



# An Illustrative Case of Bilateral Internal Carotid Artery Occlusion Concomitant with Aneurysm of the Obstructed ICA Reconstituted via Collaterals: Emphasizing the Role of Rescue Collaterals in Decision-Making

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## Abstract

In patients with bilateral internal carotid artery (ICA) obstruction, the basilar and ophthalmic arteries become the most critical arteries for brain perfusion, and the location of aneurysm formation may be associated with increased wall shear stress induced by compromised carotid circulation. Consideration of collateral routes may have an impact on therapeutic decisions for patients undergoing extracranial to intracranial (EC-IC) bypass and aneurysm surgery. We report a rare case of a young woman with bilateral ICA occlusion simultaneous with dissecting aneurysm of the obstructed ICA reconstituted via collaterals, emphasizing the functional value of collaterals and therapeutic strategy. We present a young woman with angiographic evidence of cerebrovascular early atherosclerotic disease. A young patient was found to have bilateral ICA occlusion and dissecting aneurysm of the obstructed ICA. A large fusiform aneurysm was clipped. Then, an anastomosis was performed from the left superficial temporal to the M3 segment of the middle cerebral artery. The patient's postoperative course was uneventful, and she was discharged to rehabilitation with no residual sequelae. This case illustrates a rare case of bilateral ICA occlusions, presented with robust collaterals, and dissecting aneurysm of the obstructed ICA reconstituted via collaterals. We also demonstrate excellent surgical clipping of a challenging ICA aneurysm and cerebral bypass surgery.

## Keywords

- ▶ internal carotid artery occlusion
- ▶ multiple aneurysms
- ▶ collaterals
- ▶ ICA bifurcation aneurysm
- ▶ STA-MCA bypass

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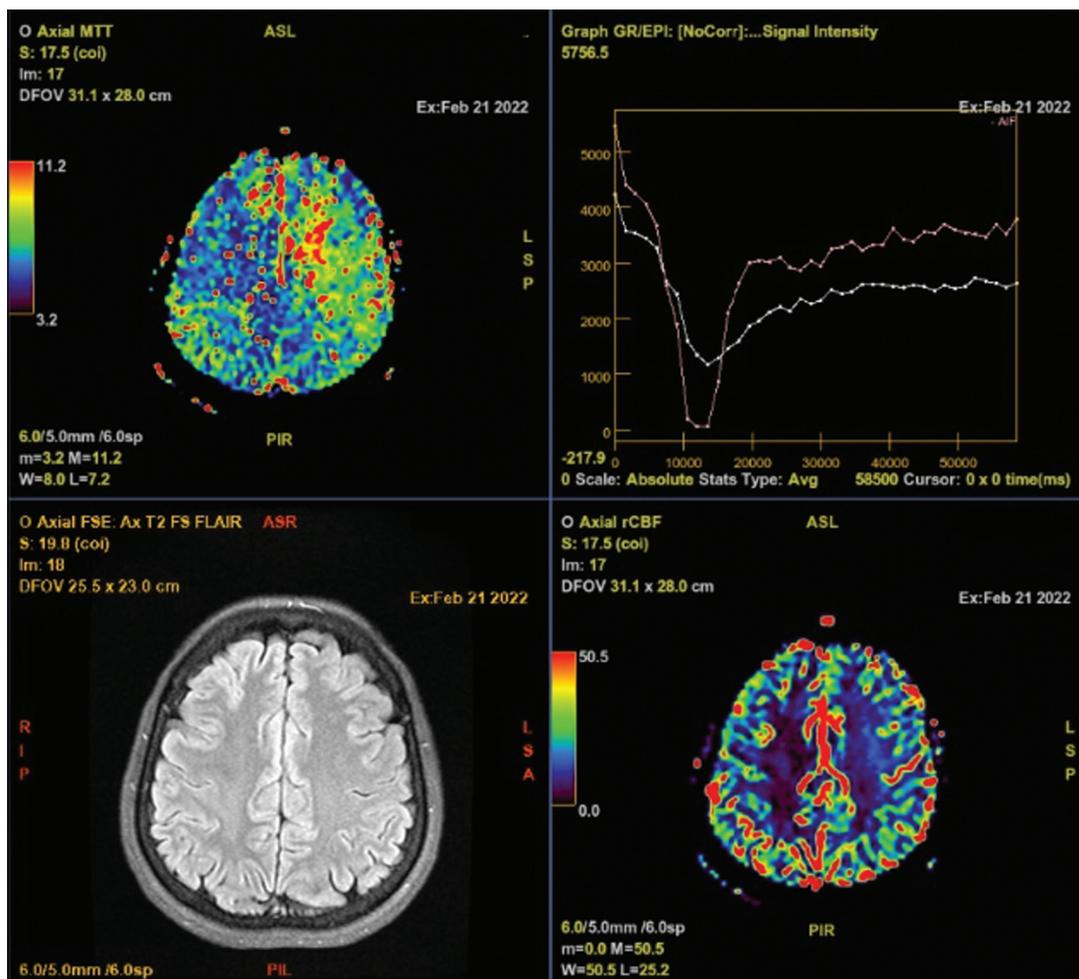
## Introduction

In patients with bilateral internal carotid artery occlusion (BICAO), the clinical presentation can range from asymptomatic to fatal ischemic stroke depending upon the presence of adequate collateral blood flow.<sup>1</sup> The collateral pathways play a critical role in preserving cerebral perfusion under different circumstances where brain ischemia may occur. The circle of Willis constitutes the primary cerebral collateral network. Thus, an inadequate function of Willisian collaterals, which may lead to the recruitment of ophthalmic or leptomeningeal collaterals, may cause hemodynamic impairment.<sup>2</sup> In the case of BICAO, the basilar and ophthalmic arteries become the most critical arteries for brain perfusion, and the location of aneurysm formation may be associated with increased wall shear stress caused by compromised carotid circulation. The frequency of concurrent extracranial internal carotid artery stenosis and an unruptured cerebral artery aneurysm is not known exactly, but has been estimated to be approximately 4%.<sup>3</sup> Consideration of collateral routes may have an impact on therapeutic decisions for patients undergoing extracranial to intracranial (EC-IC) bypass and aneurysm surgery. In this paper, we described a rare

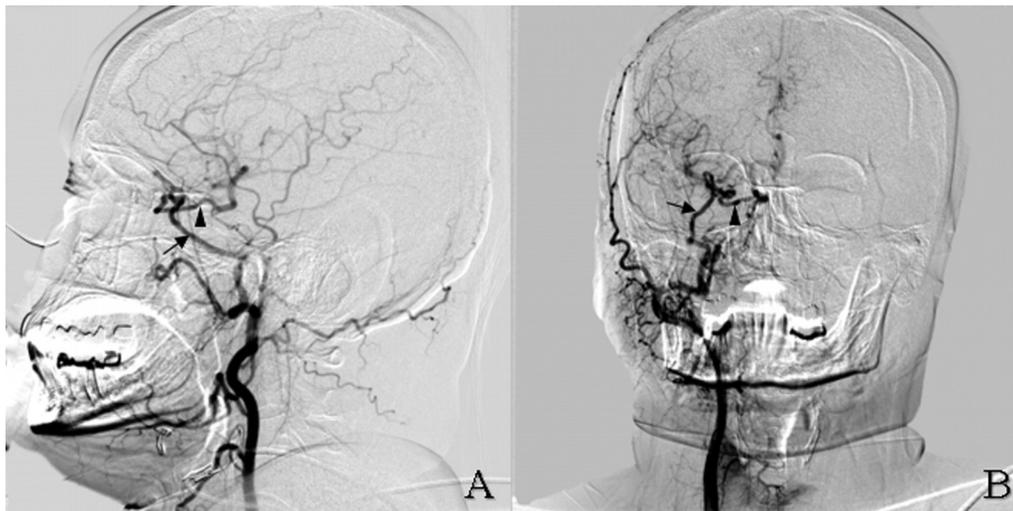
case of BICAO simultaneous with dissecting aneurysm of the obstructed ICA reconstituted via collaterals, emphasizing the functional value of collaterals and therapeutic strategy.

## Case Report

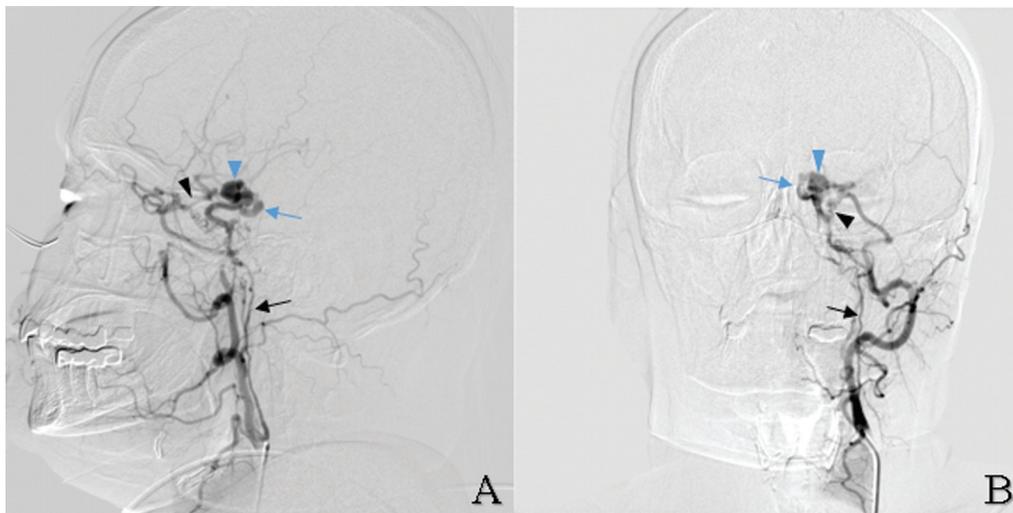
A 38-year-old woman was referred to our facility for further neurointerventional examination and possibly treatment of her dissecting ICA aneurysm. For the previous 8 years, she had experienced daily episodes of intermittent numbness without weakness in the right face and arm, which began progressively after childbirth. The episodes lasted about 10 minutes and were sometimes accompanied by a moderate throbbing headache. She had no history of trauma, fever, malaise, seizures, visual blurring, or diabetes mellitus. Her past medical history revealed only mild hypertension. She denied any previous tobacco use. There were no previous medications. There were no symptoms such as tenderness of both superficial temporal artery (STA), mouth ulcers, skin, joint, genital or eye involvement. Her family medical history revealed that her first-degree relatives suffered from ischemic heart disease and hypercholesterolemia. On physical examination, the blood pressure was 140/90 mmHg and the



**Fig. 1** PWI demonstrates prolonged mean transit time (MTT) consistent with decreased perfusion of the left hemisphere in the middle cerebral artery territory, most severely represented by the red color.



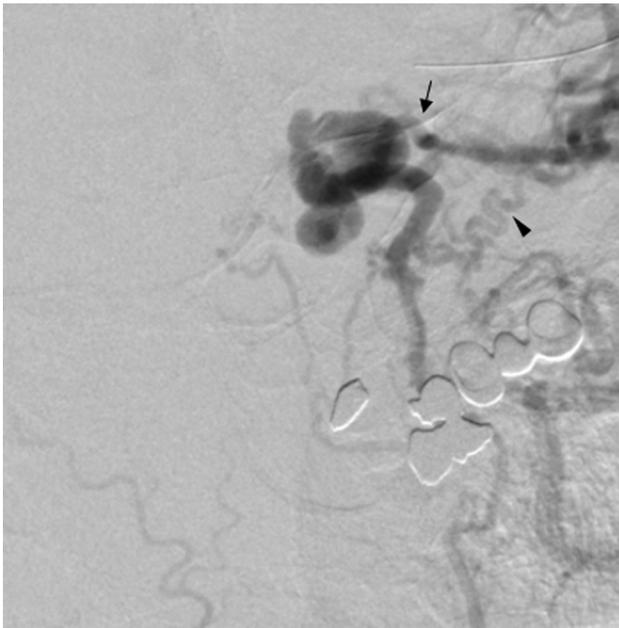
**Fig. 2** Lateral (A) and frontal (B) projections of the right carotid arteriogram. The right ICA was not opacified. Note the retrograde filling of the right ophthalmic artery (arrowhead) through the middle meningeal artery (arrow).



**Fig. 3** Lateral (A) and frontal (B) projections of the left carotid arteriogram demonstrating a long segment of severe diffuse narrowing consistent with a string sign (black arrow). The supraclinoid segment of the left ICA is filled in a retrograde manner through the left ophthalmic artery (black arrowhead), and the stenotic petrous ICA. Note a fusiform aneurysm with a diameter of  $8 \times 7$  mm arising from the left ICA terminus (blue arrowhead). Also note the left prominent posterior communicating artery (blue arrow) and the absent left anterior cerebral artery.

heart rate was 91 bpm. A neurological examination was notable only for hemihyesthesia on the right side of the body, and no significant asymmetry of the reflexes could be demonstrated. An electrocardiogram and a chest-CT were unremarkable. A diffusion-weighted MRI of the brain revealed no restriction abnormality. A perfusion-weighted image (PWI) clearly demonstrates the extent of decreased perfusion throughout the left hemisphere (**Fig. 1**). Blood tests were within the normal reference range, except for mild hyperlipidemia (an LDL of 261 mg/dL). The other relevant hematological investigations and autoimmune serologic tests suggesting vasculitis, including rheumatoid arthritis, anti-Ro/La antibodies, and antinuclear cytoplasmic antibodies showed negative results. Fibromuscular dysplasia was unlikely due to stenoses without “string-of-beads.” There were no aberrant vascular networks near the occlusive or stenotic lesions induced by Moyamoya disease. Large-vessel

vasculitis is also unlikely because the relevant hematological tests were unremarkable. Given her high lipid profile and family history, genetic dyslipidemia and early-onset carotid atherosclerosis were considered in our patient. She underwent diagnostic cerebral angiography under local anesthesia, which demonstrated complete occlusion of the right internal carotid artery from its origin up to a point just proximal to the supraclinoid portion (**Fig. 2**), and severe uniform narrowing of the left internal carotid artery in its cervical, petrous, and cavernous segments, terminating in the supraclinoid segment (**Fig. 3**). The supraclinoid segment of the left ICA is filled through the stenotic cervical ICA and in a retrograde manner from the left ophthalmic artery (**Fig. 3**). The left ophthalmic artery is markedly dilated, and anastomotic vessels are seen well filled from the middle meningeal artery branches around the orbital region (**Figs. 4 and 5**). There was no opacification of the left anterior cerebral group



**Fig. 4** Magnified view of the left carotid arteriogram. The left ophthalmic artery (*arrow*) is markedly dilated, and anastomotic vessels are seen well filled from the middle meningeal artery branches (*arrowhead*) around the orbital region.

and the left supraclinoid ICA continued as the left middle cerebral artery (MCA) (**Fig. 3**). The right anterior cerebral artery (ACA) and right middle cerebral artery were instead seen to be filling on vertebral injection through the left posterior communicating artery (PCoA) (**Fig. 6**). The right ophthalmic artery was also filled in a retrograde manner from the right middle meningeal artery branches (**Fig. 2**). The external carotid arteries and their branches were normal. There is a fusiform aneurysm with a diameter of  $8 \times 7$  mm arising from the left ICA terminus (**Figs. 3 and 5**). Surgical clipping of the large ICA bifurcation aneurysm was considered, and after the discussion of potential advantages and risks, we decided to proceed with STA-MCA bypass treatment. A left fronto-orbital craniotomy was performed for a subfrontal

approach to the aneurysm. The lateral sphenoid wing was resected to the level of the superior orbital fissure. The inside-out technique was chosen for the approach to the aneurysm. Then the Sylvian fissure is dissected from proximal to distal to expose the carotid bifurcation. The angled clip was applied to collapse the aneurysmal portion of the ICA up to the origin of PCoA (**Fig. 7A**). After final application of the clip, complete aneurysm occlusion was confirmed with intraoperative doppler and postoperative angiograms showed no residual filling (**Fig. 8**). Then an anastomosis was performed from the left superficial temporal to the M3 segment of the middle cerebral artery (**Fig. 7B**). The patency of the anastomosis was also confirmed with intraoperative doppler and postoperative control angiograms (**Fig. 8**). There were no complications related to the procedure. She recovered well postoperatively and was discharged to rehabilitation on acetylsalicylic acid and a high-intensity statin.

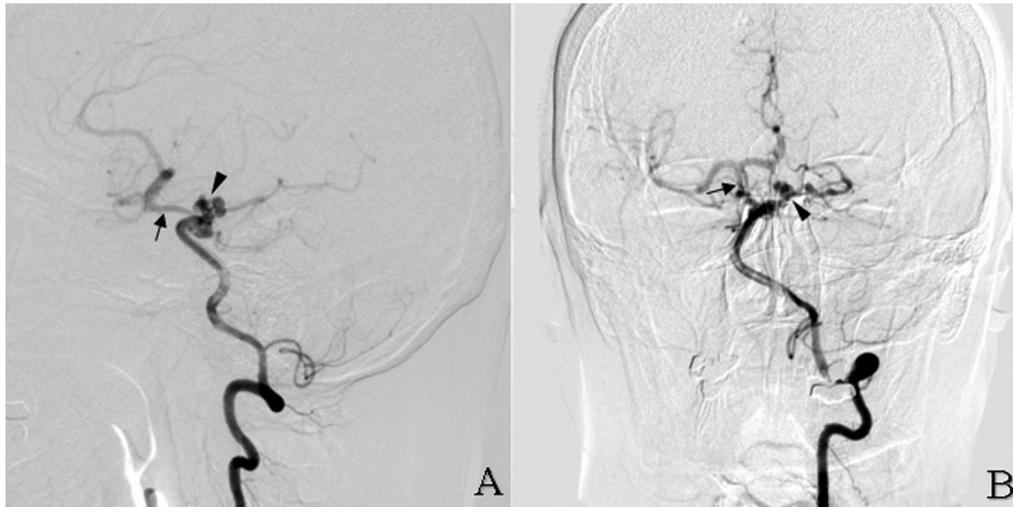
## Discussion

In this case, we described a unique case of angiographic evidence of cerebrovascular early atherosclerotic disease, where the bilateral ICA occlusion was associated with a dissected aneurysm of the obstructed ICA reconstituted via collaterals. In our case study, we mainly focused on collateral circulation and treatment paradigms. The clinical symptoms of our patient were attributed mainly to a low cerebral perfusion of the left circulation due to significant bilateral carotid disease. However, the unusual order of filling of the internal carotid artery distal to a demonstrated occlusion suggested the presence of further collateral circulation, which made our patient nearly asymptomatic.

Three major collateral pathways to the anterior cerebral circulation have been described, the most common of which is through the enlarged PCoAs.<sup>4</sup> Reversed flow through the ophthalmic artery and blood flow via leptomeningeal vessels are considered secondary collateral pathways. Two types of collateral circulation have been defined in our case of bilateral ICA occlusions, in which the ophthalmic artery supplies



**Fig. 5** (A) Intraoperative photographs showing the atheromatous left supraclinoid ICA aneurysm (*arrow*), the left ophthalmic artery (*arrowhead*), and the left optic nerve (*blue arrowhead*). (B) Note the enlarged PCoA originating from the posterior aspect of the left ICA (*arrow*) and the left MCA trunk (*arrowhead*).

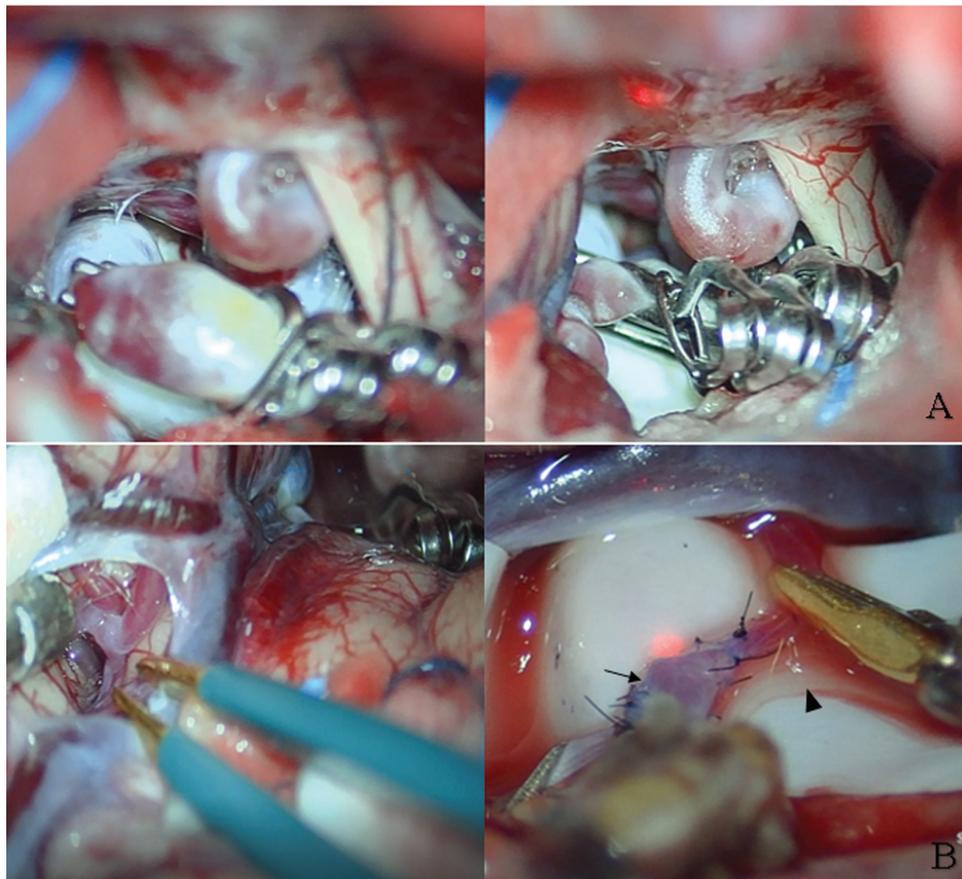


**Fig. 6** Lateral (A) and frontal (B) projections of the left vertebral arteriogram. The right ACA and right MCA were seen to be filling on the left vertebral injection through the left PCoA (arrow). A bilobed fusiform aneurysm (arrowhead) is seen at the P1-P2 junction of the left posterior cerebral artery.

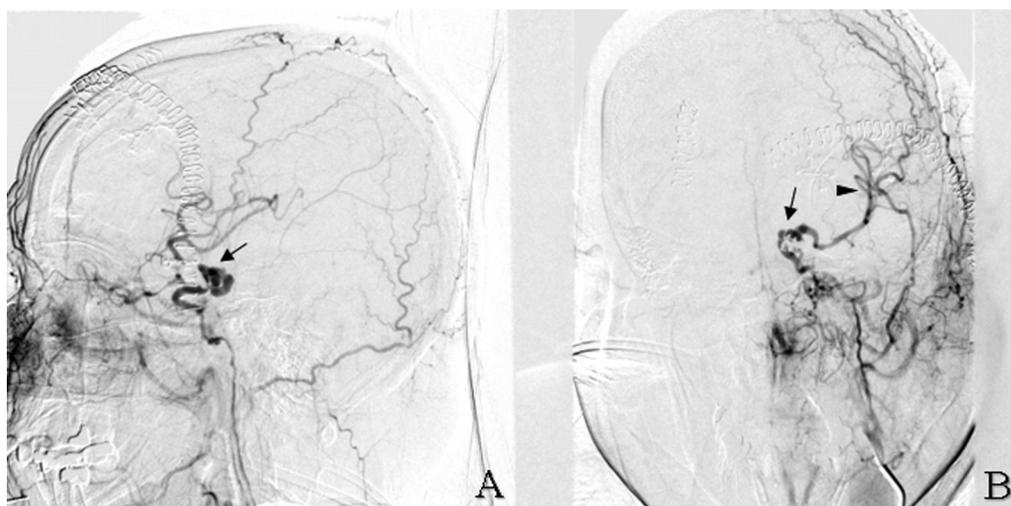
in a retrograde fashion the supraorbital ICA and PCoA supplies MCA and ACA.

There are three anastomoses between the OA and the MMA as follows: the anastomotic branch with MMA, the recurrent meningeal branch, and the anterior falx artery.<sup>5</sup>

The definitive treatment for BICAO remains unclear.<sup>6</sup> One approach would include a combination of medical therapy with dual antiplatelet (90 days duration)+statin therapy and surgical revascularization, while another is to pursue medical treatment alone.<sup>7</sup> According to a meta-analysis



**Fig. 7** (A) The intraoperative image showing the left ICA bifurcation aneurysm was clipped directly. (B) An anastomosis was performed from the left superficial temporal (arrow) to the M3 segment of middle cerebral artery (arrowhead).



**Fig. 8** Lateral (A) and frontal (B) left carotid angiograms showing no postoperative residual filling (arrow) and the patency of the bypass site between STA and the M3 branch of the left MCA (arrowhead).

study performed by Mylonas et al, there was no significant difference in the outcome between medical therapy or revascularization treatment in these patients.<sup>8</sup>

In our patient, the basilar and ophthalmic arteries became the most critical arteries for brain perfusion, and cerebral aneurysm was located in the bifurcation area where the hemodynamic stress might have occurred. The high wall stress induced by compromised carotid circulation may also be responsible for the aneurysm arising from the ICA bifurcation. We believe that this is a nice illustration of dissecting aneurysm of the obstructed ICA reconstituted via collaterals associated with bilateral ICA occlusion in a patient with cerebrovascular early atherosclerotic disease.

## Conclusion

This case illustrates a rare case of bilateral ICA occlusions, presented with robust collaterals, and dissecting aneurysm of the obstructed ICA reconstituted via collaterals. We also demonstrate excellent surgical clipping of a challenging ICA aneurysm and cerebral bypass surgery. In this care report, we emphasized the importance of collateral circulation and treatment paradigms.

### Ethical Approval

Ethical approval was not sought for this case report as it was not required due to the nature of the case report.

### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for the review of the editor-in-chief of this journal on request.

### Funding

None.

### Conflicts of Interest

None declared.

## References

- 1 Karki M, Devarakonda PK, Dhulipalla L, Pattipati M, Ayala-Rodriguez C. Bilateral internal carotid artery occlusion, an unusual clinical entity in a young adult. *Cureus* 2021;13(06):e15971
- 2 Yamauchi H, Kudoh T, Sugimoto K, Takahashi M, Kishibe Y, Okazawa H. Pattern of collaterals, type of infarcts, and haemodynamic impairment in carotid artery occlusion. *J Neurol Neurosurg Psychiatry* 2004;75(12):1697–1701
- 3 Liang Y, Wang J, Li B. Coexistence of internal carotid artery stenosis with intracranial aneurysm. *Int J Stroke* 2014;9(03):306–307
- 4 Chaudhry SR, Barreto S, Ezhapilli SR. Bilateral congenital absence of the internal carotid arteries: a case report. *Radiol Case Rep* 2018;13(06):1146–1149
- 5 Akdemir Aktaş H, Ergun KM, Tatar İ, Arat A, Hayran KM. Evaluation of the anastomoses between the ophthalmic artery and the middle meningeal artery by superselective angiography. *Surg Radiol Anat* 2020;42(11):1355–1361
- 6 AbuRahma AF, Copeland SE. Bilateral internal carotid artery occlusion: natural history and surgical alternatives. *Cardiovasc Surg* 1998;6(06):579–583
- 7 Derdeyn CP, Chimowitz MI, Lynn MJ, et al; Stenting and Aggressive Medical Management for Preventing Recurrent Stroke in Intracranial Stenosis Trial Investigators. Aggressive medical treatment with or without stenting in high-risk patients with intracranial artery stenosis (SAMMPRIS): the final results of a randomised trial. *Lancet* 2014;383(9914):333–341
- 8 Mylonas SN, Antonopoulos CN, Moulakakis KG, Kakisis JD, Liapis CD. Management of patients with internal carotid artery near-total occlusion: an updated meta-analysis. *Ann Vasc Surg* 2015;29(08):1664–1672