 doi: 10.2176/jns-nmc.2023-0088

NMC Case Report Journal 10, 259-263, 2023

A Case of Ruptured Carotid Traumatic Blood Blister-like Aneurysm

Yoshiyuki MATSUMOTO,[1] Ryuta NAKAE,[1] Fumihiro MATANO,[2] Asami KUBOTA,[2] Akio MORITA,[2] Yasuo MURAI,[2] and Shoji YOKOBORI[1]

[1]*Department of Emergency and Critical Care Medicine, Nippon Medical School Hospital, Tokyo, Japan*
[2]*Department of Neurological Surgery, Nippon Medical School Hospital, Tokyo, Japan*

Abstract

Ruptured cerebral aneurysms that occur in the anterior wall of the internal carotid artery (ICA) are known as blood blister-like aneurysms (BBAs); they have been reported to account for 0.3% to 1% of all ruptured ICA aneurysms. In this report, we describe the treatment of an unusual traumatic BBA (tBBA) with high-flow bypass using a radial artery graft, which resulted in a favorable outcome. A 59-year-old female suffered from an acute epidural hematoma, traumatic subarachnoid hemorrhage, and traumatic carotid-cavernous sinus fistula (tCCF) after being involved in a motor vehicle accident. Her angiography results showed tCCF and a tBBA on the anterior wall of the right ICA. On the fourth day after injury, we found rebleeding from the tBBA and performed an emergency high-flow bypass using a radial artery graft with lesion trapping as a curative procedure for the tCCF and tBBA. Postoperatively, right abducens nerve palsy appeared, but no other neurological symptoms were noted; the patient was thereafter transferred to a rehabilitation hospital 49 days after injury. Traumatic ICA aneurysms commonly occur close to the anterior clinoid process, form within 1 to 2 weeks of injury, and often rupture around 2 weeks after trauma. This case was considered rare as the ICA was likely injured and bleeding at the time of injury, resulting in a form of tBBA; this allowed early detection and appropriate treatment that resulted in a good outcome.

Keywords: traumatic brain injury, intracranial aneurysm, carotid artery injuries, rupture, extracranial-intracranial arterial bypass

Introduction

Ruptured cerebral aneurysms that occur in the anterior wall of the internal carotid artery (ICA) are known as blood blister-like aneurysms (BBAs); they have been reported to account for 0.3% to 1% of all endogenous ruptured ICA aneurysms.[1,2] BBAs are often difficult to treat because of their small diameter, very wide necks, and fragile arterial walls from arterial dissection; also, they are known to recur and re-rupture as a result of inadequate treatment.[3] To date, only one case of ruptured traumatic BBA (tBBA) has been reported, that is, in a child.[4] Here, we report the first adult case of a ruptured tBBA with traumatic carotid-cavernous fistula (tCCF), which was treated with high-flow bypass with lesion trapping.

Case Report

A 59-year-old woman was transported to another emergency center after being hit by a motorcycle while walking. She presented with disturbance of consciousness (Glasgow Coma Scale score: E1V1M4) and hemorrhagic shock. As per her whole-body computed tomography (CT) scan, a right acute epidural hematoma, subarachnoid hemorrhage (SAH) confined to the suprasellar region (Fig. 1A), skull base and posterior clinoid process fractures (Fig. 1C), pelvic fracture, and right femoral neck fracture were noted. Due to severe bleeding from her pelvic fracture, the patient was intubated and managed with transcatheter arterial embolization. At the same time, digital subtraction angiography (DSA) of the right common carotid artery was performed, which indicated a right tCCF and a tBBA located on the anterior wall of the right supraclinoid ICA. The patient was thereafter transferred to our hospital for more

Received April 21, 2023; Accepted July 28, 2023

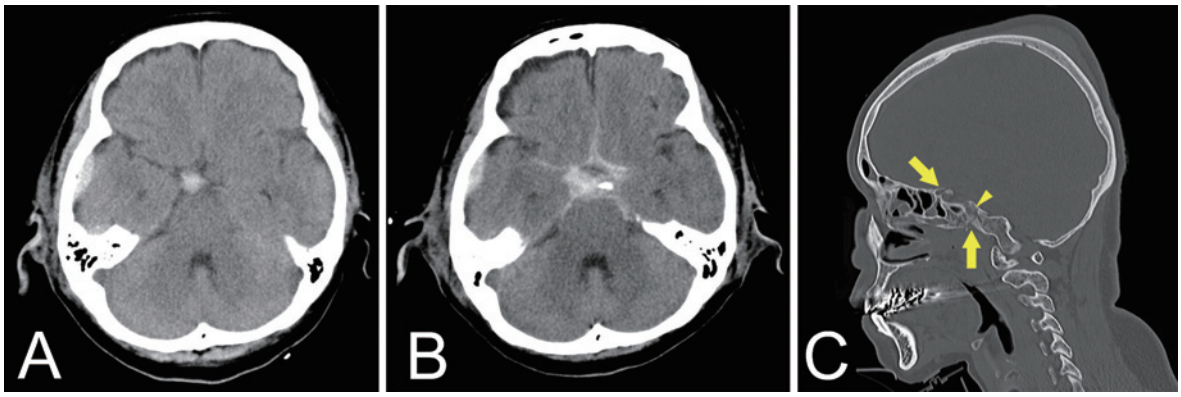

Fig. 1 Axial view of computed tomography at the time of hospital arrival (A) and at the time of rebleeding (B) shows a hematoma confined to the suprasellar region that has changed to a diffuse subarachnoid hemorrhage. Sagittal view of computed tomography at the time of hospital arrival (C) shows skull base fractures (yellow arrows) and posterior clinoid process fracture (yellow arrowhead).

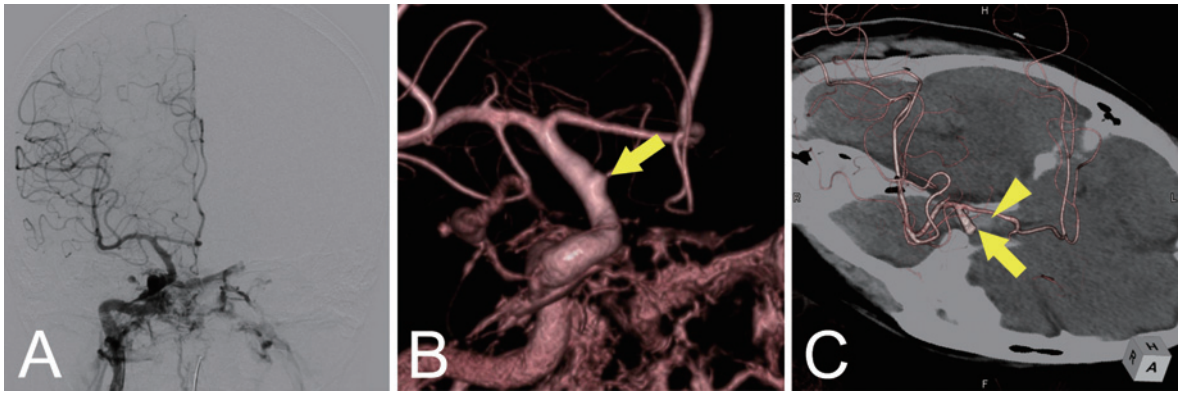

Fig. 2 Anterior view of right internal carotid digital subtraction angiography (DSA) (A) and three-dimensional rotational angiography (B) third day post-injury shows a carotid-cavernous fistula and a blood blister-like aneurysm on the anterior wall of the right internal carotid artery (yellow arrow). Fusion image of computed tomography at the time of hospital arrival and DSA (C) shows a blood blister-like aneurysm (yellow arrow) that is consistent with the location of the hematoma (yellow arrowhead).

specialized treatment. On the third day after injury, a second DSA showed no change in the tCCF or shape of the tBBA (Fig. 2). We planned to perform a high-flow bypass using radial artery (RA) graft and lesion trapping to treat tBBA and tCCF simultaneously in one surgery. On the fourth day after the injury, anisocoria was observed, and a head CT scan was repeated, which showed diffuse SAH (Fig. 1B). It was determined that the aneurysm had re-ruptured, which led us to perform an emergency operation.

General anesthesia was continued, and the patient was placed in the supine position with the head rotated to the left and fixed with pins; one neurosurgeon performed a craniotomy, while another surgeon simultaneously harvested the right RA. First, the right ICA and external carotid artery (ECA) were exposed at the cervical region, and the hypoglossal nerve was identified to mark the root of the RA. A right frontotemporal skin incision was made to expose the right superficial temporal artery (STA); then, a right frontotemporal craniotomy was performed with opening of the middle cranial fossa. The Sylvian fissure was opened to expose the M2 segment of the right middle cerebral artery (MCA), and the anterior branch of the STA and the M2 were bypassed as an assist bypass under monitoring of MCA pressure. The ECA and the proximal M2 that anastomosed the STA were then bypassed using a RA graft. The cervical ICA was thereafter ligated and occluded, and bypass blood flow was confirmed via Doppler ultrasound and indocyanine green fluorescence to ensure adequate blood flow. The Sylvian fissure was further opened, and the ruptured tBBA was visualized in the supraclinoid ICA (Fig. 3). A thick hematoma was observed around the aneurysm, but there was no evidence of enlargement or shape change in the tBBA. The intracranial ICA, which is just proximal to the posterior communicating artery, was clipped and occluded. The anterior clinoid process was partially removed via an intradural approach, and the right ophthalmic artery was identified and oc-

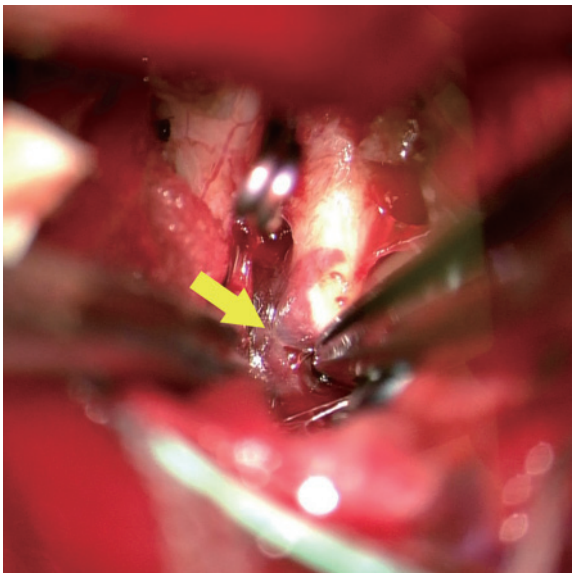

Fig. 3 Intraoperative image shows a blood blister-like aneurysm in the anterior wall of the internal carotid artery (yellow arrow).

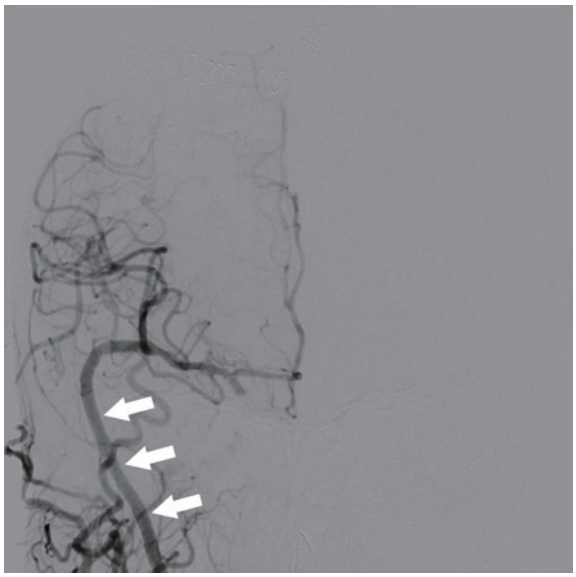

Fig. 4 Anterior view of a postoperative digital subtraction angiography of the right common carotid artery shows good bypass patency (arrows).

cluded using a clip. After securing blood flow to each bypass, the wound was closed, and the procedure was terminated. Postoperatively, blood pressure was controlled with nicardipine and spasm with fasudil hydrochloride hydrate and cilostazol for 14 days. The patient's state of consciousness gradually improved, and she was then extubated. DSA was performed at 7 days postoperatively and showed good bypass patency (Fig. 4). A right abducens nerve palsy appeared, but no other neurological symptoms were noted, and femoral orthopedic surgery was performed 29 days after the injury. The patient was transferred to a rehabilitation hospital on day 49 post-injury.

Discussion

Traumatic ICA aneurysms are known to occur near the anterior clinoid process and are often associated with skull base fractures. Generally, the mechanism of traumatic ICA aneurysm development is thought to be due to the histological or anatomical characteristics of the ICA. The intracranial ICA is often characterized by histological loss of the external elastic lamina and anatomically less fixation with the surrounding tissues. Blunt external forces stretched the supraclinoid ICA, and that local forces were applied to the ICA by the anterior clinoid process, which resulted in the formation of the tBBA.[5] Furthermore, this case was associated with tCCF, which is known to be caused by arterial dissection,[6,7] and it is possible that the arterial dissection may have progressed to the supraclinoid ICA, resulting in tBBA.

Traumatic intracranial aneurysms differ from nontraumatic intracranial aneurysms in terms of angiographic features, with the neck of the aneurysm often being indistinct and the aneurysm being irregularly shaped.[8,9] There has only been one report of a BBA due to trauma in a child, as described by Haji et al.,[4] and none in an adult. In that report, a head CT scan showed SAH and a tBBA from the initial examination as in the present case, and the aneurysm was noted to enlarge over a short period of time. Most traumatic aneurysms are pathologically pseudoaneurysms, characterized by a short-term change in shape,[10-12] and the case described by Haji et al. reflects these characteristics. The commonality between the present case and that of Haji et al. is that the traumatic ICA aneurysm had already ruptured at the time of initial presentation. Traumatic intracranial aneurysms form within 1 to 2 weeks of injury and often rupture around 2 weeks after traumatic brain injury,[5,10,13] but our present case and that of Haji et al. had bleeding from the ICA injured region at the time of injury, which enabled early detection and likely led to the detection of the tBBA, which did not enlarge in our case.

There have been several reports of BBAs treated with IVR using braided stents or flow diverter stents.[14-17] Zhang et al.[16] reported that treatment of BBA with overlapping low-profile visualized intraluminal support stent-assisted coil embolization has resulted in an overall occlusion rate of 92.3% and a procedure-related complication rate of 7.7%. A systematic review of flow diverter treatment for BBA[17] showed procedure-related morbidity and mortality of 26% and 3%, respectively. However, the medium- to long-term efficacy and safety of BBA treatment by IVR with a braided stent or flow diverter are yet to be established; furthermore, it remains unclear whether dual antiplatelet therapy should be used in the acute phase of cere-

bral aneurysm rupture.[16] We believe that dual antiplatelet therapy should not be performed in situations where there is a risk of re-rupture after treatment. In addition, in patients with multiple trauma, including traumatic brain injury as in this case, administration of dual antiplatelet therapy may exacerbate intracranial hemorrhage and bleeding at the site of other complicated injuries.

On the other hand, the efficacy and safety of high-flow bypass with RA grafting and lesion trapping for BBA have been reported.[3,18,19] Murai et al. reported that in their high-flow bypass with RA grafting, the 5-year or longer patency rate of the graft was 94%, and the symptomatic ischemic complication rate was 4.9%.[20,21] It can be safely performed even in patients with intracranial hemorrhage or multiple trauma because dual antiplatelet therapy is not required, and there is no possibility of postoperative rupture. Even in emergency operations under conditions that do not allow preoperative cerebral blood flow testing, the risk of postoperative complications, including hyperperfusion and ischemic complications, has been determined to be reduced by intraoperative maneuvers such as MCA pressure measurements, additional STA-MCA bypass, and indocyanine green fluorescence.[19,22,23] On the other hand, when surgery is performed during the acute phase of trauma, it is necessary to consider the difficulty of surgery due to decreased bypass patency caused by hypercoagulability,[24-26] swelling of subcutaneous tissues at the surgical site, and subcutaneous bleeding. The risk of abducens nerve palsy associated with internal carotid artery occlusion,[27] even if temporary, should also be considered, as was observed in this present case. Therefore, treatment should be selected according to individual conditions and circumstances. The present case also had tCCF, and high-flow bypass has also established its efficacy as a treatment for tCCF.[28,29]

Conclusion

This case has been considered rare as the ICA was likely injured and bleeding at the time of injury, resulting in the formation of tBBA. In addition to tBBA, this case was also complicated by tCCF, which could be safely treated by high-flow bypass using a RA graft with lesion trapping as a curative procedure.

Acknowledgments

We thank Libby Cone, MD, MA, from Dmed (www.dmed.co.jp) for editing a draft of this manuscript.

Author Contributions

Conception and design of the study: Matsumoto, Nakae, Matano, and Murai. Acquisition of data: Matsumoto, Nakae, Matano, and Murai. Drafting of the article: Matsumoto, Nakae, Matano, and Murai. Review of the submitted version of the manuscript: all authors. Study supervision: Morita and Yokobori. All authors have read and approved the final manuscript.

Informed Consent

Informed consent was provided by the patient and her guardians before submitting this study to NMC Case Reports for publication.

Conflicts of Interest Disclosure

The authors and all co-authors have no conflicts of interest to declare. Authors who are members of the Japan Neurosurgical Society have registered online for self-reported COI Disclosure Statement Forms.

References

1) Gonzalez AM, Narata AP, Yilmaz H, et al.: Blood blister-like aneurysms: Single center experience and systematic literature review. *Eur J Radiol* 83: 197-205, 2014
2) Wrobel CJ, Taubman K: Blood-blister-like aneurysms. *J Neurosurg* 92: 1076-1077, 2000
3) Murai Y, Matano F, Shirokane K, et al.: Lesion trapping with high-flow bypass for ruptured internal carotid artery blood blister-like aneurysm has little impact on the anterior choroidal artery flow: Case series and literature review. *World Neurosurg* 153: e226-e236, 2021
4) Haji FA, Boulton MR, de Ribaupierre S: Blister-like supraclinoid internal carotid artery pseudoaneurysm in a 15-year-old male: Case report and review of the literature. *Pediatr Neurosurg* 47: 449-454, 2011
5) Buckingham MJ, Crone KR, Ball WS, Tomsick TA, Berger TS, Tew JM Jr: Traumatic intracranial aneurysms in childhood: two cases and a review of the literature. *Neurosurgery* 22: 398-408, 1988
6) Men S, Oztürk H, Hekimoğlu B, Sekerci Z: Traumatic carotid-cavernous fistula treated by combined transarterial and transvenous coil embolization and associated cavernous internal carotid artery dissection treated with stent placement. Case report. *J Neurosurg* 99: 584-586, 2003
7) Yong RL, Heran NS: Traumatic carotid cavernous fistula with bilateral carotid artery and vertebral artery dissections. *Acta Neurochir (Wien)* 147: 1109-1113, 2005
8) Proust F, Callonec F, Bellow F, Laquerriere A, Hannequin D, Freger P: Tentorial edge traumatic aneurysm of the superior cerebellar artery. Case report. *J Neurosurg* 87: 950-954, 1997
9) Yeap MC, Chung MW, Chen CT: Traumatic aneurysm at the superior cerebellar artery: illustrative case. *J Neurosurg Case Lessons* 2: CASE21577, 2021
10) Saito K, Baskaya MK, Shibuya M, Suzuki Y, Sugita K: False traumatic aneurysm of the dorsal wall of the supraclinoid internal carotid artery: Case report. *Neurol Med Chir (Tokyo)* 35: 886-891, 1995
11) Tan S, Zhou X, Lu Y, et al.: Low-profile visualized intraluminal support stent for the endovascular treatment of traumatic intracranial internal carotid artery pseudoaneurysms. *Neurosurg Rev* 45: 2231-2237, 2022
12) Tsunoda S, Inoue T, Matsufuji H, Segawa M, Akabane A: Trau-

matic pseudoaneurysm resulting from avulsion of the falcine branch of an azygos anterior cerebral artery: A case report. *Acta Neurochir (Wien)* 164: 2441-2445, 2022
13) Parkinson D, West M: Traumatic intracranial aneurysms. *J Neurosurg* 52: 11-20, 1980
14) Aihara M, Shimizu T, Naito I, et al.: Endovascular treatment strategy and clinical outcomes for ruptured blood blister-like aneurysms of the internal carotid artery using low-profile visualized intraluminal support stent. *World Neurosurg* 149: e146-e153, 2021
15) Cerejo R, Bain M, John S, et al.: Flow diverter treatment of cerebral blister aneurysms. *Neuroradiology* 59: 1285-1290, 2017
16) Zhang X, Shen R, Zhao J, Sun J, Zhang Q, Chen Z: Using overlapping low-profile visualized intraluminal support stent-assisted coil embolization for treating blood blister-like aneurysms of the internal carotid artery. *Neurosurg Rev* 44: 1053-1060, 2021
17) Zhu D, Yan Y, Zhao P, et al.: Safety and efficacy of flow diverter treatment for blood blister-like aneurysm: A systematic review and meta-analysis. *World Neurosurg* 118: e79-e86, 2018
18) Kazumata K, Nakayama N, Nakamura T, Kamiyama H, Terasaka S, Houkin K: Changing treatment strategy from clipping to radial artery graft bypass and parent artery sacrifice in patients with ruptured blister-like internal carotid artery aneurysms. *Neurosurgery* 10 Suppl 1: 66-72, 2014
19) Matano F, Murai Y, Tanikawa R, et al.: Intraoperative middle cerebral artery pressure measurements during superficial temporal artery to middle cerebral artery bypass procedures in patients with cerebral atherosclerotic disease. *J Neurosurg* 125: 1367-1373, 2016
20) Murai Y, Mizunari T, Kobayashi S, et al.: Basic techniques of radial artery graft to prevent surgical complications. *Surg Cereb Stroke* 41: 33-38, 2013 (Japanese)
21) Murai Y, Morita A, Mizunari T, et al.: Basic techniques and perioperative care of radial artery graft: Lessons learned from 130 cases. *Surg Cereb Stroke* 47: 6-11, 2019 (Japanese)
22) Murai Y, Mizunari T, Koketsu K, et al.: Target-controlled infusion technique with indocyanine green videoangiography for radial artery graft. *Clin Neurol Neurosurg* 119: 70-74, 2014
23) Murai Y, Mizunari T, Umeoka K, Tateyama K, Kobayashi S, Teramoto A: Ischemic complications after radial artery grafting and aneurysmal trapping for ruptured internal carotid artery anterior wall aneurysm. *World Neurosurg* 77: 166-171, 2012
24) Nakae R, Murai Y, Morita A, Yokobori S: Coagulopathy and traumatic brain injury: Overview of new diagnostic and therapeutic strategies. *Neurol Med Chir (Tokyo)* 62: 261-269, 2022
25) Nakae R, Murai Y, Wada T, et al.: Hyperfibrinolysis and fibrinolysis shutdown in patients with traumatic brain injury. *Sci Rep* 12: 19107, 2022
26) Nakae R, Murai Y, Takayama Y, et al.: Neurointensive care of traumatic brain injury patients based on coagulation and fibrinolytic parameter monitoring. *Neurol Med Chir (Tokyo)* 62: 535-541, 2022
27) Field M, Jungreis CA, Chengelis N, Kromer H, Kirby L, Yonas H: Symptomatic cavernous sinus aneurysms: Management and outcome after carotid occlusion and selective cerebral revascularization. *AJNR Am J Neuroradiol* 24: 1200-1207, 2003
28) Hasegawa H, Inoue T, Tamura A, Saito I: Urgent treatment of severe symptomatic direct carotid cavernous fistula caused by ruptured cavernous internal carotid artery aneurysm using high-flow bypass, proximal ligation, and direct distal clipping: Technical case report. *Surg Neurol Int* 5: 49, 2014
29) Mizunari T, Murai Y, Kim K, Kobayashi S, Kamiyama H, Teramoto A: Posttraumatic carotid-cavernous fistulae treated by internal carotid artery trapping and high-flow bypass using a radial artery graft: Two case reports. *Neurol Med Chir (Tokyo)* 51: 113-116, 2011

Corresponding author: Ryuta Nakae, MD, PhD
Department of Emergency and Critical Care Medicine, Nippon Medical School Hospital, 1-1-5 Sendagi, Bunkyo-ku, Tokyo 113-8603, Japan.
e-mail: nakae@nms.ac.jp