Case Report

Early treatment of progressive vertebral arteriovenous fistula caused by cervical penetrating injury

Mamoru Murakami,1 Daisuke Maruyama,1 Gaku Fujiwara,1 Yujiro Komaru,1 Nobukuni Murakami,1 and Ryoji Iiduka2

1Department of Neurosurgery, and 2Department of Emergency and Critical Care Medicine, Japanese Red Cross Society Kyoto Daini Red Cross Hospital, Kyoto, Japan

Background: Penetrating injury of the vertebral artery (VA) is uncommon because it lies deep in the neck and is surrounded by a bony foramen. Vertebral–venous fistula is a rare vascular condition in which there is direct aberrant communication among the extracranial vertebral artery, its radicular or muscular branches, and adjacent venous structures.

Case Presentation: We report an asymptomatic patient of fistula from the vertebral artery to the paravertebral veins secondary to a cervical stab wound that increased in size and flow, as observed on the angiogram 10 days later, which was successfully treated by endovascular surgery. The postoperative angiogram showed improved visualization of the bilateral posterior cerebral arteries.

Conclusion: Endovascular embolization at the early phase should be undertaken for traumatic high-flow vertebral–venous fistula, even if the patient is asymptomatic, to prevent progressive posterior circulation insufficiency due to the rapid growth of the fistula, which can ultimately lead to the steal phenomenon.

Key words: Arteriovenous fistula, endovascular surgery, penetrating injury, vertebral artery

BACKGROUND

CERVICAL PENETRATING INJURY can produce vertebral artery (VA) transection, arteriovenous fistulae, pseudoaneurysm, arterial dissection, and progressively enlarging hematoma.1–3 Cases of vertebral–venous fistula (VVF) vary in presentation, including audible bruit or subjective complaint of tinnitus. Less commonly, high-flow fistulae can result in venous hypertension, arterial steal, or cervical radiculopathy. Although there are characteristic clinical manifestations, VVF cases, including ours, frequently occult and are detected only by screening angiography for patients suspected of having vascular pathology.3 Surgical obliteration was once considered the mainstay of treatment for VVF; however, endovascular techniques for VVF treatment have been reported with satisfactory results.2,4–7 In this report, we describe a case of VVF secondary to a cervical stab wound that was successfully treated by endovascular surgery 10 days after the injury.

CASE

A 58-year-old woman was admitted to our hospital with hemorrhagic shock due to suicidal cervical stab wounds. On admission, her blood pressure was 69/46 mmHg, which recovered and remained stable after resuscitation. No active bleeding was observed from the two stab wounds, which were observed at zone II with surrounding hematoma to the right of the midline (Fig. 1A). No extravasation was noted on cervical post-enhanced computed tomography (CT). We undertook local wound exploration under general anesthesia, and found lacerations of the right internal jugular vein and the facial vein, which were repaired with sutures. Intubation care under sedation was continued until the following day. On the next day, 80-row 3-D CT angiogram (CTA) showed occlusion of the right VA at the C3 level (Fig. 1B). No arteriovenous fistula was noted. A retrospective review of the reconstructed CT the day before also showed occlusion of the right VA. The patient immediately underwent conventional angiography. The right VA angiogram revealed termination of the right VA at the C3 level after muscular branching, and the left VA angiogram

Corresponding: Mamoru Murakami, MD, Department of Neurosurgery, 355-5 Haruobi-cho, Kamigyō-ku, Kyoto 602-8026, Japan. E-mail: mmamor0125@gmail.com.
Received 10 Jun, 2019; accepted 18 Oct, 2019; online publication 5 Nov, 2019
Funding Information
No funding information provided.
revealed anterograde flow in the basilar artery, and retrograde flow across the VA union down to the right VA and posterior inferior cerebellar artery (Fig. 2A). A high-flow single AVF communicating with the right distal VA and paravertebral veins at the C2–3 level was also observed (Fig. 2B). The right internal carotid artery angiogram revealed no congestion of the intracranial venous drainage. Although the patient had no symptoms, we carried out elective endovascular obliteration within a week, but the patient’s consent for the treatment could not be obtained due to psychological anxiety. Magnetic resonance (MR) angiogram 3 days later showed no apparent VVF (Fig. 2C).

Eventually, after 10 days, the patient agreed to the treatment. A follow-up angiogram 10 days later revealed an enlarged fistula with a venous drainage route from the fistula through the paravertebral veins, pterygoid plexus, and posterior cervical veins (Fig. 3A). Successive percutaneous coil embolization of the fistula was carried out. Briefly, using a guiding catheter (7 Fr Roadmaster; Goodman, Nagoya, Japan) at the left VA, a balloon occlusion catheter (Scepter HC 4 × 11 mm; Terumo Corporation, Tokyo, Japan) was settled at the C1 level of the right VA across the VA union to control shunt flow. Following this, a microcatheter (Excelsior SL-10; Stryker, Kalamazoo, MI, USA) was positioned at the fistula point, which was occluded with seven detachable coils (Target coils, Stryker; and Hydrosoft coils, Terumo Corporation) (Fig. 3B). Immediately after the embolization, the bilateral posterior cerebral arteries became clearly visible on the left VA angiogram (Fig. 3C), compared with the preoperative angiogram where each posterior cerebral artery was visualized through the posterior communicating artery. This suggested an improvement in circulation of posterior cerebral arteries. The patient was transferred to psychological care at a different hospital 2 weeks after the surgery with slight dysphagia due to right recurrent nerve injury. Follow-up CTA after 8 months showed no detectable recanalization of the fistula. Follow-up conventional angiogram has not been obtained due to continued psychological care.

**DISCUSSION**

There are no definitive guidelines for the management of VA injuries following penetrating cervical

---

**Fig. 1.** A, Photograph of two self-inflicted stab wounds in a 58-year-old woman at the right of the cervical midline (arrows). B, Cervical 3-D computed tomography angiogram (80-row) on the day following admission showing occlusion of the right vertebral artery at the C3 level.

**Fig. 2.** Angiograms of a 58-year-old woman with traumatic vertebral arteriovenous fistula (AVF). A, B, Initial left vertebral artery (VA) angiogram showing antegrade flow in the basilar artery and retrograde flow across the VA union down to the right VA (A), entering into single AVF communicating with the paravertebral veins at the C2–3 level (B). C, Magnetic resonance angiogram 3 days after the angiogram showing no apparent AVF (white arrow).
injury; however, there are guidelines for patients with non-penetrating cervical injury. It can be agreed that slow-flow VVF can be followed by serial angiography in asymptomatic or clinically stable patients. For patients with symptomatic high-flow VVF, especially those with intracranial hypertension or an arterial steal, the VVF should be closed with successive treatment after the initial diagnostic angiography. However, the best treatment for asymptomatic patients with high-flow VVF remains controversial. An aggressive approach to high-flow VVF is commonly accepted because they rarely close spontaneously but there are a few reports of spontaneous regression of the fistula. In the present case, we planned elective endovascular treatment when the follow-up angiogram showed no regression of the VVF. Similar cases of elective treatment have been reported: Albuquerque et al. reported a patient with a gunshot wound who had a small fistula on the initial angiogram and underwent endovascular obliteration after 2 weeks due to the pronounced fistula. Kypson et al. reported a case of enlarged VVF with increased neck bruit that was treated 1 week after injury. We propose that elective obliteration of the fistula should be considered for patients with high-flow AVF, even if the patient is asymptomatic, when the follow-up angiogram within at least 14 days after the injury shows no regression of VVF. Obliterating the fistula is the primary goal for the treatment of VVF. Detachable balloons have been used safely and effectively, but we could obliterate the fistula tightly within the short segment using a couple of hydrogel-coated coils. Although this patient has not been able to undergo angiography due to continuing psychological care, serial angiographic follow-up is mandatory to document a persistent cure.

We should describe one point of difficulty for diagnosis of VVF using helical CTA, which is sufficient for the initial evaluation of cervical vessel injury and enables satisfactory triage of patients with conventional angiography. In this case, both the initial and the second CTA showed no VVF. On our retrospective review of these CTAs, which were not targeted for cervical arterial injury, but for the systemic evaluation of injuries from the face to the chest, we supposed the interval time from injection of contrast medium to imaging is too quick to detect the VVF, which resulted in visualization of only occlusion of the VA. An accurate time interval for CT imaging to target the cervical arterial injury is necessary for accurate detection of fistulae. Yeh et al. reported cases with VVF due to blunt trauma, which were initially suspected on brain MR angiography. We could detect no apparent VVF on MR angiogram in this case. We suggest it is difficult to diagnose the VVF accurately only on MR angiogram, which could show some degree of enlarged vein surrounding the VA.

CONCLUSION

We report a case of fistula from the VA to the paravertebral veins, secondary to cervical stab wounds, which was successfully embolized with coils 10 days after the injury. We consider early treatment by endovascular embolization of VVF to be important, even if the patient is asymptomatic with high-flow VVF.

DISCLOSURE

Approval of the research protocol: N/A.

Informed consent: Due to difficulty in contacting the patient, who is under continuing psychological care, to obtain consent for publication, we have carefully de-identified patient...
information. The patient’s husband has consented to the submission of the case report for publication in the journal. Following the decision from our hospital’s ethics committee, we applied an opt-out methodology for submission without consent based on the low risk of leaking patient information (No. 2018-10).

Registry and registration no. of the study/trial: N/A.
Animal studies: N/A.
Conflict of interest: None.

REFERENCES
1 Golueke P, Sclafani S, Phillips T, Goldstein A, Scalea T, Duncan A. Vertebral artery injury – diagnosis and management. J. Trauma 1987; 27: 856–65.
2 Yee LF, Olcott EW, Knudson MM, Lim RC. Extraluminal, transluminal, and observational treatment for vertebral artery injuries. J. Trauma 1995; 39: 480–6.
3 Muñera F, Soto JA, Palacio DM et al. Penetrating neck injuries: Helical CT angiography for initial evaluation. Radiology 2002; 224: 3663–72.
4 Albuquerque FC, Javedan SP, McDougall CG. Endovascular management of penetrating vertebral artery injuries. J. Trauma 2001; 53: 574–80.
5 O’Shaughnessy BA, Bendok BR, Parkinson RJ, Shaibani A, Batjer HH. Transarterial coil embolization of a high-flow vertebral–jugular fistula due to penetrating craniocervical trauma: case report. Surg. Neurol. 2005; 64: 335–40.
6 Herrera DA, Vargas SA, Dublin AB. Endovascular treatment of traumatic injuries of the vertebral artery. AJNR Am. J. Neuroradiol. 2008; 29: 1585–89.
7 Kypson AP, Wentzensen N, Georgiade GS, Vaslef SN. Traumatic vertebral–jugular arteriovenous fistula: case report. J. Trauma 2000; 49: 1141–43.
8 Harrigan MR, Hadley MN, Dhall SS et al. Management of vertebral artery injuries following non-penetrating cervical trauma. Neurosurgery 2013; 72: 234–43.
9 Bergquist E, Bergstrom K, Hugosson R, Jorulf H. Complicated arteriovenous fistula after vertebral angiography. J. Neuroradiol 1971; 2: 170–4.
10 Yeh CH, Chen YL, Wu YM, Huang YC, Wong HF. Anatomically based approach for endovascular treatment of vertebro–vertebral arteriovenous fistula. Interv. Neuroradiol. 2014; 20: 766–73.