

THE DILEMMA OF TREATING DIRECT CAROTICO-CAVERNOUS FISTULA: SHOULD WE SACRIFICE THE ICA?

Ismail, M.A.^{1*}, Abd Aziz, K.H.²

¹ Department of Radiology, Hospital Canselor Tuanku Muhriz UKM, Jalan Yaacob Latif, Bandar Tun Razak, Cheras, Kuala Lumpur, Malaysia.

² Department of Radiology, Hospital Kuala Lumpur, Jalan Pahang, 50586, Kuala Lumpur, Malaysia.

*Corresponding author:

Mohd Ashyiraff Ilani Bin Ismail, Department of Radiology, Hospital Canselor Tuanku Muhriz UKM, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Cheras, Kuala Lumpur, Malaysia.

Email: ashyiraff94@gmail.com

DOI: <https://doi.org/10.32896/tij.v6n3.1-8>

Submitted: 31.07.2026

Accepted: 28.09.2026

Published: 30.09.2026

ABSTRACT:

Introduction: Direct carotid-cavernous fistulas (CCFs) require urgent intervention to prevent irreversible ocular morbidity and intracranial hemorrhage. While endovascular reconstruction is the gold standard, device-related complications like stent thrombosis can severely limit transarterial access. We present a case utilizing therapeutic parent artery occlusion as a definitive rescue strategy when conventional reconstructive routes are exhausted.

Materials and Methods

A 16-year-old male with a post-traumatic Barrow Type A CCF underwent initial stent-assisted coiling. An interruption of his dual antiplatelet therapy, secondary to an exhausted medication supply, led to acute stent thrombosis, precluding further transarterial navigation. The residual high-flow fistula exhibited persistent cortical venous reflux, posing an imminent hemorrhagic risk. Multiple transvenous salvage attempts via the inferior petrosal sinus, superior ophthalmic vein, and vein of Labbé were unsuccessful due to acquired venous occlusions and acute vessel angulations.

Results

High-resolution C-arm CT was utilized to delineate the complex fistula anatomy. Diagnostic cerebral angiography confirmed robust collateral cross-circulation via the anterior communicating artery (ACoM). Given the inaccessible shunt and imminent risk of hemorrhage from cortical reflux, a clinical decision was made to proceed with parent vessel sacrifice. The right internal carotid artery was therapeutically occluded at the cavernous and proximal segments using detachable coils. Post-embolization angiography demonstrated complete fistula exclusion with preserved hemispheric perfusion. The patient achieved rapid clinical stability with no ischemic neurological deficits.

Conclusion

Therapeutic internal carotid artery sacrifice remains a safe, definitive rescue maneuver for complex, residual CCFs when standard endovascular pathways are compromised, provided good contralateral flow from the ACoM or ipsilateral flow from the PCoM. Meticulous angiographic validation of

collateral hemodynamics is mandatory to ensure patient safety while neutralizing the risk of secondary hemorrhage.

Keywords: Carotid-Cavernous Fistula; Carotid Artery, Internal; Embolization, Therapeutic; Brain Injuries, Traumatic; Stents; Thrombosis; Collateral Circulation

INTRODUCTION

Carotid-cavernous fistula (CCF) is a rare clinical entity characterized by an abnormal arteriovenous shunt within the cavernous sinus. These are traditionally classified into two types: direct and indirect. Direct fistulas involve a high-flow communication directly between the internal carotid artery (ICA) and the cavernous sinus. In contrast, indirect fistulas are lower-flow shunts formed by meningeal branches of the internal or external carotid arteries [1]. Clinical manifestations include proptosis, chemosis, and a detectable ocular bruit. These lesions are most widely categorized using the Barrow Classification, which serves as the cornerstone for determining hemodynamic risk and choosing the appropriate endovascular strategy [2].

Barrow Type A fistulas represent direct, high-flow communications between the internal carotid artery (ICA) and the cavernous sinus. These are typically traumatic in etiology and require prompt intervention as they rarely resolve spontaneously. In contrast, Barrow Types B, C, and D are indirect, low flow dural shunts supplied by meningeal branches of the ICA, ECA, or both, respectively. Treatment of direct CCF primarily aims to occlude the abnormal shunt while preserving the patency of the internal carotid artery (ICA). Modern endovascular techniques serve as the mainstay of treatment and are generally categorized into reconstructive or deconstructive approaches [3].

Reconstructive Techniques utilize detachable balloons, coils, or covered stents to reconstruct the arterial wall and seal the fistula orifice. Deconstructive approach includes vessel sacrifice

in the case of fail reconstruction due to technical difficulties - such as the stent thrombosis or unfavorable anatomy observed during this patient's second-stage procedure, the parent artery may be sacrificed. This decision is clinically viable only when sufficient collateral circulation is demonstrated.

The primary goal of treatment is the occlusion of the fistula while maintaining ICA patency. However, reconstructive efforts can be hindered by technical limitations such as balloon rupture or distal migration. While covered stents offer an alternative for parent artery preservation, they carry risks of complications, most notably stent thrombosis, which may occur if antiplatelet therapy is interrupted [4].

The therapeutic sacrifice of the internal carotid artery (ICA) remains a definitive treatment option for direct carotid-cavernous fistulae (CCF) that are refractory to conventional endovascular reconstruction. This deconstructive approach is clinically feasible only when the patient demonstrates adequate collateral blood flow via the Circle of Willis, particularly through the anterior communicating artery (ACom) [5].

CASE REPORT

We report a case of 16-year-old male who sustained a moderate TBI with intracranial hemorrhage following bicycle accident. He subsequently developed a direct right CCF Barrow type A, confirmed by a diagnostic cerebral angiogram. During first intervention, the patient underwent stent-assisted coiling. Eight coils were deployed transarterially, and a Neuroform Atlas stent was placed across the fistula to prevent stent

migration into the CCA. Post-procedure imaging showed reduced flow into the CCF and improved intracranial flow. The patient was maintained on dual antiplatelet therapy (DAPT).

However, follow-up angiogram done later revealed a residual direct right CCF with persistent cortical reflux and no intracranial flow from the right ICA run. However, imaging demonstrated robust collateral circulation to the right anterior circulation via the ACom on a left ICA run.

Subsequently, a second-stage embolization was attempted. Upon further clinical review during the second-stage procedure, it was discovered that the patient's Dual Antiplatelet Therapy (DAPT) had been interrupted for seven consecutive days prior to admission due to an exhausted medication supply. This medication interruption was identified as the primary catalyst for the subsequent stent thrombosis observed during angiography.

To better understand the complex CCF components, high-resolution C-arm CT (utilizing a 20-30% contrast concentration) was utilized. Multiple access routes to the cavernous sinus were explored; attempt via Inferior Petrosal Sinus however occluded, attempt via Vein of Labbe was unsuccessful due to acute angulation, attempt via Superior Ophthalmic Vein (SOV) was unsuccessful due to inadequate catheter length and attempt via transarterial was also unsuccessful due to the microcatheter could not advance beyond the distal half of the previously placed stent, which was found to be thrombosed.

Given the technical failure of reconstruction and the confirmed adequacy of collateral flow, the decision was made to sacrifice the right ICA. The clinical decision to sacrifice the ICA involved a multi-disciplinary review of neurosurgical and interventional radiological findings. The adequacy of collateral circulation was verified through contralateral ICA injections to ensure the safety of permanent vessel occlusion.

The cavernous and proximal segments of the right ICA were embolized using Microplex Cosmos and PGLA coils. Post-embolization angiograms showed stagnation of flow into the CCF and no cortical venous reflux. Left ICA run demonstrated good flow into the right anterior circulation from the left ICA via ACOM with preservation of the right ophthalmic artery. A post-procedure CT scan confirmed no intracranial bleed. The patient remained neurologically stable, and DAPT was discontinued.

DISCUSSION

The primary objective in managing direct carotid-cavernous fistulas (CCF) is the complete exclusion of the fistula while preserving the patency of the parent artery [6]. Modern reconstructive techniques, such as the stent-assisted coiling performed during this patient's first intervention, have high success rates but are not without significant risks. As seen in this case, the discovery of a thrombosed distal half of the previously placed Neuroform Atlas stent rendered further transarterial navigation and reconstructive efforts unfeasible.

Stent thrombosis is a serious complication that can occur following the cessation of antiplatelet therapy, injury to the blood vessel lining, or due to a hypercoagulable state; in some cases, it may even occur without a known cause [7]. In our patient, following the interruption of Dual Antiplatelet Therapy (DAPT) due to supply depletion, the thrombosed stent acted as a physical barrier to the fistula orifice, forcing a transition to a deconstructive "rescue" maneuver. This case also highlights the importance of good interdepartmental communication so that patient's situation (exhausted DAPT supply) can be prevented.

The utilization of high-resolution C-arm CT is advantageous for gaining a better understanding of CCF components, as it allows for the visualization of vascular anatomy alongside non-vascular

structures [6]. In our case, the use of 20-30% contrast (at a rate of 2.5- 3 ml/s over 25 seconds with 3-5s delay of X-ray) provided the necessary resolution to map the fistula anatomy when the thrombosed stent precluded standard transarterial navigation.

When the transarterial route is compromised, interventionalists typically seek retrograde venous access. However, this case illustrates the anatomical hurdles that may complicate these routes. Although attempt via Inferior Petrosal Sinus (IPS) is the most common venous approach, its occlusion in this patient eliminated the primary retrograde pathway. While an attempt was made via the facial vein to reach the SOV and cavernous sinus, inadequate catheter length prevented successful embolization. The attempt via the Vein of Labbe was also unsuccessful as the route was further restricted by acute angulation, a common anatomical variant that limits navigability.

The failure of these alternative routes, combined with the presence of high-risk cortical reflux, necessitated definitive occlusion to prevent the imminent risk of hemorrhagic stroke or severe ocular morbidity. The decision to sacrifice the ICA is a radical step that requires absolute certainty regarding the patient's cerebral hemodynamics. The most critical factor in this case was the pre-procedural DSA that demonstrated "good crossflow" via the Anterior Communicating Artery (ACoM) during the contralateral (left) ICA injection.

This physiological buffer is a prerequisite for safe parent artery occlusion. In the absence of a successful reconstructive option, sacrificing the ICA at the cavernous and proximal segments provides a definitive cure by eliminating the high-pressure arterial inflow that drives the fistula. For a young patient, ensuring robust collateral circulation is paramount to avoid long-term ischemic deficits [8].

ICA sacrifice represents as an effective and durable solution for complex, residual traumatic CCFs that are refractory to conventional

endovascular reconstruction. While vessel preservation remains the ideal, the clinical priority must remain the prevention of catastrophic intracranial hemorrhage and the resolution of debilitating ocular symptoms [8].

Furthermore, while a balloon occlusion test (BOT) is typically performed prior to parent artery sacrifice, the presence of an already thrombosed stent precluded this standard physiological assessment. The occluded stent acted as a mechanical barrier, rendering the navigation and inflation of a test balloon within the proximal ICA technically unfeasible and posing an unacceptably high risk of distal thromboembolism. Consequently, relying on the angiographically confirmed robust ACoM crossflow allowed for a safe and immediate deconstructive 'rescue' maneuver without the execution of a formal BOT.

CONCLUSION

Sacrificing the internal carotid artery is an effective and safe solution for complex, residual traumatic CCFs when reconstructive endovascular routes are no longer viable. In patients with robust collateral circulations, this technique provides immediate and definitive exclusion of the fistula, mitigating the risks of cortical reflux and secondary hemorrhage.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the conduct of this study or the preparation of this manuscript.

FUNDING

This report received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

INFORMED CONSENT

Written informed consent was obtained from the patient & legal guardian for the publication of this case report and any accompanying images.

DATA AVAILABILITY STATEMENT

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

REFERENCE

1. Vilela MAP. Fístula carotídeo-cavernosa. Rev Bras Oftalmol. 2013;72(1):70-75. doi: 10.1590/s0034-72802013000100015.
2. Mishra K, Kumar V, Vinay, Gandhi A, Srivastava T. Carotid cavernous fistula: Redefining the angioarchitecture. J Cerebrovasc Endovasc Neurosurg. 2022;24(4):356-365. doi: 10.7461/jcen.2022.E2022.05.004.
3. Briganti F, Tortora F, Marseglia M, Napoli M, Cirillo L. Covered stent implantation for the treatment of direct carotid-cavernous fistula and its mid-term follow-up. Interv Neuroradiol. 2009;15(2):185-190. doi: 10.1177/159101990901500208.
4. Cherian M, Kalyanpur T, Narsinghpura K, Yadav M, Mehta P, Paul K. Covered coronary stent grafts as a treatment option for carotid-cavernous fistulas: Our initial experience. Neurol India. 2011;59(6):895-899. doi: 10.4103/0028-3886.91373.
5. Gupta AK, Purkayastha S, Krishnamoorthy T, Bodhey NK, Kapilamoorthy TR, Kesavadas C, et al. Endovascular treatment of direct carotid cavernous fistulae: a pictorial review. Neuroradiology. 2006;48(11):831-839. doi: 10.1007/s00234-006-0132-x.
6. Ide S, Kiyosue H, Tokuyama K, Hori Y, Sagara Y, Kubo T. Direct carotid cavernous fistulas. J Neuroendovasc Ther. 2020;14(12):583-592. doi: 10.5797/jnet.ra.2020-0131.
7. Kanemaru K, Nishiyama Y, Yoshioka H, Satoh K, Hashimoto K, Hanihara M, et al. In-stent thrombosis after carotid artery stenting despite sufficient antiplatelet therapy in a bladder cancer patient. J Stroke Cerebrovasc Dis. 2013;22(7):1196-1200. doi: 10.1016/j.jstrokecerebrovasdis.2012.12.015.
8. Nurimanov C, et al. Endovascular management of carotid-cavernous fistulas: a 16-year retrospective analysis of multimodal treatment strategies and long-term clinical outcomes. Front Neurol. 2025;16:1625899. doi: 10.3389/fneur.2025.1625899.

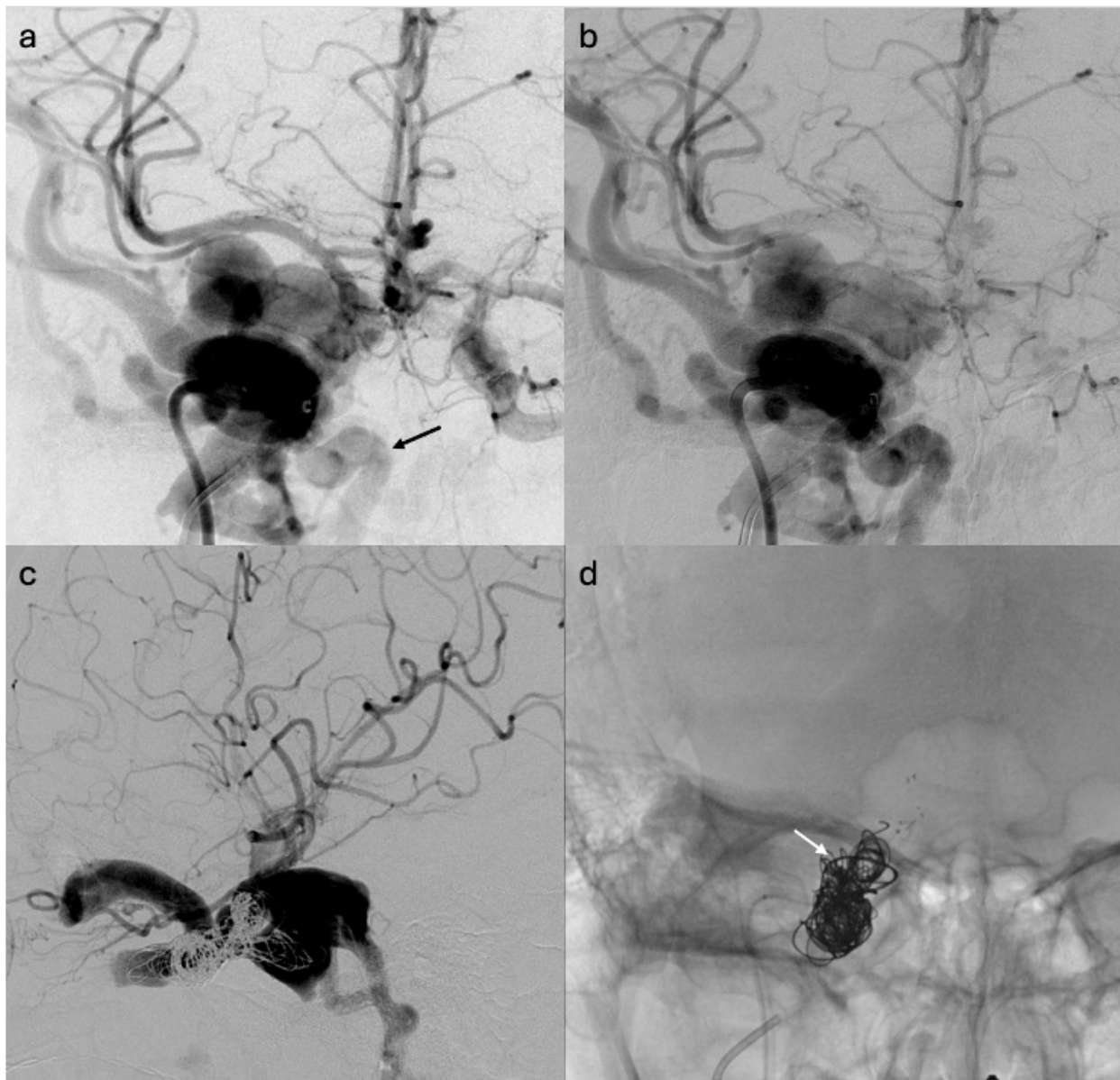
FIGURE LEGENDS:

Figure 1 (a-d): Digital Subtraction Angiogram (DSA) showing direct CCF from right ICA with dilated superior ophthalmic vein in keeping with Barrow type A (black arrow, 1a). Dilated superior and inferior ophthalmic veins and subsequently drain into the dilated facial vein and right IJV (1b). Post coiling run shows reduced flow into the right CCF with improved intracranial flow (1c). Coils seen within right cavernous sinus (white arrow, 1d).

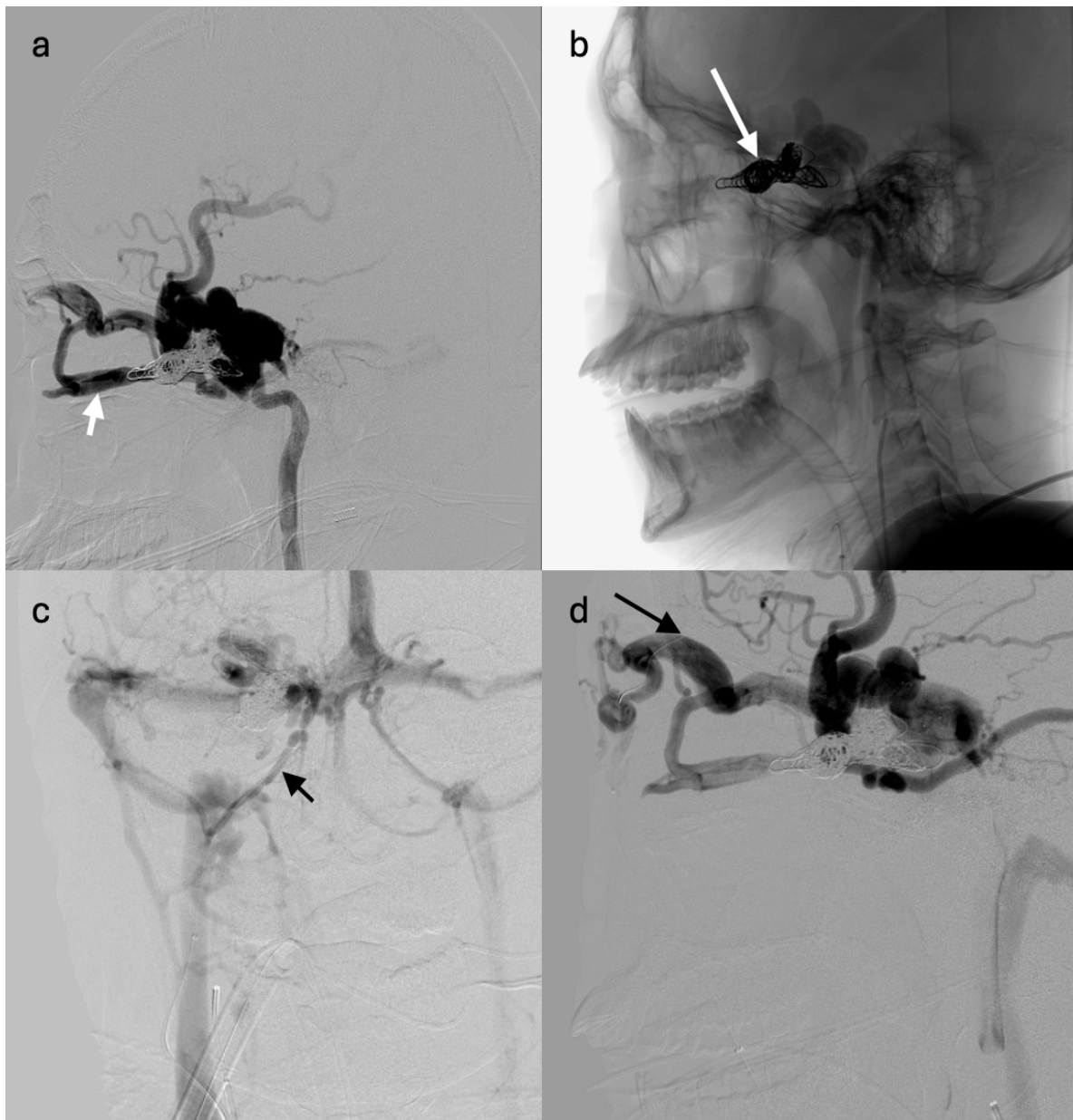


Figure 2 (a-d): showing residual direct CCF from right ICA with dilated superior ophthalmic vein (short white arrow, 2a). Native images demonstrating coil within the cavernous sinus (long white arrow, 2b). Attempt via the inferior petrosal sinus, however unsuccessful (short black arrow, 2c). Attempt via the superior ophthalmic vein which was also unsuccessful (long black arrow, 2d).

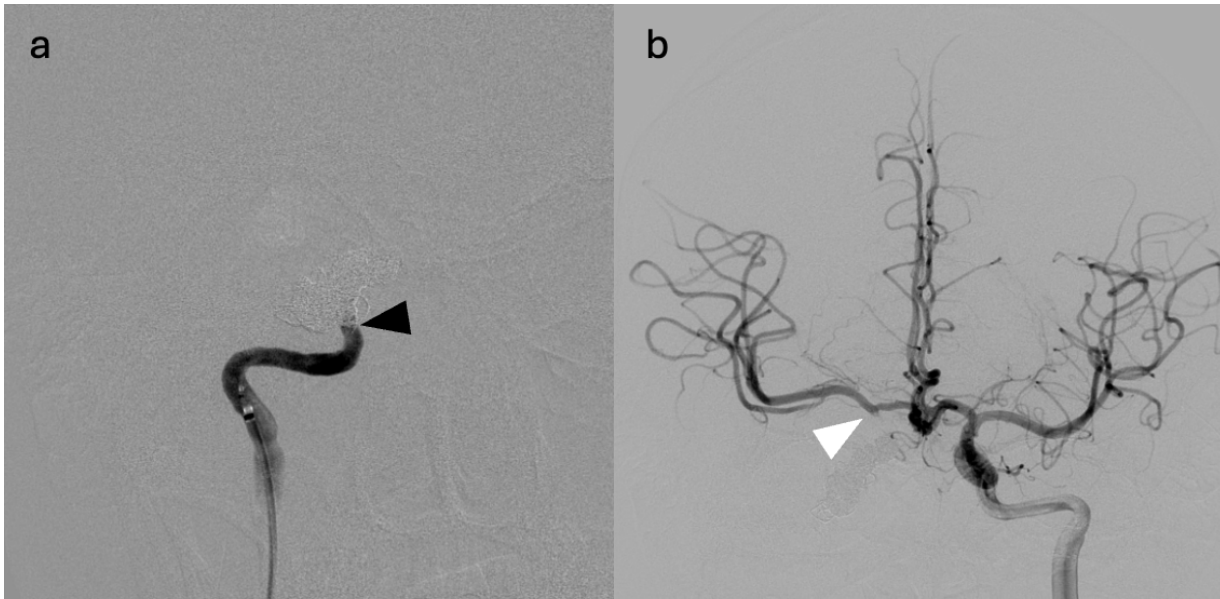


Figure 3 (a-b): Post embolization angiogram showing cessation of flow to right ICA (black arrowhead, 3a). Left ICA angiogram run showed patent right anterior circulation via the ACom (white arrowhead, 3b).