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Case Report

Strategy for endovascular coil embolization of a penetrating vertebral artery injury

Hiroki Uchikawa, Yutaka Kai[1], Yuki Ohmori[1], Jun-Ichi Kuratsu[1]

Department of Neurosurgery, Saiseikai Kumamoto Hospital, [1]Department of Neurosurgery, School of Medicine, Kumamoto University, Kumamoto, Japan

E-mail: *Hiroki Uchikawa - h.uchikawa.1223@gmail.com; Yutaka Kai - ykai_1961@yahoo.co.jp; Yuki Ohmori - ohmori4497@gmail.com; Jun-ichi Kuratsu - jkuratsu@kumamoto-u.ac.jp
*Corresponding author

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Abstract

Background: Penetrating vertebral artery injuries (VAIs) are even rarer than carotid artery injuries. For anatomical reasons, the surgical management of VAI is difficult, and endovascular management often yields a good outcome. We report our strategy for the endovascular treatment of a patient with a penetrating VAI at the V2 segment of the left vertebral artery.

Case Description: In a fall on a large rake, a 76-year-old man was stabbed in the left neck by three tines. Although he manifested no neurological deficits, computed tomography (CT) suggested penetrating VAI. Digital subtraction angiography confirmed VAI and extravasation, and he underwent endovascular coil embolization. Two microcatheters, inserted proximal and distal to the injury sites, were used for successful endovascular coil embolization. Postoperative magnetic resonance imaging - and single photon emission CT studies denied cerebral infarction and a decrease in cerebral perfusion. The patient exhibited no neurological deficits and was able to leave the hospital on foot.

Conclusion: This is the rare documentation of a patient whose penetrating VAI was treated by simultaneous coil embolization and foreign body removal. Imaging studies confirmed the patency and perfusion of the intracranial artery. Our treatment strategy produced a good outcome in this unusual patient.

Key Words: Embolization, penetrating neck trauma, stab wound, traumatic vertebral artery injury

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INTRODUCTION

Only approximately 0.5% of all trauma patients present with traumatic vertebral artery injury (VAI) which is even more rare than carotid artery injury.[9] We encountered a patient with a penetrating VAI at the V2 segment of the left vertebral artery and report our strategy for his endovascular treatment which involved simultaneous coil embolization and foreign body removal.

CASE REPORT

In a fall on a large rake, this 76-year-old man was stabbed in the left neck by three tines [Figure 1]. He was taken to our emergency department with three metal tines penetrating his left neck; he was fully conscious and exhibited no neurological deficits. His vital signs were stable, and there was no apparent active bleeding. All laboratory data were normal.

A plain computed tomography (CT) scan showed that one of the tines penetrated between the C3/4 transverse foramen suggesting left vertebral artery damage. The other tine was attached to the hyoid bone and thyroid cartilage. His epiglottis was slightly swollen; there was no air leak, and he reported no respiratory discomfort. Other important structures such as the spinal cord and other major arteries and veins were intact. CT angiography (CTA) demonstrated obstruction of the left vertebral artery at the V2 segment proximal to the penetrating tine [Figure 2]. Because the metal artifact limited detailed evaluation we performed digital subtraction angiography (DSA) under general anesthesia to study his hemodynamic status and to select treatment. Angiography through the left vertebral artery revealed obstruction of the left vertebral artery and some oozing beside the metal tine [Figure 3]. Blood flow from the contralateral vertebral artery perfused the posterior fossa, and bilateral posterior communicating arteries were fetal type. We selected endovascular embolization to prepare for extravasation from the damaged vertebral artery.

After inserting a 6-Fr guiding catheter (Slim guide®, Medikit, Japan) into the left vertebral artery, we navigated two microcatheters (Excelsior®, Stryker Neurovascular, USA) into the proximal and distal sides to the injury point. It might be better that we use a stent to suppress the bleeding point and preserve anterograde blood flow, but vertebral artery at the injury point was too narrow to pass the stent device. A 4-Fr catheter was then inserted into the right vertebral artery for evaluation of the contralateral circulation. In the middle of slowly and carefully withdrawing the metal tine, we noted extravasation and decided that endovascular embolization was indicated. We first performed coil embolization at the entry - and the proximal side using the microcatheter inserted at the proximal side. Then we embolized the distal side to the site of entry using the distal microcatheter. Extravasation ceased after complete embolization of the left vertebral artery [Figure 4]. The tine was withdrawn, and the other two tines were removed at the same time. There was neither bleeding nor cerebrospinal fluid leakage after their removal and drainage tubes were inserted into the three stab wounds. As postembolization laryngoscopy revealed laryngeal wall damage by one of the tines, we performed tracheotomy.

Postoperative magnetic resonance imaging showed no evidence of cerebral infarction and single photon emission CT (SPECT) demonstrated normal cerebral perfusion [Figure 5]. His laryngeal swelling disappeared after a few weeks, and he was extubated. The perioperative administration of antibiotics prevented focal or general infection. He manifested no neurological deficits and was able to leave the hospital on foot.

Figure 1: Paramedics on the scene carefully cut down the tines. The patient's vital signs were stable, and he manifested no neurological deficits

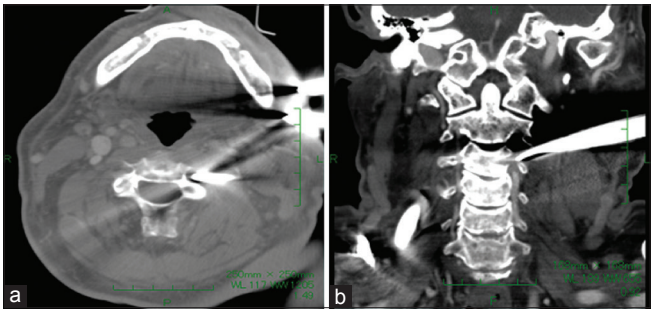

Figure 2: (a) A plain computed tomography (CT) scan (axial view) indicated vertebral artery injury. (b) An enhanced CT scan (coronal view) demonstrated left vertebral artery interruption

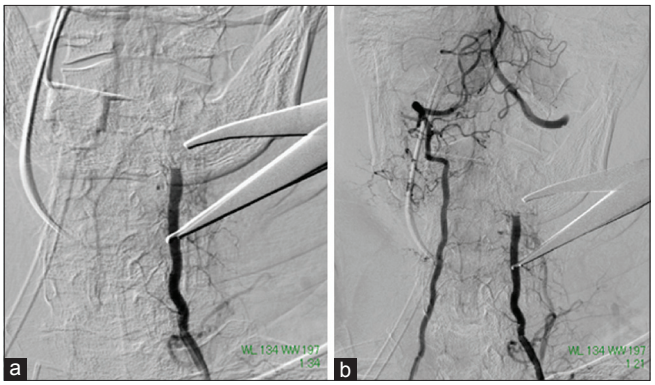

Figure 3: Digital subtraction angiography showed vertebral artery injury. The left vertebral artery was interrupted at the V2 segment at a site proximal to the tip of the tine (a). The contralateral vertebral artery was perfused on both sides of the posterior circulation (b)

DISCUSSION

Traumatic VAIs are seen in approximately 0.5% of all trauma patients.[9] VAI is strongly associated with head and neck injuries such as cervical spine fractures[5,7] and penetrating VAI is even less common than carotid artery injury in patients with trauma or blunt VAI. Without proper management, the morbidity - and mortality rates of patients with penetrating VAI are relatively high.[4] Among patients with gunshot - and stab wounds

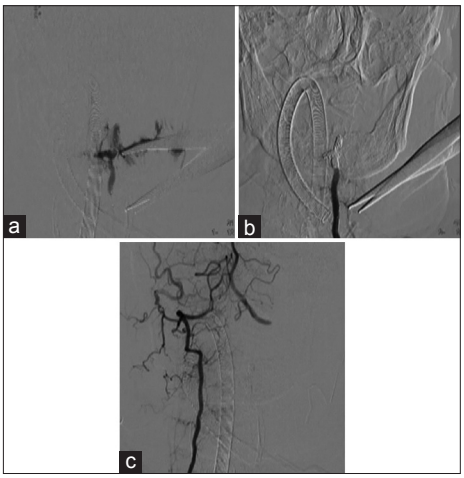

Figure 4: (a) Digital subtraction angiography (DSA) performed after injecting the left vertebral artery via a microcatheter showed extravasation from the vessel upon removal of the tine. (b) DSA performed after injecting the left vertebral artery via a guiding catheter showed no extravasation from the left vertebral artery after embolization. (c) DSA performed after right vertebral artery injection showed good contralateral vertebral artery flow. The damaged vessel was not contrast-enhanced

the incidence of penetrating VAI is 1.0% and 7.4%, respectively.[13] Based on their angiographic appearance, VAI are classified into five types. Grade V, the most severe grade, is vessel transection [Table 1].[3,15]

The major problem in the management of VAI is the severe limitation with direct open access to the vertebral artery. Because these vessels pass into the transverse foramen, proximal and distal - and surgical local control is difficult.[6] Consequently, we often select endovascular treatment to address traumatic VAI and we and others obtained good outcomes even in unstable trauma patients.[1] However, the diagnosis of VAI is difficult especially in the absence of neurological deficits or spinal cord injury and the appropriate modality to screen for VAI is controversial. DSA has been the gold standard for the diagnosis and treatment of VAI when a foreign body is located near a vital structure.[10] Eastman *et al*. who used 16-slice CTA and catheter angiography to screen 146 trauma patients suspected of blunt vascular injury reported that in 98% the findings were concordant.[8] This suggests CTA as the first choice for screening for VAI.

In our patient, plain cervical CT revealed no severe spinal or vertebral damage. However, immediate withdrawal of the tines would have worsened our patient's situation. We confirmed our suspicion of VAI by performing CTA before their removal. DSA showed no flow in the posterior circulation on the affected side. Collateral circulation from the right vertebral artery was good, and the bilateral posterior communicating arteries were of the fetal type. These findings indicated that safe embolization of the left vertebral artery was possible. If

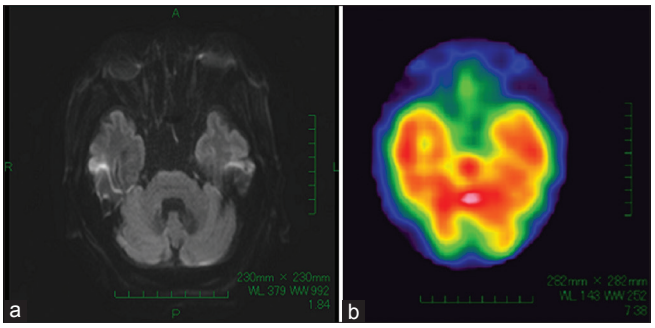

Figure 5: (a) The axial diffusion-weighted magnetic resonance imaging scan revealed no ischemic region. (b) On the single photon emission computed tomography image, there is no evidence of a decrease in cerebral perfusion in the posterior circulation

Table 1: Cerebrovascular injury grading scale

Injury grade	Description
I	Luminal irregularity or dissection with <25% luminal narrowing (nonclinically significant narrowing)
II	Dissection or intramural hematoma with >25% luminal narrowing, intraluminal thrombus, or raised intimal flap (potentially clinically significant)
III	Pseudoaneurysm
IV	Occlusion
V	Transection with free extravasation (usually lethal injuries)

symptomatic case of the vertebrobasilar ischemia, we treated in the same way, because active bleeding was most fatal. Furthermore, it would be difficult to rescue ischemia because it took too long time from the onset. We inserted two microcatheters at sites proximal and distal to the damaged artery to embolize both sides simultaneously because their proximal introduction alone would not have allowed control of the distal flow after embolization of the proximal side. Although distal control might not always be necessary, we purposely inserted microcatheter at the distal side to the damaged point for safety. If microcatheter could not be inserted at the distal side anterogradely, we would insert microcatheter from right vertebral artery retrogradely. Our use of the 6-Fr guiding catheter, which facilitates the application of advanced techniques that involve multiple microdevices rendered endovascular treatment safe and easy.[12]

Traumatic VAI can be endovascularly treated with coils, balloons, or stents.[2,11,14] Although what is best or common treatment is controversial, coil embolization would be most common treatment in the literature, especially for bleeding cases.[1,2] We chose coil embolization because the damaged vessels were too narrow for the passage of stents or balloons. Xia *et al*. encountered a case similar to ours; they treated their patient's VAI with coils and also obtained a good outcome.[16] The long-term results of endovascular treatment for VAI remain unclear. In

patients manifesting a decrease in cerebral perfusion we would consider extracranial-intracranial arterial anastomosis. While posttreatment SPECT confirmed normal cerebral perfusion in our patient, additional studies are needed to identify the optimal strategy for the treatment of patients with VAI.

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