

Case Report



Occlusion of Both Vertebral Arteries With Development of Collateral Circulation From the Deep Cervical Artery After Cervical Spine Trauma

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Conflict of Interest

The authors have no financial conflicts of interest.

ABSTRACT

Careful evaluation of vertebral artery injuries is important after cervical translation injuries or transverse foramen fractures. Treatment of trauma can be complicated in cases of concomitant vertebral artery injuries. A 76-year-old woman was admitted to our hospital with left hemiparesis (Motor grade 3) after a motorcycle accident. Cervical spine magnetic resonance imaging (MRI) and computed tomography (CT) revealed a C3 burst fracture and a left C3 lateral mass and lamina fracture. CT angiography revealed fracture fragments that predisposed the vertebral artery to injury throughout its course in the area. CT angiography confirmed that both vertebral arteries were occluded at the C3 fracture site. Subsequent brain MRI revealed acute infarction in the right occipital area. Although both vertebral arteries were occluded, the infarction site did not correspond to the territory supplied by these vessels; therefore, we performed transfemoral cerebral angiography, which revealed collateralization of the bilateral vertebral arteries by the deep cervical artery. The deep cervical arteries are located between the posterior muscles; therefore, a fixation operation performed using the posterior approach may have affected the collateral circulation and led to exacerbation of the infarction site. Therefore, surgery was performed using an anterior approach and it was possible to minimize the risk of cerebral infarction through preservation of collateral circulation.

Keywords: Cervical vertebrae; Vertebral artery; Collateral circulation; Cerebral angiography

INTRODUCTION

Vertebral artery injury (VAI) occurs in approximately 0.5% of patients admitted for trauma.¹⁾ However, approximately 70% of cervical spinal (C-spine) trauma cases are accompanied by VAI.¹⁾ In particular, VAI is significantly higher in patients with C-spine translation injuries or transverse foramen fractures.⁸⁾ Neurological deficits can occur in the presence of VAI, with incidence varying from 0% to 24%.⁴⁾ Catheter angiography is the gold standard for diagnosing VAI.¹²⁾ However, computed tomography (CT) angiography has sensitivity and

specificity similar to those of catheter angiography in the evaluation of VAI.³⁾ Treatments include observation and antiplatelet, anticoagulation, and endovascular treatments.^{3,4,7)}

Our case involved a patient with a grade V (occlusion) VAI due to C-spine trauma. Cerebral angiography showed that ischemia of the posterior circulation was minimal due to collateral circulation from the deep cervical artery.

CASE REPORT

A 76-year-old female visited the emergency room with left hemiparesis after a motorcycle accident. C-spine CT and magnetic resonance imaging (MRI) were performed to evaluate neck pain and the left hemiparesis (Motor Gr 3). A C3 burst fracture and C3–4 subluxation were observed on the C-spine CT scan. Additionally, bilateral C3 and 4 transverse process fractures were observed throughout the C3 lateral mass and lamina. The transverse process fracture at C3 and 4 was bony invasion into the transverse foramen through which the vertebral artery passed. Therefore, neck CT angiography was performed, which revealed that the vertebral artery was occluded at the C3 and 4 fracture site. However, vertebral artery flow was observed at the C2 level (**FIGURE 1**). In C-spine MRI, focal increased signal intensity was observed at the C2–3 levels and retropharyngeal and prevertebral hematomas were observed across the C2-3-4-5 levels. Brain MRI was performed because of the possibility of vertebral artery dissection and cerebral posterior circulation disorder. MRI of the right posterior cerebral circulation revealed acute infarction in the occipital area (**FIGURE 2**).

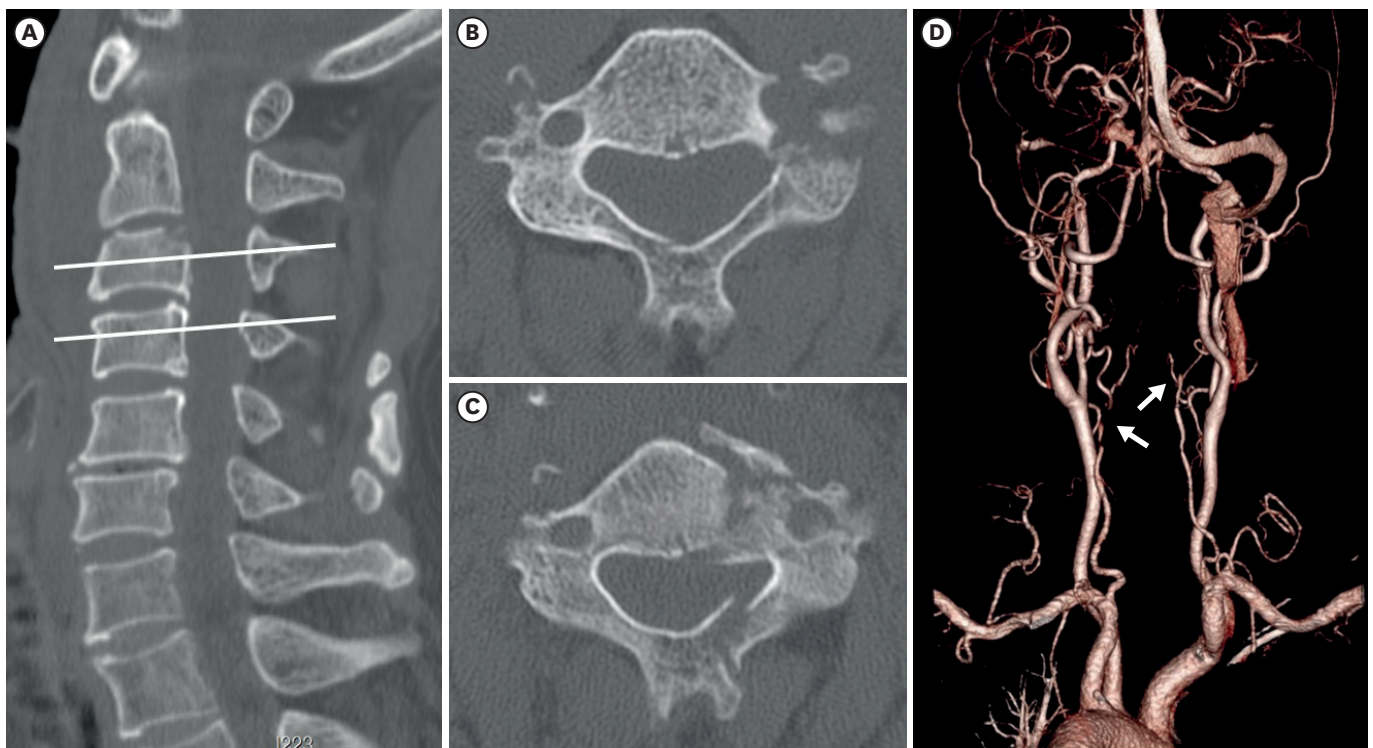


FIGURE 1. Cervical spine computed tomography (A) Sagittal image. (B) Left vertebral body, lamina, and transverse foramen fracture at the C3 level. (C) Left transverse foramen fracture at the C4 level. (D) Cervical spine computed tomography angiography showing occlusion of both vertebral arteries in the V2 segment (foraminal segment) (white arrow).

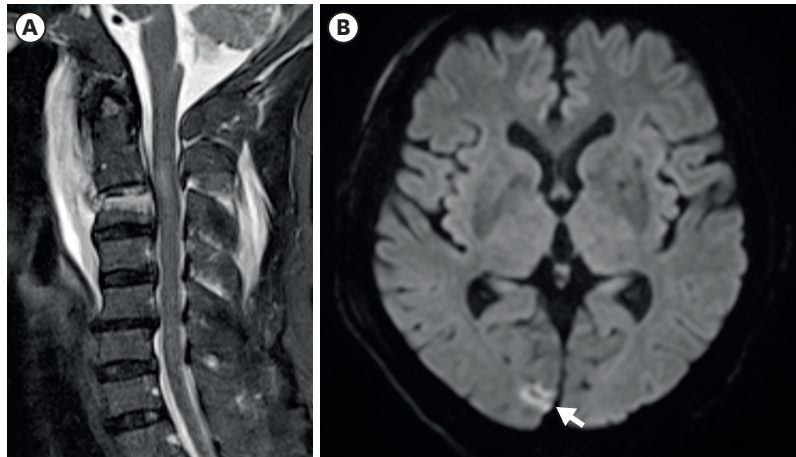


FIGURE 2. (A) A sagittal MRI scan showing hematoma in the anterior vertebral body and posterior ligament injury. (B) MRI showing limited acute infarction (white arrow) in the right occipital area. MRI: magnetic resonance imaging.

Transfemoral cerebral angiography (TFCA) was performed to further investigate circulation because the extent of the infarction was not as severe as expected considering both vertebral arteries were totally occluded. TFCA revealed that collateral circulation was formed at the C2 level vertebral arteries via the deep cervical artery located between the posterior muscles (**FIGURE 3**).

In this case, if surgical treatment was to be performed using the posterior approach, the vertebral artery would likely be seriously injured because collateral circulation would be cut due to dissection and retraction of the posterior muscle. Therefore, cervical fusion at the C2-3-4-5 levels was performed using the anterior approach (**FIGURE 4**). The operation was performed under general anesthesia, and the duration of general anesthesia was 2.5 hours and 2 hours of operation time. And, the blood pressure during surgery was maintained at 120 mmHg/80 mmHg. Antiplatelet agents (aspirin 100 mg, clopidogrel 75 mg) were used to treat infarction and vertebral artery dissection from 3 days after surgery

Early ambulation was achieved and the patient did not develop any further neurological deficits. The patient was followed for 2 years, and the patient had a full recovery and ambulation was possible.

We obtained informed consent from the patient and approval from the Institutional Review Board of our Hospital (approval No. 2022-04-026).

DISCUSSION

The relationship between C-spine fracture and VAI was first reported by Carpenter in 1961.⁶⁾ The foraminal (V2) segment adjacent to the osseous structure is a vulnerable site for VAI, in which C-spine trauma-associated VAI frequently occurs.⁸⁾

The vertebral artery arises from both subclavian arteries and is divided into four segments. The first segment, V1 (extraosseous segment), extends from the origin of the subclavian artery to the transverse foramen of the sixth cervical vertebra. The second segment, V2 (foraminal segment), passes through the transverse foramen from C6 to C1. The third

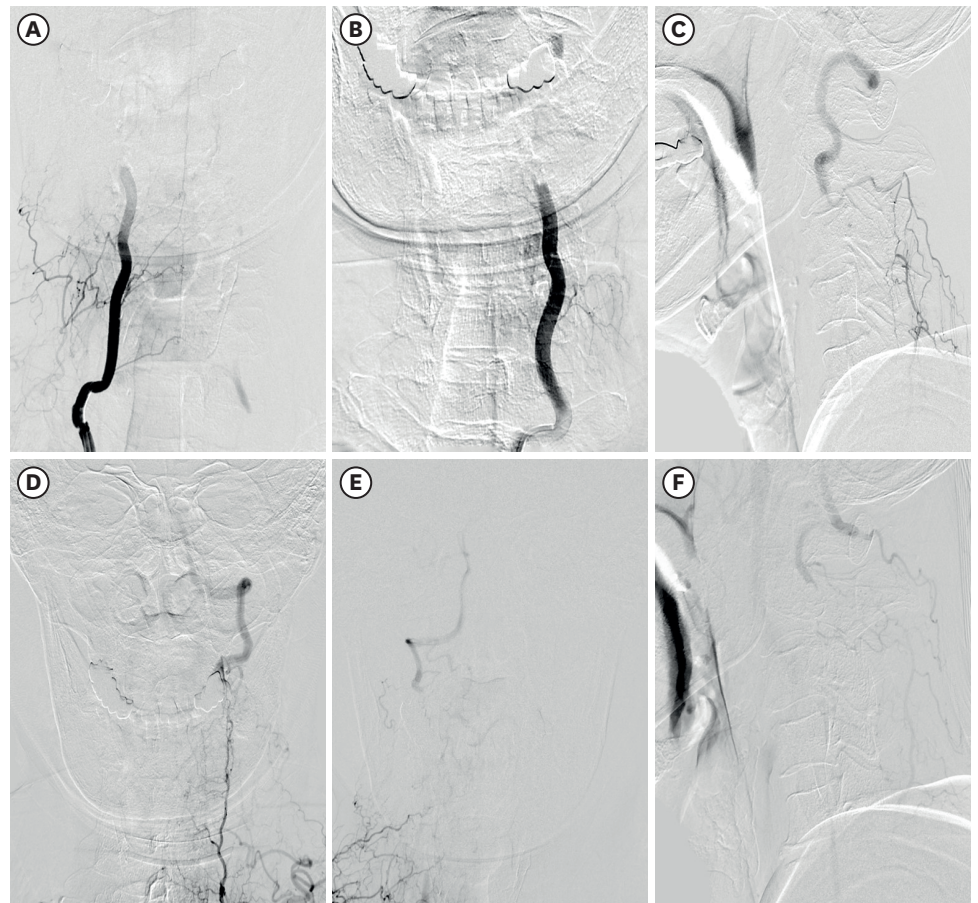


FIGURE 3. Cerebral angiography. (A and B) Total vertebral artery occlusion. (C and D) Collateral circulation from the left deep cervical artery. (E and F) Collateral circulation from the right deep cervical artery.

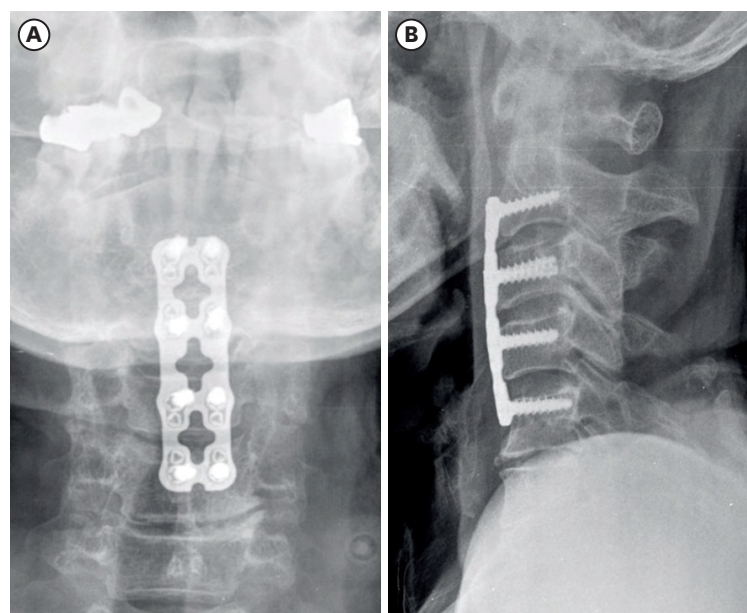


FIGURE 4. C2-3-4-5 anterior cervical fixation. (A) Anterior-posterior radiography. (B) Lateral radiography.

segment, V3 (extraspinal segment), starts at the foramen of C1 and travels posteromedially to the atlas and passes through the dura at the foramen magnum. The bilateral vertebral arteries then merge to form the basilar artery.⁹⁾

It is essential to evaluate for VAI when a cervical spine fracture occurs. Torina et al. retrospectively reviewed MRI angiographies from 632 patients with cervical spine injury revealing that vertebral artery thrombosis was observed in 13% of patients.¹³⁾ Another study prospectively examining patients with C-spine fractures using cerebral angiography reported that 33%–39% of patients had accompanying VAI.^{3,12)} Notably, the risk of VAI varies according to the shape of the cervical spine fracture. *High VAI risk fractures include* those involving the transverse foramen, subluxations, and the upper cervical spine (C1-3).⁸⁾ Vaccaro et al.¹⁴⁾ reported that VAI was observed in 25% of transverse process fractures and 40% of facet dislocations, and Kral et al.¹⁰⁾ reported that VAI was observed in 8% of transverse fractures and 21% of fracture dislocations. Importantly, Miller et al.^{11,12)} reported VAI in 48% of transverse process fractures and 44% of traumatic subluxations. Cothren et al.⁸⁾ reported that VAI was observed in 37% of patients with transverse foramen involvement, subluxation, or upper cervical spine injury, and had an accuracy of 91% when screening using this protocol.

VAI classification can be divided into grades from initial flaps to complete occlusion (**TABLE 1**).²⁾ Grade I includes irregularity of the vessel wall or a dissection/intramural hematoma with less than 25% luminal stenosis. Grade II includes intraluminal thrombus or a visualized raised intimal flap, or dissection/intramural hematoma with $\geq 25\%$ luminal narrowing. Grade III includes pseudoaneurysms, and grade IV is vessel occlusion. Finally, the most severe form, grade V, includes vessel transections or hemodynamically significant arteriovenous fistulas.

VAI can cause a variety of symptoms, including posterior circulation, transient ischemic attack, stroke, vertebral artery thrombosis, and death.⁵⁾ VAI can also present asymptotically. VAI results from vertebral obstruction, which can cause insufficient blood flow to the posterior circulation of the brain (vertebrobasilar insufficiency), thrombus formation at the site of arterial luminal injuries with embolization, obstruction of blood flow into the posterior cerebellar arteries with lateral medullary syndrome infarcts, and anterior spinal artery compromise with consequent spinal cord ischemia.⁹⁾

The incidence of posterior circulation stroke related to VAI has been reported to be 0%–24%. In general, grade I, II, and III arterial injuries increase the likelihood of embolic stroke opposed to occlusion.^{11,12)} In our case with a grade IV occlusion, the probability of an ischemic stroke was higher than that of an embolic stroke. However, the management of VAI remains controversial. Biffel et al.³⁾ recommended anticoagulation therapy for all grades except grade V. Evidently, when serious brain injury, such as an intracranial hemorrhage, accompanies VAI, systemic anticoagulation is an absolute contraindication. However, it has been reported that in the absence of appropriate anticoagulation therapy, the risk of posterior circulation stroke increases by 3-folds and the risk of poor neurologic outcome worsens by 10-folds.

TABLE 1. Cerebrovascular injury grading scale based on angiographic appearance

Grade	Description
I	Irregularity of vessel wall or a dissection/intramural hematoma with <25% luminal stenosis
II	Intraluminal thrombus or visualized raised intimal flap, or dissection/intramural hematoma with $\geq 25\%$ luminal narrowing
III	Pseudoaneurysm
IV	Vessel occlusion
V	Vessel transaction or hemodynamically significant arteriovenous fistula

CONCLUSIONS

In our case, VAI occurred due to C-spine trauma in the form of a cervical transverse foramen fracture and translation. Sufficient examination and cerebral angiography confirmed collateral circulation of both vertebral arteries through the deep cervical artery in the posterior cervical muscle. According to the angiography results, an anterior approach was selected to effectively minimize the patient's risk of further complications, thereby preserving the collateral circulation to the cerebral posterior circulation.

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