Ruptured vertebrobasilar junction aneurysm supplied by reversed flow from the anterior spinal artery: illustrative case report

Collin Gonce MS3, Kiana Prather MS4, Christopher Graffeo MD PhD
University of Oklahoma, Department of Neurosurgery
University of Oklahoma College of Medicine, Oklahoma City, Oklahoma

INTRODUCTION

In patients with vertebral artery (VA) occlusion, spontaneous flow reversal may occur in the anterior spinal artery (ASA) as a source of compensatory supply to the posterior circulation. Turbulent flow and increased flux through these small arteries may predispose to luminal damage and intracranial aneurysm formation. We report a novel case of a ruptured ASA-VA junction aneurysm in a patient with chronic bilateral VA occlusion, successfully treated with endovascular embolization.

Case

A 62-year-old female with uncontrolled hypertension presented with severe headache, vomiting, neck stiffness, and drowsiness. Her systolic blood pressure was 200 upon admission, for which she received intravenous nicardipine. Head CT imaging demonstrated diffuse aneurysmal SAH with intraventricular extension and hydrocephalus (Hunt Hess Grade III; modified Fisher grade IV; **Fig. 1A-B**). CT angiogram demonstrated unique vertebrobasilar anatomy with an absent left VA, chronic right VA occlusion distal to the PICA origin, and a complex, bilobed aneurysm arising from the ASA-VA junction (**Fig. 1C-D**).

Treatment & Periprocedural Care

An external ventricular drain (EVD) was emergently placed, and the patient subsequently underwent digital subtraction angiography (DSA), which demonstrated reversal of flow from the ASA to the distal stump of the occluded right VA (**Fig. 2A-C**). DSA also confirmed that the ASA provided the dominant vertebrobasilar supply, along with small collaterals arising from the proximal of occlusion in the distal right VA (**Fig. 2B**). The aneurysm had an irregular, multilobulated morphology, and measured 4.7 mm (neck-to-dome) x 2.8 mm x 5.2 mm (**Fig. 2D-F**)

Endovascular embolization was performed using a 6 French Medtronic Wrist Sheath introduced via the ulnar artery into the right vertebral artery. The aneurysm was then filled with platinum coils following superselective microcatheterization with an SL-10 microcatheter and 014 Synchro soft microguidewire (Stryker Neurovascular, Fremont, CA) through the right cervical VA perforators anastomosing with the ASA (**Fig. 3**). Post-coiling DSA confirmed successful aneurysm obliteration, with preservation of ASA patency and flow to the posterior circulation (**Fig. 3B-C**). The hospital course was complicated by delayed cerebral ischemia in spite of protocol-based enteral nicardipine for vasospasm prophylaxis, as well as persistent hydrocephalus ultimately requiring ventriculoperitoneal shunt placement. The patient was discharged to acute inpatient rehabilitation and then returned home. She had made a complete neurological recovery as of her 3-month postoperative follow-up visit.

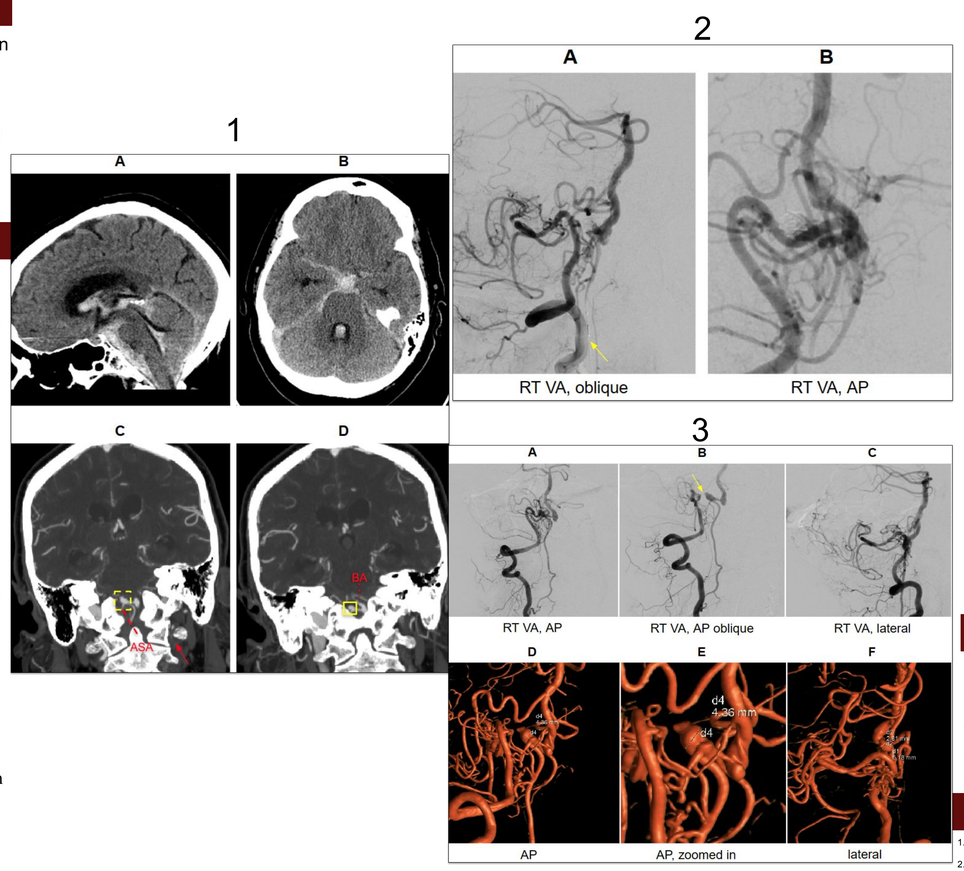

Figure 1. CT head and CT angiogram at presentation. (**A-B**) CT head without contrast (sagittal, axial) demonstrates diffuse subarachnoid hemorrhage in the basal cisterns with extension into the lateral, third, and fourth ventricles. (**C-D**) Coronal CT angiogram demonstrates unique vertebrobasilar anatomy with an absent left VA (red arrow, **C**) and an occluded right VA terminating in the PICA. A complex, bilobed aneurysm was seen at the ASA-VA junction (yellow box, **C-D**). *Abbreviations: ASA, anterior spinal artery; PICA, posterior inferior cerebellar artery; VA, vertebral artery.*

Figure 2. DSA demonstrating the complex aneurysm and unique anatomy. (**A-C**) DSA via the right VA shows aneurysm at the distal stump of the occluded right VA (yellow arrow) supplied by reversed flow from the ASA. (**D-F**) The aneurysm measures 4.7 mm (neck-to-dome) x 2.8 mm x 5.2 mm on 3D reconstruction. *Abbreviations: AP, anteroposterior; ASA, anterior spinal artery; DSA, digital subtraction angiography; R, right; VA, vertebral artery.*

Figure 3. Endovascular coiling of the ASA-VA junction aneurysm using superselective microcatheterization via the ASA (yellow arrow). (A) Coiling of the aneurysm through the ASA. **(B)** Close-up AP view of the coiled aneurysm. **(C)** Post-coiling DSA demonstrated a patent ASA supplying the posterior circulation. *Abbreviations: AP, anteroposterior; ASA, anterior spinal artery; DSA, digital subtraction angiography; R, right; VA, vertebral artery.*

Discussion

We report a novel case of a SAH in an intracranial aneurysm arising from an abnormal circulatory variant in which chronic bilateral VA occlusion/atresia resulted in an ASA supply to the vertebrobasilar circulation, successfully treated with endovascular embolization. In addition to highlighting unusual anatomy, this case demonstrates the versatility of contemporary endovascular techniques and their potential for safe, effective, and creative application across a range of unusual clinical presentations.

Intracranial aneurysms arising from the VA or vertebrobasilar junction represent a major challenge to both open and endovascular strategies, due to the complex anatomy, high-flow location, and potential for severe morbidity from disease sequelae or treatment complications. Many such aneurysms are ideal for microsurgical treatment, which provides access for both complex clip reconstructions, as well as a range of revascularization strategies such as intracranial-intracranial bypass (13). Notwithstanding, in patients with a favorable SAH grade, preference is generally given to endovascular strategies if a safe and durable treatment can be achieved (14). Although embolization may predispose to increased risk of long-term disease recurrence, periprocedural complication rates are comparable or improved, and patient recovery is favorable due to the minimally invasive nature of the interventions (15).

Although this case highlights a successful application of endovascular techniques to an unusual anatomic configuration, it also emphasizes the numerous attendant risks of such a treatment. Pronounced risks in the posterior circulation include thromboembolism, coil prolapse precipitating parent vessel occlusion, and aneurysm rupture during embolization—a particularly dangerous event in the relatively uncontrolled endovascular setting (8,9). These considerations are highly salient in the setting of variant anatomy, as the vascular tolerance for procedural maneuvers is less predictable, and the consequences of injury in posterior circulation supplied by a single vessel are potentially extreme.

CONCLUSIONS

We report the index case of an ASA-VA junction aneurysm arising in the setting of ASA flow reversal secondary to bilateral VA occlusion, treated with superselective micro-catheterization for endovascular embolization. The clinical and radiographic results highlight the versatility, efficacy, and safety of coiling for atypical aneurysms, provided appropriate patient selection including consideration of the relative risks and benefits compared to microsurgical strategies.

REFERENCES

1. Uygur ER, Lanzino G. The origin of the anterior spinal artery from the vertebral artery: A brief overview of its anatomical variations and initial course. In: George B, Bruneau M, Spetzler RF, editors. Pathology and surgery around the vertebral artery [Internet]. Paris: Springer; 2011 [cited 2023 Mar 28]. p. 49–51. Available from: https://doi.org/10.1007/978-2-287-89787-0_6
2. Lu J, Liu J, Wang L, Qi P, Wang D. Bilateral segmental agenesis of carotid and vertebral arteries with rete mirabile and the prominent anterior and posterior spinal arteries as compensations. Interv Neuroradiol J Peritherapeutic Neuroradiol Surg Proced Relat Neurosci. 2014;20(1):13–9.
3. Stojanović B, Vasović L, Vlajković S, Trandafilović M, Mladenović M. Variation of some arteries of the vertebrobasilar system: case report. Surg Radiol Anat. 2017 Jun 1;39(6):689–92.
4. Kawamura S, Yoshida T, Nonoyama Y, Yamada M, Suzuki A, Yasui N. Ruptured anterior spinal artery aneurysm: a case report. Surg Neurol. 1999 Jun;51(6):608–12.
5. Kang HS, Han MH, Kim SH, Kwon OK, Roh HG, Ko YC. Anterior Spinal Artery as a Collateral Channel in Cases of Bilateral Vertebral Arterial Steno-Occlusive Diseases. Am J Neuroradiol. 2007 Feb 1;28(2):222–5.
6. Frösen J, Cebral J, Robertson AM, Aoki T. Flow-induced, inflammation-mediated arterial wall remodeling in the formation and progression of intracranial aneurysms. Neurosurg Focus. 2019 Jul 1;47(1):E21.
7. Yamakawa H, Yoshimura S, Iwama T. Anterior spinal artery as a collateral channel in patients with acute bilateral vertebral artery occlusions. Two case reports. Neurol Med Chir (Tokyo). 2009 Aug;49(8):354–8.
8. Ihn YK, Shin SH, Baik SK, Choi IS. Complications of endovascular treatment for intracranial aneurysms: Management and prevention. Interv Neuroradiol. 2018 Jun;24(3):237–45.
9. Derdeyn CP, Cross DT, Moran CJ, Brown GW, Pilgram TK, Diringer MN, et al. Postprocedure ischemic events after treatment of intracranial aneurysms with Guglielmi detachable coils. J Neurosurg. 2002 May;96(5):837–43.
10. Uchiyama S, Yoshida M, Shimizu H. [MR imaging of the anterior spinal artery in a case of bilateral vertebral arterial occlusion]. Rinsho Shinkeigaku. 1995 Jan;35(1):60–3.
11. Garnier P, Januel AC, Demasles S, Michel D. Collateralization of vertebral arteries. Neurology. 2003 Feb 25;60(4):720–720.
12. Doppman JL, Di Chiro G, Glancy DL. Collateral circulation through dilated spinal cord arteries in aortic coarctation and extraspinal arteriovenous shunts. An arteriographic study. Clin Radiol. 1969 Jan 1;20(2):192–7.
13. Lawton MT, Lang MJ. The future of open vascular neurosurgery: perspectives on cavernous malformations, AVMs, and bypasses for complex aneurysms. J Neurosurg. 2019 May 1;130(5):1409–25.
14. Lindgren A, Vergouwen MD, van der Schaaf I, Algra A, Wermer M, Clarke MJ, et al. Endovascular coiling versus neurosurgical clipping for people with aneurysmal subarachnoid haemorrhage. Cochrane Database Syst Rev. 2018 Aug 15;8(8):CD003085.
15. Molyneux AJ, Kerr RSC, Yu LM, Clarke M, Sneade M, Yarnold JA, et al. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. Lancet Lond Engl. 2005 Sep 3;366(9488):809–17.