## Title

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# Microvascular decompression of a vertebral artery loop causing cervical radiculopathy: illustrative case

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**BACKGROUND** Vertebral artery loops are a rare cause of cervical radiculopathy. Surgical options for nerve root decompression include an anterior or posterior approach, with or without additional microvascular decompression.

**OBSERVATIONS** The authors describe a case of a 49-year-old man with a long-standing history of left-sided neck pain and migraines, who was found to have a vertebral artery loop in the left C3–4 neural foramen compressing the left C4 nerve root. The patient underwent a posterior cervical decompression with instrumented fusion and macrovascular decompression of the left C4 nerve root via Teflon felt insertion. In a literature review, we identified 20 similar cases that had also been managed surgically.

**LESSONS** Although the anterior approach is more frequently described in the literature, a posterior approach for nerve compression by a vertebral artery loop is also a safe and effective treatment. The authors report the third case of this surgical approach with a good outcome.

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**KEYWORDS** microvascular decompression; cervical radiculopathy; vertebral artery loop

An ectatic or tortuous vertebral artery course is a rare cause of cervical radiculopathy.[1–4] These lesions can be congenital or acquired. The natural incidence of vertebral artery loops is estimated to be 1%–5.9%, based on cadaveric studies and retrospective reviews of databases of cervical vessel imaging. It remains unknown how frequently these lesions cause symptomatic compression of the neural elements.[5–7] Symptomatic cases typically present with neck pain, occipitocervical pain, cervical radiculopathy, and, in some cases, vertebrobasilar insufficiency.[2,8,9] Asymptomatic cases can be discovered incidentally on cervical spine imaging after traumatic injury.[8]

First-line therapy with conservative management is unlikely to provide lasting symptom relief. Various surgical options have been described in the literature, including anterior and posterior approaches to the affected level for bony decompression, with or without direct manipulation of the vertebral artery loop away from the affected nerve root using typical techniques for microvascular decompression (MVD).[8,10–14] These approaches also have adapted techniques specific to MVD for trigeminal neuralgia, including Teflon felt and sling transposition.[15–17] Rare cases of vertebral artery transection with end-to-end anastomosis or sacrifice have also been described.[18,19]

## Illustrative Case

A 49-year-old man presented with a decades-long history of left-sided neck pain and migraines, which had acutely worsened over the past few years. The pain was exacerbated by neck extension and head turn to the contralateral side. On physical examination, the patient had full strength in all extremities with a positive Spurling's sign and tenderness to palpation over the left midcervical region. The pain was refractory to several lines of conservative management, including physical therapy and peripheral nerve blocks.

Computed tomography (CT) angiography showed a dominant left vertebral artery with an ectatic vertebral artery loop that coursed

**ABBREVIATIONS** CT = computed tomography; MVD = microvascular decompression.
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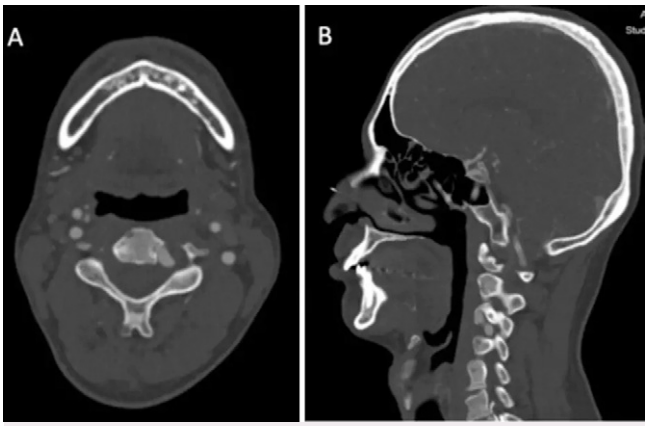


**FIG. 1.** Preoperative axial (**A**) and sagittal (**B**) CT angiography sequences showing a left vertebral artery loop occupying an enlarged left C3–4 neuroforamen.

through the left C3–4 foramen and compressed the anterior aspect of the C4 nerve root (Fig. 1A and B).

The risks and benefits of an anterior versus posterior surgical approach were discussed extensively with the patient prior to surgery. To aid in this discussion, a customized three-dimensional model of the patient's cervical spine was created. On the basis of this model, our surgical team recommended a posterior approach to visualize the affected nerve root before the vertebral artery and minimize direct manipulation of the vertebral artery in our decompression. The patient was counseled that cervical fusion would allow more complete decompression than foraminotomy alone because of the ability to remove the entire facet.

A standard posterior left C3–4 hemilaminectomy, facetectomy, and foraminotomy was performed to visualize the area of neurovascular compression (Video 1). Intraoperative neuronavigation was used to plan a trajectory length and angle that would allow sufficient lateral mass screw purchase after laminectomy. The C4 nerve root was skeletonized from its origin at the thecal sac to the lateral edge of the foramen. A microvascular Doppler probe was used to localize the vertebral artery within the working space. Doppler signals from the vertebral artery could be transduced through the nerve itself. Next, a plane was developed between the nerve root and vertebral artery. The vertebral artery was mobilized inferiorly away from the nerve, and two Teflon pledgets were inserted (Fig. 2). Doppler ultrasound confirmed that arterial signals could no longer be transduced from the nerve. Finally, the posterior fusion was completed at C3–4 with lateral mass screws under navigation, and an autograft was harvested from an iliac crest graft site. A subfascial surgical drain was placed.

**VIDEO 1.** Clip showing MVD of a vertebral artery loop causing cervical radiculopathy via a posterior cervical approach. Click here to view.

Postoperatively, the patient remained neurologically intact on examination. Postoperative radiographic images confirmed that his cervical fusion instrumentation was in good position (Fig. 3). In the immediate postoperative setting, the patient was unable to tell if his neck pain had improved. At the 1-year follow-up, however, the patient reported that his migraines were less frequent and that his neck pain had entirely resolved.

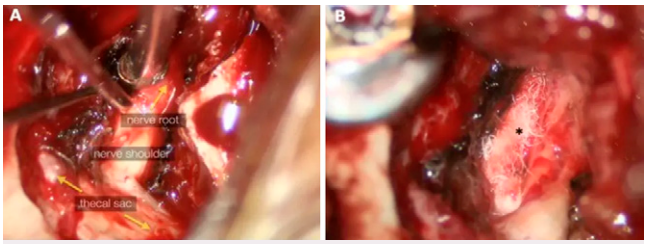


**FIG. 2.** Intraoperative views of the C4 nerve root before (**A**) and after (**B**) MVD involving microdissection of the nerve root away from the vertebral artery and placement of a Teflon interposition graft (*asterisk*).

### Patient Informed Consent

The necessary patient informed consent was obtained in this study.

## Discussion

### Observations

In a review of the literature, we identified 18 articles describing 20 patients who had undergone surgical management for a vertebral artery loop causing cervical radiculopathy between 1970 and 2021 (Table 1). Summary statistics describing the results of our literature review are shown in Table 2.

From our review, we found that most (75.0%) patients were female. The mean age at the time of surgical consultation was 55.4 years (range 27–76 years). Patients typically presented with a yearslong history of poorly controlled symptoms (median 3 years, interquartile range 2–7 months). Common symptoms included occipital pain, cervical radiculopathy, and neck or arm radicular pain.

On physical examination, 7 patients had a completely normal neurological status (35.0%). Neurological findings encountered on examination included hyperreflexia, cervical myelopathy, radiculopathy, and paresthesias that localized to the affected level on neuroimaging.

Neuroimaging obtained for diagnostic work-up and surgical planning included radiographs, CT myelograms, CT angiograms, magnetic resonance imaging of the cervical spine, and catheter

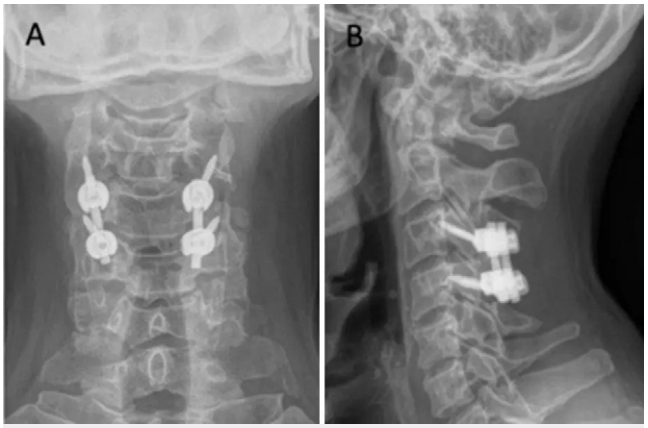


**FIG. 3.** Postoperative anteroposterior (**A**) and lateral (**B**) radiographs of the cervical spine showing posterior instrumentation in good position.

**TABLE 1. Literature review of surgical management for symptomatic cases of vertebral artery loops causing neurovascular compression**

| Authors & Year | Age (yrs), Sex | Presenting Symptoms | Pertinent Exam Findings | Side, Level Affected | Surgical Approach | Outcome at Last FU |
|---|---|---|---|---|---|---|
| Zimmerman & Farrell,1970[13] | 50, F | Lt occipital & cervical pain | None | Lt C4–5 | Pst decompression | Asymptomatic at 10 mos |
| Anderson & Shealy, 1970[14] | 54, F | Migraines, lt neck & facial pain | None | Lt C3–4 | Pst decompression | Asymptomatic at several mos |
| Sharma et al., 1993[23] | 75, F | Occipital neuralgia, cervical myelopathy | Generalized hyperreflexia, spasticity, reduced sensation at/below C2 dermatome | Lt C2–3 | Pst decompression & fusion, MVD w/ Surgicel plug | Improvement in symptoms & exam (some residual spasticity) at 1.5 yrs |
| Satoh et al., 1993[20] | 59, F | Lt neck & arm pain | None | Lt central canal C1 | Suboccipital decompression, C1 laminectomy | Asymptomatic at 2 yrs |
| Duthel et al., 1994[22] | 37, F | Lt shoulder & arm radicular pain, paresthesias | Diminished lt triceps reflex | Lt C5–6 | Anterolat decompression, MVD w/ Teflon | Asymptomatic, normal exam at 3 mos |
| Detwiler et al. 1998[8] | 70, M | Rt neck pain | Rt shoulder girdle muscle atrophy | Rt C3–4 | Pst decompression, MVD | Asymptomatic, normal muscle bulk at 2 yrs |
| Sakaida et al. 2001[19] | 62, M | Lt shoulder & arm radicular pain | Decreased biceps jerk, deltoid weakness, paresthesias | Lt C4–5 | Anterolat decompression, vertebral loop transection w/ end-to-end anastomosis | Asymptomatic, normal exam at 2 yrs |
| Korinth & Mull, 2007[15] | 68, F | Cervical radiculopathy | Decreased biceps jerk, deltoid | Rt C4–5 | Anterolat decompression, MVD w/ Teflon pledget | Asymptomatic, normal exam (FU length not reported) |
| Dahdaleh et al., 2010[12] | 55, M | Presyncope, lt neck & shoulder pain | None | Lt C2–3, C3–4 | Pst cervical fusion w/ o decompression | Asymptomatic at 6 mos |
| Hage et al., 2012[10] | 27, F | Cervical radiculopathy | Rt finger extension weakness | Rt C6–7 | Anterolat decompression, MVD | Asymptomatic, normal exam at 13 mos |
| Chibbaro et al., 2012[1] | 50, F | Cervical radiculopathy | None | Lt C5–6 | Anterolat decompression, MVD | Asymptomatic, normal exam at 1 yr |
| Tandon et al., 2013[17] | 52, F | Neck pain, radicular arm pain | None | Rt C4–5 | Anterolat decompression, MVD w/ sling | Asymptomatic at 1 yr |
| Ekşi et al., 2016[6] | 60, M | Neck pain, lt arm weakness | Lt deltoid & biceps weakness | Lt C5–6 | Pst decompression | Improvement in symptoms, change in neurological exam & FU length not reported |
| Wood et al., 2021[4] | 35, M | Cervical radiculopathy | Decreased sensation in C6–8 dermatomes | Lt C5–6 | Anterolat decompression, MVD w/ Dacron graft | Asymptomatic, persistent weakness on exam, FU length not reported |
|  | 48, F | Lt shoulder pain, cervical radiculopathy | Lt upper-extremity hyperreflexia, positive Spurling's | Lt C3–4, C4–5 | Anterolat decompression, MVD w/ Dacron graft | Asymptomatic, persistent weakness on exam, FU length not reported |
| Wang et al., 2017[2] | 51, F | Cervical radiculopathy | Wrist extensor weakness, reduced sensation | Lt C5–6 | Anterolat decompression, MVD w/ Teflon graft | Asymptomatic, residual numbness at 4 mos |

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**TABLE 1. Literature review of surgical management for symptomatic cases of vertebral artery loops causing neurovascular compression**

| Authors & Year | Age (yrs), Sex | Presenting Symptoms | Pertinent Exam Findings | Side, Level Affected | Surgical Approach | Outcome at Last FU |
|---|---|---|---|---|---|---|
| | 49, F | Lt occiput, neck, biceps pain | Reduced sensation over fingers | Lt C3–4 | Anterolat decompression, MVD | Improved symptoms at 6 mos |
| Venteicher et al., 2019[7] | 72, F | Cervical radiculopathy | Deltoid weakness | Rt C4–5 | Anterolat decompression, MVD w/ pledget | Asymptomatic, normal exam at 1 yr |
| Khansuheb et al., 2020[18] | 62, F | Cervical radiculopathy | None | Lt C6–7 | Endovascular coiling for VA sacrifice | Asymptomatic at 9 mos |
| Farshad et al., 2022[21] | 76, F | Cervical radiculopathy | None | Rt C5–6 | Ant discectomy & fusion, foraminotomy w/ VA manipulation | Asymptomatic at 1 yr; cage subsidence on FU imaging |

ant = anterior; FU = follow-up; pst = posterior; VA = vertebral artery.

angiography of the vertebral artery. These studies showed that the left vertebral artery was most frequently affected (68.4%). Vertebral artery loops were found between C1 and C7. The most frequently affected levels were C4–5 and C5–6 (n = 6, 30% each).

Our findings are consistent with those of other published studies showing left-sided dominance, presentation within the 5th–6th decades of life, and affects to the C4–5 level.[6,7]

**TABLE 2. Summary of presentation, surgical management, and outcomes of 20 cases of vertebral artery loops causing neurovascular compression**

| Characteristic | Value |
|---|---|
| Mean age in yrs | 55.6 |
| Female sex | 15 (75.0%) |
| Median duration of symptoms in yrs (IQR) | 3 (2–7) |
| Lt VA affected | 14 (70.0%) |
| Level affected | |
| C1 | 1 (5.0%) |
| C2–3 | 2 (10.0%) |
| C3–4 | 5 (25.0%) |
| C4–5 | 6 (30.0%) |
| C5–6 | 6 (30.0%) |
| C6–7 | 2 (10.0%) |
| Surgical management | |
| Ant approach plus MVD | 11 (55.0%) |
| Pst approach | 4 (20.0%) |
| Pst approach plus MVD | 2 (10.0%) |
| VA sacrifice | 2 (10.0%) |
| Suboccipital craniotomy, partial C1 laminectomy | 1 (5.0%) |
| Status of presenting symptoms, neurological deficits at last FU | |
| Total resolution | 14 (70.0%) |
| Partial resolution | 6 (30.0%) |
| No improvement | 0 (0%) |

FU = follow-up; IQR = interquartile range; VA = vertebral artery.

In the literature, 9 patients (45.0%) had documented failure of conservative management. Attempted conservative therapies included anti-inflammatories, epidural steroid injections, suprascapular nerve block, acupuncture, trigger point injections, and physical therapy.[2,4,7,8,15,17,18,20] Three patients (15.0%) had undergone previous surgeries without resolution of symptoms. These surgeries included anterior cervical discectomy and fusion, multiple shoulder surgeries, and posterior cervical foraminotomy.[1,4,7]

From our literature review, we found that the majority (n = 11, 55.0%) of patients underwent an anterior approach for bony decompression and MVD.[1,2,4,7,10,15,17,19–23] In terms of the MVD technique, 6 of these cases used an interposition graft (Teflon or Dacron), and 1 used an allograft sling; in 4 cases, the artery was transpositioned via microdissection alone. Only 1 case underwent additional anterior discectomy and fusion. Seven patients (35.0%) underwent a posterior cervical decompression and fusion procedure, and only 2 underwent concurrent MVD.[6,8,12–14,22] In 1 case, the artery was dissected away from the nerve. In the second case, a Surgicel plug was placed between the artery and nerve. In the second case, a suboccipital decompression and partial C1 laminectomy was performed for central stenosis caused by an ectatic left vertebral artery.

In rare instances, patients underwent a procedure to either excise the vertebral artery loop entirely or to sacrifice the affected artery (n = 2, 10.0%).[18,19] In each case, a balloon occlusion test was performed beforehand to estimate the safety of vertebral artery temporary occlusion or sacrifice.

Our illustrative case is the third case reported using a posterior approach with MVD. A posterior approach is more likely to require cervical fusion but decompresses the nerve root directly. Advantages of the anterior approach include direct visualization of the vertebral artery anterior to the nerve. The risk of vascular injury from direct manipulation of the vertebral artery versus the risk of nerve root injury by more direct manipulation of the nerve root depends on the surgeon's expertise and comfort.

All 20 patients identified in the literature tolerated surgery well, with good outcomes in terms of symptom resolution. The median follow-up time after surgical intervention was 12 months (interquartile range 7.5–15.5 months). At the last follow-up, 14 patients (70.0%) had total resolution of all symptoms and physical examination

findings, whereas 6 (30.0%) had partial resolution. Among 20 procedures, the only noted complication was cage subsidence in the patient undergoing anterior decompression, MVD, and discectomy with fusion at the affected level.[20] In this case, the patent remained asymptomatic, so no reoperation was performed.

### Lessons

An ectatic vertebral artery loop is an uncommon cause of cervical radiculopathy but should be considered in the differential diagnosis. An updated literature review of symptomatic cases showed a predominance in women, in the left vertebral artery, and at the C4–5 and C5–6 levels. Surgical management typically involves an anterior or posterior approach to the site of neurovascular compression, with or without MVD.

Although the anterior approach is more frequently described, a posterior approach can also be efficacious. Each case should be addressed according to the surgeon's comfort, the patient's preference, and relevant anatomy.

## References


1. Chibbaro S, Mirone G, Yasuda M, Marsella M, Di Emidio P, George B. Vertebral artery loop—a cause of cervical radiculopathy. *World Neurosurg.* 2012;78(3-4):375.e11–375.e13.
2. Wang DD, Burkhardt JK, Magill ST, Lawton MT. Anterior transposition of anomalous tortuous vertebral artery causing cervical radiculopathy: a report of 2 cases and review of literature. *World Neurosurg.* 2017;101:289–295.
3. Tonsbeek AM, Groen JL, Vleggeert-Lankamp CLAM. Surgical interventions for cervical radiculopathy caused by a vertebral artery loop: a case report and review of the literature. *World Neurosurg.* 2020;135:28–34.
4. Wood L, Czyz M, Forster S, Boszczyk BM. The diagnosis and management of a vertebral artery loop causing cervical radiculopathy. *Eur Spine J.* 2021;30(12):1–6.
5. Curylo LJ, Mason HC, Bohlman HH, Yoo JU. Tortuous course of the vertebral artery and anterior cervical decompression: a cadaveric and clinical case study. *Spine (Phila Pa 1976).* 2000;25(22): 2860–2864.
6. Ekşi MS, Toktaş ZO, Yõlmaz B, et al. Vertebral artery loops in surgical perspective. *Eur Spine J.* 2016;25(12):4171–4180.
7. Venteicher AS, Quddusi A, Coumans JV. Anterolateral approach for a cervical nerve root compression syndrome due to an ectatic vertebral artery. *Oper Neurosurg (Hagerstown).* 2019;17(1):E29–E32.
8. Detwiler PW, Porter RW, Harrington TR, Sonntag VK, Spetzler RF. Vascular decompression of a vertebral artery loop producing cervical radiculopathy. Case report. *J Neurosurg.* 1998;89(3):485–488.
9. Paksoy Y, Levendoglu FD, Ogün CO, Ustün ME, Ogün TC. Vertebral artery loop formation: a frequent cause of cervicobrachial pain. *Spine (Phila Pa 1976).* 2003;28(11):1183–1188.
10. Hage ZA, Amin-Hanjani S, Wen D, Charbel FT. Surgical management of cervical radiculopathy caused by redundant vertebral artery loop. *J Neurosurg Spine.* 2012;17(4):337–341.
11. Bruneau M, Cornelius JF, George B. Microsurgical cervical nerve root decompression by anterolateral approach. *Neurosurgery.* 2006;58(1 suppl):ONS108–ONS113.
12. Dahdaleh NS, Albert GW, Hasan DM. Multiple symptomatic vertebral artery loops treated with posterior cervical fusion. *J Clin Neurosci.* 2010;17(6):788–790.
13. Zimmerman HB, Farrell WJ. Cervical vertebral erosion caused by vertebral artery tortuosity. *Am J Roentgenol Radium Ther Nucl Med.* 1970;108(4):767–770.
14. Anderson RE, Shealy CN. Cervical pedicle erosion and rootlet compression caused by a tortuous vertebral artery. *Radiology.* 1970; 96(3):537–538.
15. Korinth MC, Mull M. Vertebral artery loop causing cervical radiculopathy. *Surg Neurol.* 2007;67(2):172–173.
16. Ju CI, Kim JM, Kim JG, Kim SW, Lee SM. A new sling technique in cervical radiculopathy caused by vertebral artery loop compression. *World Neurosurg.* 2017;104:1049.e11–1049.e15.
17. Tandon A, Chandela S, Langer D, Sen C. A novel sling technique for microvascular decompression of a rare anomalous vertebral artery causing cervical radiculopathy. *Neurosurg Focus.* 2013; 35(3):E2.
18. Khansuheb MZ, Kouznetsov E, Manchak M, Durrani Q, Drofa A. Vertebral artery sacrifice: novel strategy in treatment of vertebral artery loop. *World Neurosurg.* 2020;134:280–283.
19. Sakaida H, Okada M, Yamamoto A. Vascular reconstruction of a vertebral artery loop causing cervical radiculopathy and vertebrobasilar insufficiency. Case report. *J Neurosurg.* 2001;94(1 suppl): 145–149.
20. Satoh S, Yamamoto N, Kitagawa Y, Umemori T, Sasaki T, Iida T. Cervical cord compression by the anomalous vertebral artery presenting with neuralgic pain report. *J Neurosurg.* 1993;79(2):283–5.
21. Farshad M, Spirig JM, Burkhard MD. Anterior artery release, distraction and fusion (ARDF) for radiculopathy caused by a vertebral artery loop. *Eur Spine J.* 2022;31(12):3696–3702.
22. Duthel R, Tudor C, Motuo-Fotso MJ, Brunon J. Cervical root compression by a loop of the vertebral artery: case report. *Neurosurgery.* 1994;35(1):140–142.
23. Sharma RR, Parekh HC, Prabhu S, Gurusinghe NT, Bertolis G. Compression of the C-2 root by a rare anomalous ectatic vertebral artery. Case report. *J Neurosurg.* 1993;78(4):669–672.


### Disclosures

Dr. Chou reported personal fees from Globus and Orthofix outside the submitted work.

### Author Contributions

Conception and design: Abla, Semonche. Acquisition of data: Abla, Semonche, Matles, Chou, Chang. Analysis and interpretation of data: Abla, Semonche, Rinaldo, Lee, Chang. Drafting the article: Abla, Semonche, Rinaldo, Chang. Critically revising the article: Abla, Semonche, Rinaldo, Lee, Matles, Chou, Chang. Reviewed submitted version of manuscript: Abla, Semonche, Rinaldo, Lee, Chang. Approved the final version of the manuscript on behalf of all authors: Abla. Statistical analysis: Semonche. Administrative/technical/material support: Abla, Semonche, Dubnicoff. Study supervision: Abla, Semonche, Chang. Patient care: Matles.

### Supplemental Information

Videos

*Video 1.* https://vimeo.com/901908520.

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