JOURNAL OF NEUROSURGERY:
Case Lessons

**J Neurosurg Case Lessons** 5(16): CASE2334, 2023
DOI: 10.3171/CASE2334

# Cervical radiculopathy due to extracranial vertebral artery dissection treated by stent placement with a flow diversion effect: illustrative case

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**BACKGROUND** Cervical radiculopathy due to extracranial vertebral artery dissection (VAD) is extremely rare. The disease is usually treated with conservative treatment because of its favorable prognosis. However, there is a possibility that conservative treatment may bring about no improvement in radiculopathy. Although stent placement with a flow diversion effect may be effective in such cases, there are no reported cases that were treated with stent placement.

**OBSERVATIONS** A 40-year-old healthy man presented with severe right neck pain, right arm pain, and right arm weakness after cracking his neck. A neurological examination revealed right C5 radiculopathy. Neuroimaging studies revealed right extracranial VAD. The VAD compressed the right C5 nerve root. Although medications were administered, there was no improvement in the symptoms. He experienced severe radicular pain. The authors performed stent placement with a flow diversion effect 10 days after the onset of VAD. His radicular pain improved immediately after the procedure, and the remaining radiculopathy completely improved within 1 month. Follow-up angiography showed complete improvement of the VAD.

**LESSONS** Stent placement with a flow diversion effect may be considered when radiculopathy that hinders a patient's daily life exists. Stent placement may bring about rapid improvement in radiculopathy, especially radicular pain.

https://thejns.org/doi/abs/10.3171/CASE2334

**KEYWORDS** extracranial; flow diversion; radiculopathy; stent; vertebral artery dissection

Extracranial vertebral artery dissection (VAD) usually presents with neck and occipital pain.[1,2] Some cases are accompanied by ischemic symptoms in the posterior circulation.[1,2] Extracranial VAD is thus well recognized as an important cause of stroke in young adults.[1–3]

In contrast, cervical radiculopathy caused by extracranial VAD has been rarely reported.[4–19] In most such cases, the prognosis seems to be favorable, as radiculopathy improves within 6 months after conservative treatment. However, persistent severe radicular pain or motor dysfunction may hinder a patient's life until the symptoms improve. In such situations, early stent placement may be effective in improving the symptoms more rapidly than conservative treatment.

Although endovascular treatment, such as stent placement, stent-assisted coil embolization, or parent artery occlusion, is performed for intracranial VAD,[20] there have been no previous reports of treatment with stent placement for extracranial VAD presenting with radiculopathy.

We herein report a case of radiculopathy due to extracranial VAD successfully treated by stent placement with a flow diversion effect.

## Illustrative Case

A 40-year-old healthy man presented to our hospital with severe right neck pain, right arm pain, and right arm weakness after cracking his neck, a habit he practiced. His right arm pain and weakness manifested 2 days after the onset of his neck pian. A neurological examination revealed muscle weakness in the right deltoid (manual muscle test [MMT]: 2/5) and the right biceps (MMT: 2/5) and severe radicular pain in the right C5 area. These findings indicated that the patient had right C5 radiculopathy.

**ABBREVIATIONS** DSA = digital subtraction angiography; LVIS = low-profile visualized intraluminal support; MMT = manual muscle test; MRI = magnetic resonance imaging; VA = vertebral artery; VAD = vertebral artery dissection.

**INCLUDE WHEN CITING** Published April 17, 2023; DOI: 10.3171/CASE2334.
**SUBMITTED** January 19, 2023. **ACCEPTED** February 21, 2023.

Brain magnetic resonance imaging (MRI) showed no abnormality. Cervical magnetic resonance angiography revealed a pearl-and-string sign in the right extracranial vertebral artery (VA), indicating VAD (Fig. 1A). Spinal coronal MRI revealed that the right expanded VA had compressed the right C5 nerve (Fig. 1B and C). The right expanded VA filled the right C5 intervertebral foramen on axial MRI and computed tomography angiography (Fig. 1D and E). Digital subtraction angiography (DSA) revealed right multiple VADs at C4–5 and C5–6 (Fig. 2A and B). The VAD at C4–5 filled the right C5 intervertebral foramen on the oblique view (Fig. 2C). Three-dimensional DSA showed that the true and false lumens were divided by the subintimal flap (Fig. 2D). We therefore diagnosed right C5 radiculopathy due to right extracranial VAD.

Conservative therapy using steroids, pregabalin, adenosine triphosphate disodium trihydrate, and mecobalamin without anticoagulant or antiplatelet medications as well as physiotherapy were started. However, the radiculopathy showed no improvement 1 week after the treatment, and the patient experienced severe radicular pain and inconvenience in his dominant arm. We therefore planned stent placement.

A loading dose of dual antiplatelet medications (300 mg of aspirin and 20 mg of prasugrel) was given orally 1 day before the procedure. The value of the aspirin reaction unit and the P2Y12 reaction unit evaluated by the VerifyNow system (Werfen) showed appropriate platelet inhibition before the procedure. With the patient under general anesthesia and systemic heparinization (5000 units), a 7-Fr sheath was placed in the right femoral artery. A 6-Fr Envoy guiding catheter (Johnson & Johnson) was placed in the right VA. A Headway 21 microcatheter (MicroVention Terumo) was advanced to the distal VA over the VAD using a 0.014-inch micro-guidewire (CHIAKI 14, Asahi Intecc) (Fig. 3A and C). The low-profile visualized intraluminal support (LVIS) device ($5.5 \times 33$ mm, MicroVention Terumo) was then deployed to cover the VADs using the dynamic push-pull technique (Fig. 3E). DSA obtained immediately after the procedure showed a reduction in the expanded VA (Fig. 3B and D).

The patient's clinical course was uneventful. His radicular pain improved 1 day after the procedure. His muscle weakness in the right biceps improved within 1 week, and that in the right deltoid improved within 1 month. Oral intake of aspirin continued for 2 months. DSA performed 2 months after the procedure showed complete improvement of the VADs (Fig. 4).

## Discussion

### Observations

This case demonstrates that early stent placement brings rapid improvement in cervical radiculopathy due to extracranial VAD. This may be the first report of treatment with stent placement for radiculopathy due to extracranial VAD. We selected the LVIS stent. This stent is a novel, self-expandable, braided stent with greater metal coverage (23%) and a smaller cell size (approximately 0.9 mm) than other coil-assist stents.[21,22] Because it is braided, the wires of the LVIS stent can slide over one another and thereby generate a spatially varying mesh density, which can increase the mesh density of the LVIS stent at the aneurysm orifice during deployment using the push-pull technique.[22,23] As a result, the ability to create a flow diversion effect with the LVIS stent is thus anticipated.

Spontaneous cervicocephalic arterial dissection is well known as an important cause of stroke in young adults.[1–3] There are known ethnic differences in the affected arteries, with internal carotid dissection being common in White populations, whereas VAD is more common in Asian populations.[3] Furthermore, the frequency of intracranial VAD has been reported to be up to 3- to 10-fold greater than that of extracranial VAD in Asian populations.[3] The annual incidence of extracranial VAD is reported to be 1 to 1.5 per 100,000.[2] Therefore, extracranial VAD is rare in both White and Asian populations.

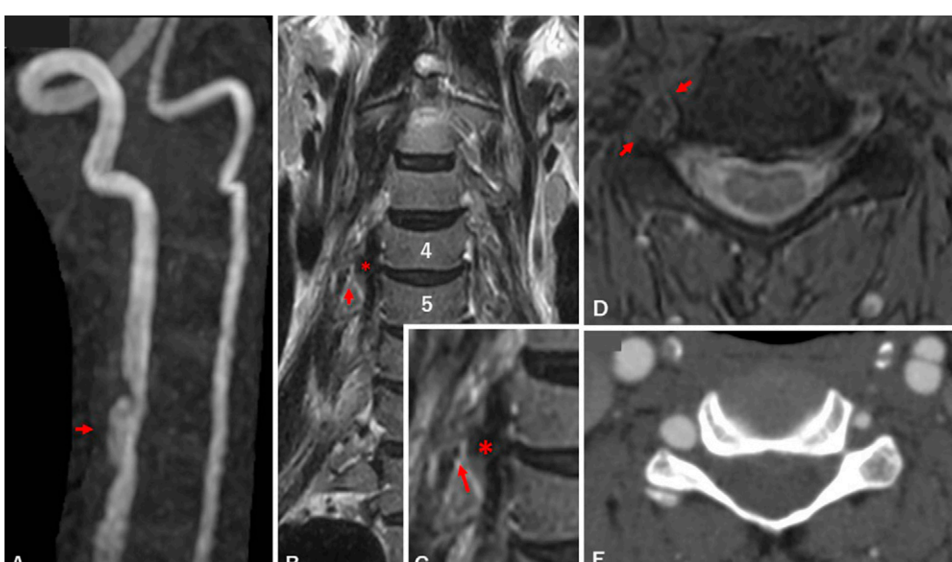


**FIG. 1.** Cervical magnetic resonance angiography (MRA) shows the pearl-and-string sign (*arrow*) in the right VA (**A**). Coronal T2-weighted MRI shows that the expanded VA (*asterisks*) compressed the right C5 nerve root (*arrows*, **B and C**). The expanded VA filled the right C5 intervertebral foramen (*arrows*) on axial T2-weighted MRI (**D**) and computed tomography (CT) angiography (**E**). 4 = C4 vertebral body; 5 = C5 vertebral body.

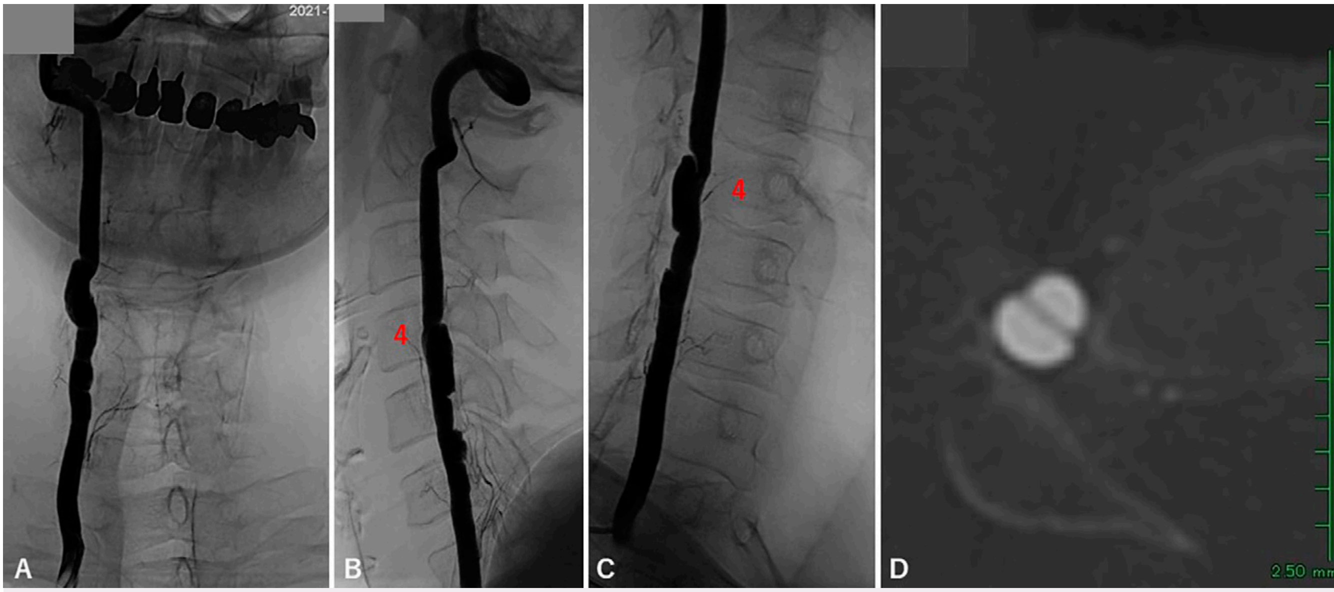


**FIG. 2.** Preoperative angiography shows right multiple VADs at the C4–5 and C5–6 levels (**A:** anteroposterior view; **B:** lateral view; **C:** oblique view). Note that the expanded VA filled the right C5 intervertebral foramen on the oblique view. Three-dimensional angiography showed that the true and false lumens were divided by the subintimal flap (**D**). 4 = C4 vertebral body.

Cervical radiculopathy is a common neurological disorder that results in radiating pain, weakness, and/or numbness caused by compression of any of the nerve roots in the neck.[24] The major cause of cervical radiculopathy is degenerative spondylosis or a herniated disk. Radiculopathy caused by extracranial VAD is very rare. It is reported that 0.5% or 0.9% of extracranial VAD cases show radiculopathy.[1,7] Therefore, it is estimated that the annual incidence of radiculopathy due to extracranial VAD is 0.005 to 0.01 per 100,000.

A total of 20 cases, including our case, have been reported in the literature.[4–19] Patients ranged in age from 15 to 55 years old (mean: 38.5 years; median: 40 years) and were predominantly male (11 men and 8 women). Most of the radiculopathy cases manifested


**FIG. 3.** Intraoperative angiography (**A and B:** anteroposterior view; **C and D:** lateral view). The expanded VA shrank (A and C: before stent placement; B and D: after stent placement). Angiographic cone-beam CT showing precise stent placement (**E**). Note that the stent was deployed to the narrow stent cell at the C4–5 level using the dynamic push-pull technique. 4 = C4 vertebral body.

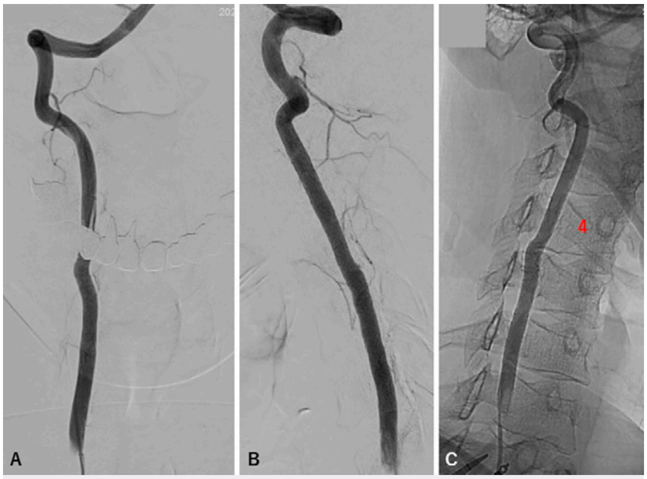


**FIG. 4.** Angiography performed 2 months after the operation showed complete improvement (**A:** anteroposterior view; **B:** lateral view; **C:** oblique view). 4 = C4 vertebral body.

a few days after the onset of neck pain. Polyradiculopathies involving 2 or 3 nerve roots were more frequent than monoradiculopathy (13 poly- and 7 monoradiculopathy) without laterality, and the most commonly affected nerve root was C5. Motor dysfunction tended to be more severe than sensory disturbance. Because the VA ascends adjacent to the ventral (motor) nerve roots, the expanded VA primarily compresses the ventral roots followed by the dorsal (sensory) roots.[10,15] This may be because motor dysfunction is more severe than sensory dysfunction.[10,15] However, the present case showed both severe motor and sensory dysfunction, unlike other reported cases, with our patient experiencing severe pharmaco-resistant radicular pain.

Compression of nerve roots due to an expanded VA or impaired perfusion of the vasa nervorum causing radicular ischemia are the most widely accepted hypotheses to explain radiculopathy secondary to VAD,[4–8] and the former seems to be more strongly supported than the latter. In the present case, we considered compression of the nerve root due to the pulsating mass of the VAD as the cause, since MRI showed that the expanded VA had obviously compressed the C5 nerve root and stent placement with a flow diversion effect rapidly improved the radiculopathy. This may resemble the oculomotor nerve palsy that occurs due to internal carotid artery–posterior communicating artery aneurysm.

According to the literature review (Table 1),[4–19] conservative treatment, such as anticoagulant or antiplatelet medication, was performed in most cases. The aim of therapy seems to be the prevention of secondary ischemic events rather than amelioration of radiculopathy. Only 2 cases were treated by surgical or endovascular treatment. Kunert et al.[17] reported a case treated with anterior surgical decompression of the affected nerve because of severe radicular pain 3 weeks after the onset of VAD. The severe radicular pain improved immediately after the operation. Uemura et al.[10] reported a case treated with endovascular parent artery occlusion because of a persistent expanded VA 6 weeks after the onset of VAD.

Based on our literature review, the prognosis seemed generally favorable, and the symptoms improved within 1 to 6 months. In the present case, the patient showed persistent severe radicular pain

**TABLE 1. Summary of reported cases of cervical radiculopathy caused by extracranial vertebral artery dissection.**

| Case No. | Authors & Year | Age (yrs)/Sex | Involved Roots | Therapy | Prognosis |
|---|---|---|---|---|---|
| 1 | Dubard et al., 1994[4] | 31/F | C4, 5 | None | Improved (1 mo) |
| 2 | | 45/M | C7 | None | Improved (ND) |
| 3 | Hetzel et al., 1996[5] | 32/F | C5, 6 | Anticoagulant medication | Improved (2 mos) |
| 4 | | 40/M | C4, 5, 6 | Anticoagulant medication | Improved (5 mos) |
| 5 | | 28/F | C5, 6 | Anticoagulant medication | Improved (4 mos) |
| 6 | Aggarwal and Burton, 1999[6] | 25/ND | C5 | ND | ND |
| 7 | Crum et al., 2000[7] | 42/M | C5, 6 | None | Improved (3 wks) |
| 8 | Fournier et al., 2000[8] | 30/M | C4, 5 | Anticoagulant medication | Improved (3 mos) |
| 9 | Berroir et al., 2002[9] | 40/M | C5, 6 | Anticoagulant medication | Improved (5 wks) |
| 10 | Uemura et al., 2004[10] | 15/M | C5 | Parent artery occlusion (6 wks*) | Improved (1 mo) |
| 11 | Hardmeier et al., 2007[11] | 52/M | C5 | Antiplatelet medication | Improved (1 mo) |
| 12 | Tabatabai et al., 2008[12] | 51/F | C5, 6 | Anticoagulant medication | Improved (4 mos) |
| 13 | McGillion et al., 2009[13] | 26/F | C4, 5 | Antiplatelet medication | ND |
| 14 | Quinn and Salameh, 2013[14] | 32/M | C5 | ND | ND |
| 15 | Silbert et al., 2013[15] | 43/F | C5, 6 | Antiplatelet medication | Improved (2 mos) |
| 16 | Eberhardt and Topka, 2015[16] | 50/F | C5 | ND | Improved (2 mos) |
| 17 | Kunert et al., 2016[17] | 44/M | C5, 6 | Anterior decompression (3 wks*) | Improved (4 mos) |
| 18 | Llull et al., 2016[18] | 49/M | C5, 6 | Antiplatelet medication | Improved (2 mos) |
| 19 | Noda et al. 2018[19] | 55/F | C5, 6, 7 | Steroids, pregabalin, & mecobalamin | Improved (6 mos) |
| 20 | Present case, 2023 | 40/M | C5 | Stent placement (10 days*) | Improved (1 mo) |

ND = not described.
* The period from the onset of vertebral artery dissection until the procedure was performed.

and motor weakness despite medications. Stent placement was therefore performed. Recently, the efficacy and safety of flow diverter stent treatment for unruptured intracranial VAD have been reported.[25,26] Because we suspected that decreasing flow into the false lumen might lead to decompression of the affected nerve, a stent with a flow diversion effect like the LVIS stent was selected. As a result, the radiculopathy, especially the severe radicular pain, rapidly improved within 1 month. Furthermore, the recovery time in the present case was shorter than in other reported cases.

### Lessons

Radiculopathy due to extracranial VAD is a very rare condition. Conservative therapy should be selected first because of the good prognosis. However, flow diverter stent placement may be considered when radiculopathy hinders the patent's daily life. Stent placement may bring about rapid improvement in radiculopathy, especially radicular pain.

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### Disclosures


The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.


### Author Contributions

Conception and design: H Matsumoto. Acquisition of data: H Matsumoto. Analysis and interpretation of data: H Matsumoto. Drafting of the article: H Matsumoto. Critically revising the article: H Matsumoto, Yamaura, Minami. Reviewed submitted version of the manuscript: H Matsumoto, Miyata, Tomogane, Masuda. Approved the final version of the manuscript on behalf of all authors: H Matsumoto. Administrative/technical/material support: A Matsumoto. Study supervision: Yoshida.

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