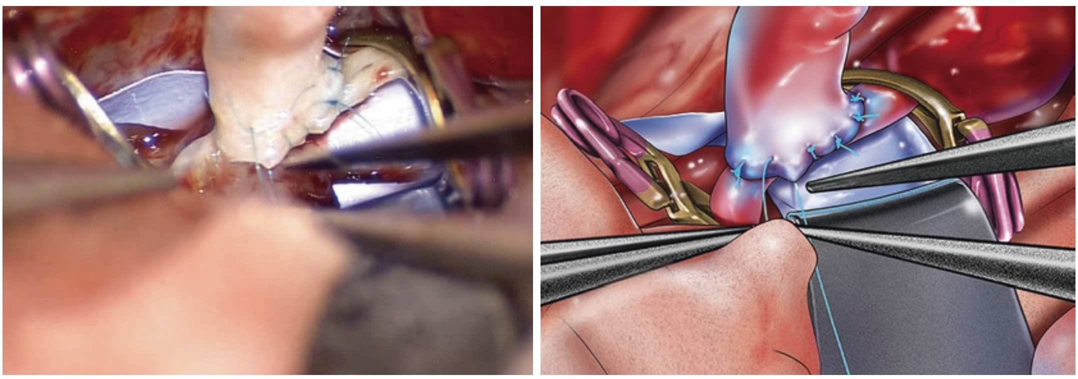

Fig. 9.10 Then, the sidewall close to the surgeon was also sutured

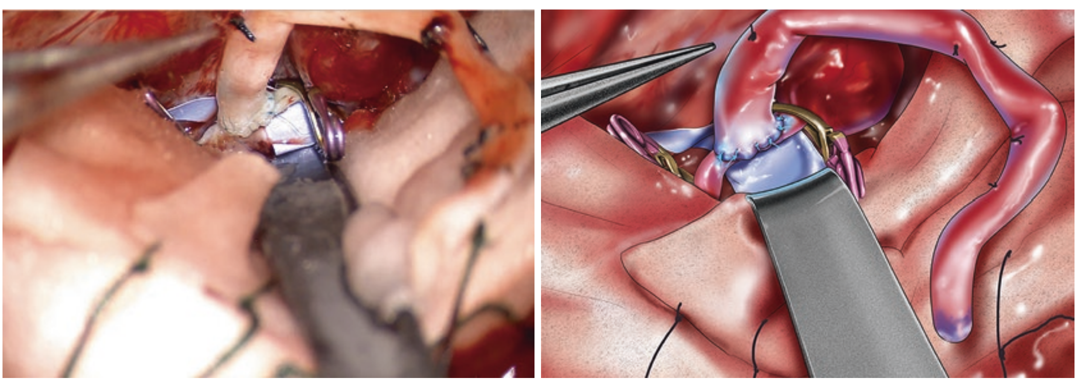

Fig. 9.11 Distal anastomosis was completed

Then, the sidewalls of the anastomosis were sutured in an interrupted fashion (Figs. 9.9 and 9.10). After distal anastomosis was accomplished (Fig. 9.11), the temporary clips were released to examine the patency of the anastomosis (Fig. 9.12), and then a temporary clip was placed on the RA graft.

Next, the A2 segment of the right ACA proximal to the aneurysm was temporarily occluded for proximal anastomosis (Fig. 9.13). This

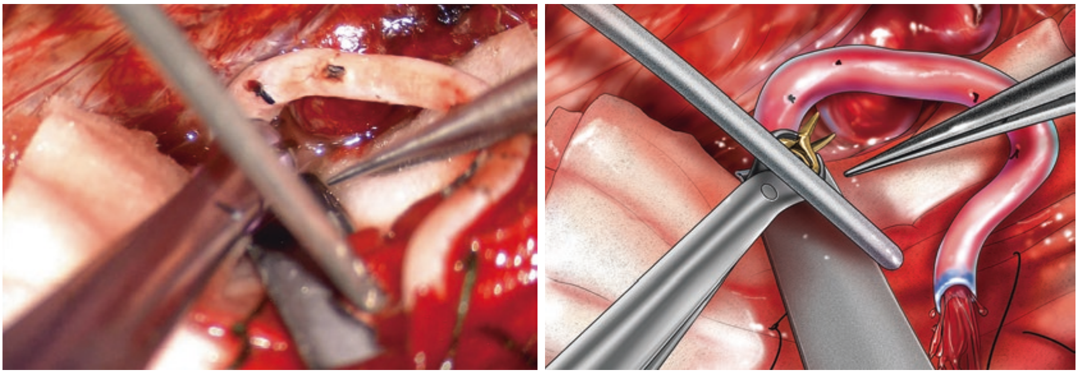

Fig. 9.12 The temporary clips were released to examine the patency of the anastomosis. Blood flushed out on the proximal end of the RA graft

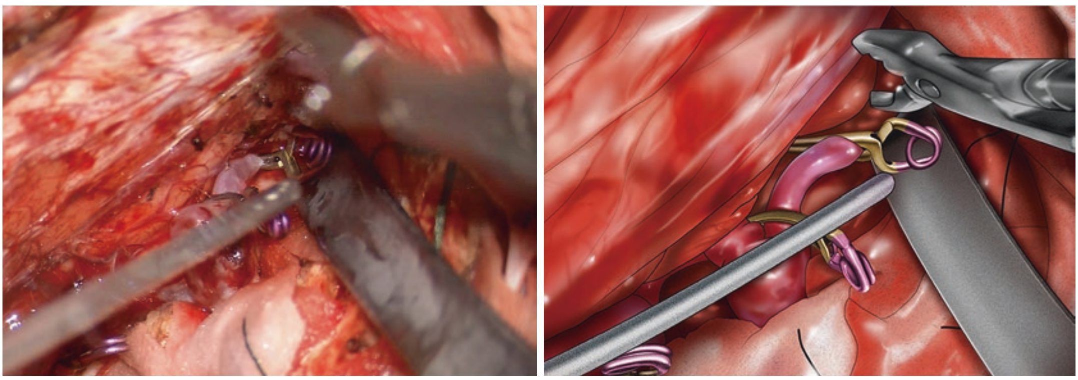

Fig. 9.13 The A2 segment of the right ACA proximal to the aneurysm was temporarily occluded for proximal anastomosis

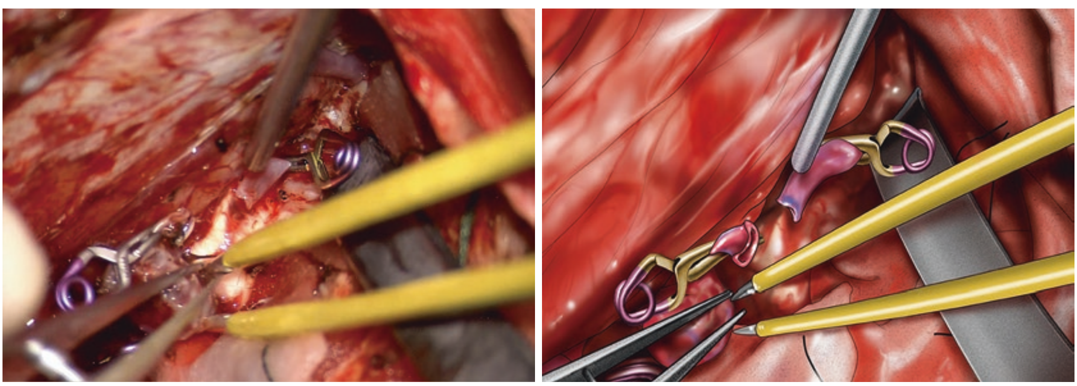

Fig. 9.14 The donor A2 segment was transected

donor A2 segment was transected and cut in a fish-mouth manner to match the caliber of the RA graft for end-to-end anastomosis. The intima edges of the stoma were marked with methylene blue (Figs. 9.14, 9.15, and 9.16), and the end-to-end anastomosis was finished with interrupted sutures. After the anastomosis, small amounts of oozing were controlled by

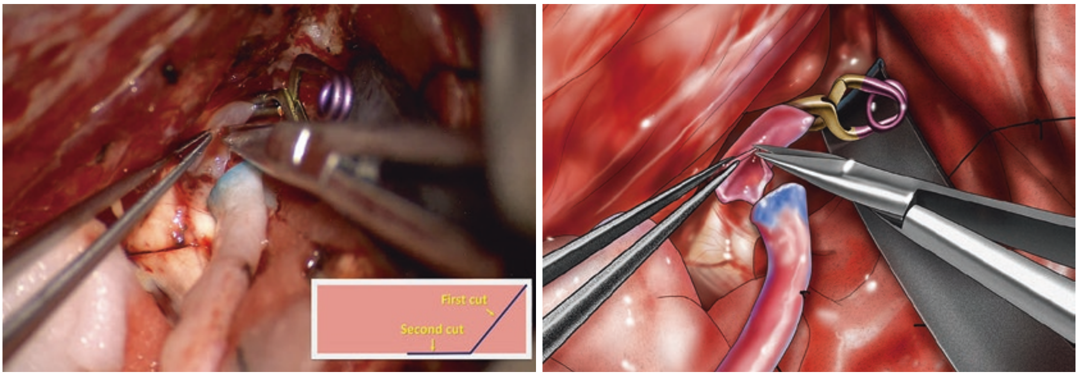

Fig. 9.15 The donor A2 segment was cut in a fish-mouth manner to match the caliber of the RA graft

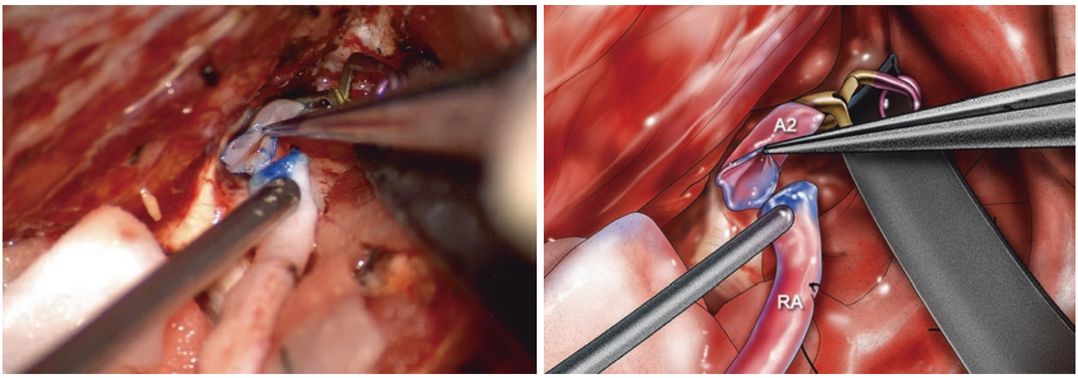

Fig. 9.16 The intima edges of the stoma were marked with methylene blue

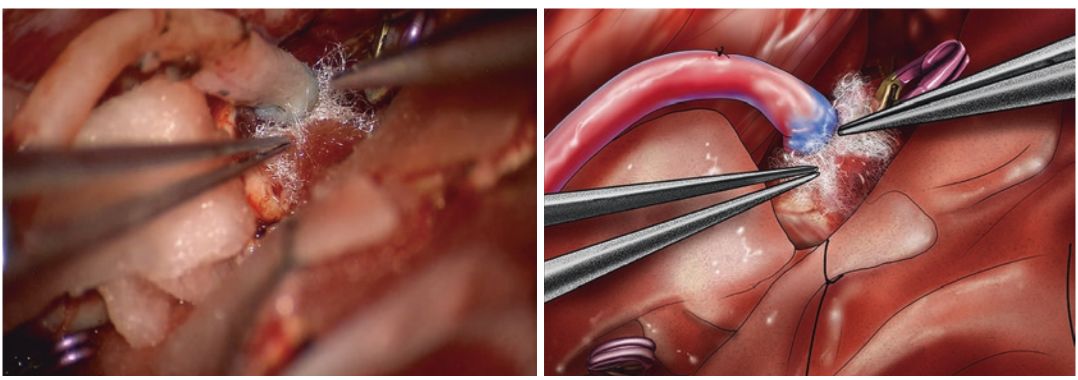

Fig. 9.17 After end-to-end anastomosis, a small amount of oozing was controlled by Surgicel

Surgicel (Fig. 9.17), and the aneurysm was proximally occluded after ACA-RA-ACA bypass (Fig. 9.18).

However, the intraoperative motor evoked potentials (MEPs) decreased gradually after the procedure. We checked the vessels with Doppler ultrasound and detected occlusion at the distal end of the RA graft; thus, the graft was cut open with a small incision, the blood clots were flushed out with heparinized saline, and the graft was closed (Fig. 9.19). The MEPs recovered very soon after clot removal.

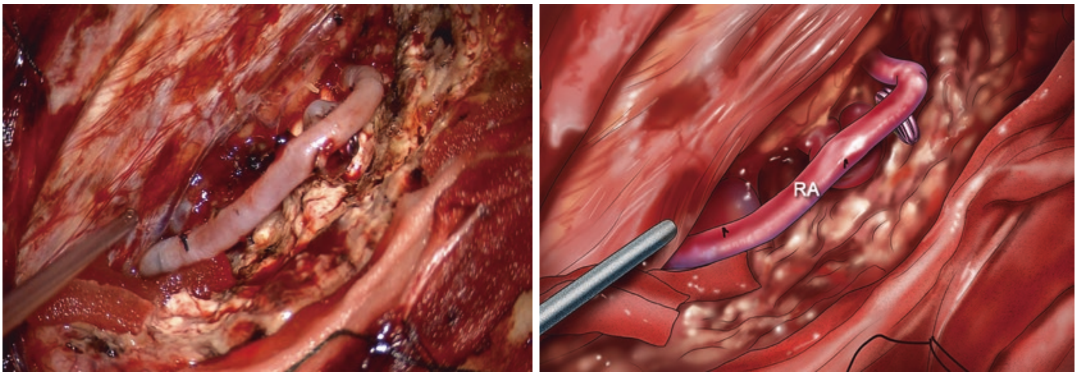

Fig. 9.18 The aneurysm was proximally occluded after ACA-RA-ACA bypass

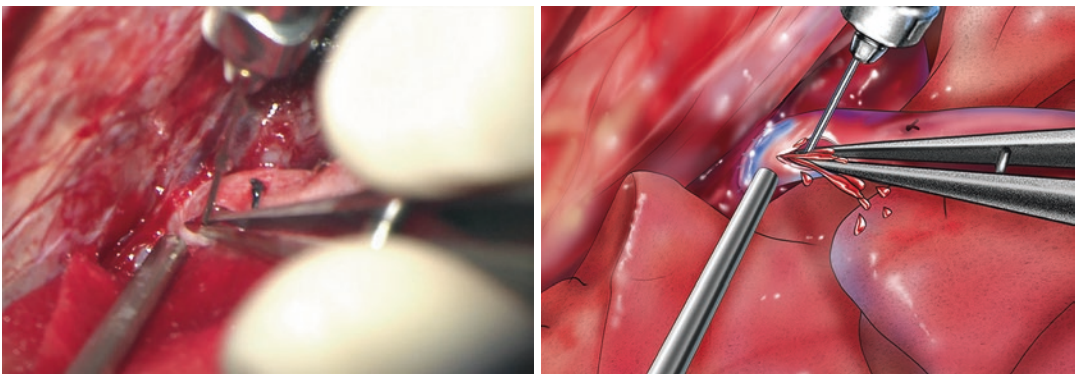

Fig. 9.19 Doppler ultrasound detected occlusion at the distal end of the RA graft. Then, the graft was cut open with a small incision, the blood clots were flushed out with heparinized saline, and the graft was closed

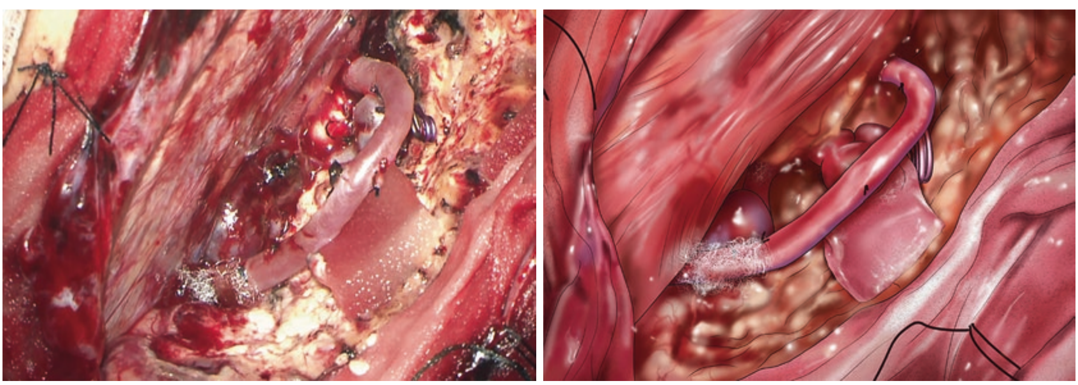

Fig. 9.20 An overview of ACA-RA-ACA bypass with proximal occlusion of the aneurysm

After ACA-RA-ACA bypass with proximal occlusion of the aneurysm (Fig. 9.20), intraoperative DSA confirmed patency of the RA graft. The proximal part of the aneurysm was not visualized, and the distal reflux blood flow preserved the patency of the right paracentral artery (red arrow) (Fig. 9.21). The patient was stable without neurological sequelae after the operation.

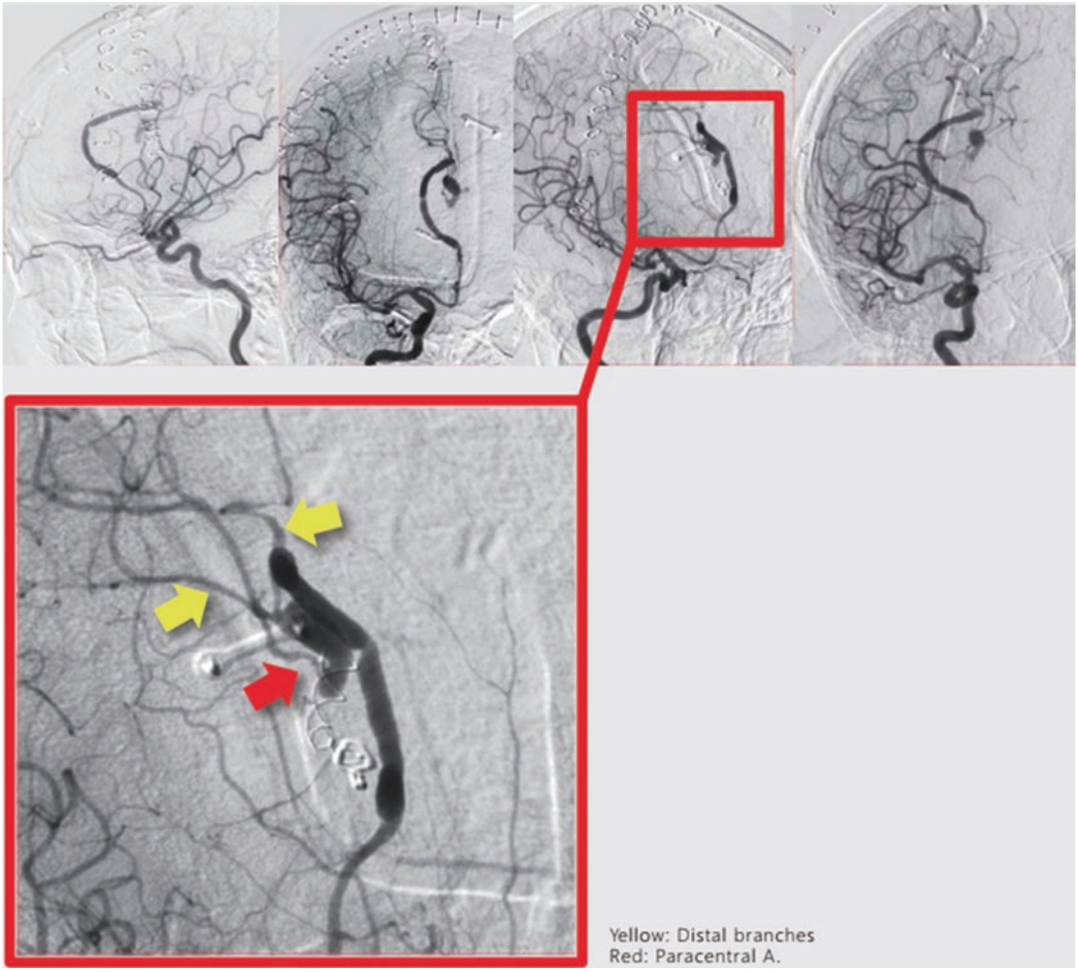

Fig. 9.21 Intraoperative DSA confirmed patency of the RA graft. The proximal part of the aneurysm was not visualized, and the distal reflux blood flow preserved the patency of the right paracentral artery (red arrow)

9.4 Comment

Is bypass outdated in the flow diverter era? Currently, the procedure to place a flow-diverting stent is relatively safe, with a very low immediate occlusion rate. However, the incidence of complete occlusion at 6 months is approximately 75–80%. The retreatment rate after placing a flow diverter is more than 10%. The periprocedural complications may be unpredictable but are fatal, and the overall complication rate is 10–15%. The overall perioperative morbidity and mortality rates range from 1% to 10%. Rerupture, delayed/non-aneurysmal intraparenchymal hemorrhage, perforator occlusion, stroke, and stent stenosis are the major complications of flow diverters. The efficacy of off-label usages of flow diverters is also contentious. Life-long anticoagulant therapy may be mandatory for some patients [1–10]. Therefore, bypass techniques are still an important skill in the arsenal of neurovascular surgeons.

In this case, aneurysm recurrence on both the proximal and distal ends of the stent obviated the possibility of endovascular retreatment. The special contradiction of left MCA occlusion with left ACA compensation weakened the tolerance of the left ACA to temporary occlusion, and side-to-side ACA-ACA bypass was too risky. The RA was harvested as a short interpositional graft for bypass, and only proximal trapping could be achieved to allow some backflow into the paracentral artery. Additionally, in this case, prolonged temporary occlusion due to two technically challenging deep bypasses raised concerns about the risk of ischemia. Therefore, end-to-side distal bypass was performed first to ensure blood perfusion into the eloquent area during the first temporary occlusion. A mismatch between the RA and donor A2 during end-to-end bypass should not be disregarded, and cutting the vessel in a fish-mouth manner was the key step for matching the calibers of the vessels and ensuring patency of the bypass.

References

1. Fiorella D, Gache L, Frame D, Arthur AS. How safe and effective are flow diverters for the treatment of unruptured small/medium intracranial aneurysms of the internal carotid artery? Meta-analysis for evidence-based performance goals. J Neurointerv Surg. 2020;12(9):869–73.
2. Chancellor B, Raz E, Shapiro M, Tanweer O, Nossek E, Riina HA, Nelson PK. Flow diversion for intracranial aneurysm treatment: trials involving flow diverters and long-term outcomes. Neurosurgery. 2020;86(Suppl 1):S36–45.
3. Gory B, Berge J, Bonafe A, Pierot L, Spelle L, Piotin M, Biondi A, Cognard C, Mounayer C, Sourour N, Barbier C, Desal H, Herbreteau D, Chabert E, Brunel H, Ricolfi F, Anxionnat R, Decullier E, Huot L, Turjman F. Flow diverters for intracranial aneurysms: the DIVERSION national prospective cohort study. Stroke. 2019;50(12):3471–80.
4. Girdhar G, Andersen A, Pangerl E, Jahanbekam R, Ubl S, Nguyen K, Wainwright J, Wolf MF. Thrombogenicity assessment of Pipeline Flex, Pipeline Shield, and FRED flow diverters in an in vitro human blood physiological flow loop model. J Biomed Mater Res A. 2018;106(12):3195–202.
5. Kiyofuji S, Graffeo CS, Perry A, Murad MH, Flemming KD, Lanzino G, Rangel-Castilla L, Brinjikji W. Meta-analysis of treatment outcomes of posterior circulation non-saccular aneurysms by flow diverters. J Neurointerv Surg. 2018;10(5):493–9.
6. Pumar JM, Mosqueira A, Cuellar H, Dieguez B, Guimaraens L, Masso J, Miralbes S, Blanco-Ulla M, Souto-Bayarri M, Vazquez-Herrero F. Expanding the use of flow diverters beyond their initial indication: treatment of small unruptured aneurysms. J Neurointerv Surg. 2018;10(3):245–8.
7. Rajah G, Narayanan S, Rangel-Castilla L. Update on flow diverters for the endovascular management of cerebral aneurysms. Neurosurg Focus. 2017;42(6):E2.
8. Griessenauer CJ, Piske RL, Baccin CE, Pereira B, Reddy AS, Thomas AJ, Abud TG, Ogilvy CS. Flow diverters for treatment of 160 ophthalmic segment aneurysms: evaluation of safety and efficacy in a multicenter cohort. Neurosurgery. 2017;80(5):726–32.
9. Brinjikji W, Murad MH, Lanzino G, Cloft HJ, Kallmes DF. Endovascular treatment of intracranial aneurysms with flow diverters: a meta-analysis. Stroke. 2013;44(2):442–7.
10. Kojima M, Irie K, Fukuda T, Arai F, Hirose Y, Negoro M. The study of flow diversion effects on aneurysm using multiple enterprise stents and two flow diverters. Asian J Neurosurg. 2012;7(4):159–65.