Symptomatic Vertebral Artery Loop: A case report and review of literature

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ABSTRACT

Vertebral artery loop formation is a rare anatomical variant capable of causing bony erosion, encroachment on cervical neural foramen, neurovascular compression, or vertebrobasilar insufficiency. Health professionals should keep the diagnosis of vertebral artery loop formation in mind, especially when the plain radiograph of the cervical spine shows enlargement of the intervertebral foramen. If overlooked, serious complications like vertebral artery injury may occur during surgery or vertebrobasilar angiography, as well as cerebrovascular stroke during transforaminal cervical epidural steroid injections. This case report aims at increasing the awareness of both clinicians and radiologists of this entity as a known rare cause of cervical radiculopathy. In suspected cases, Magnetic resonance imaging & Magnetic resonance angiography should always be the first choice in this regard.

CASE REPORT

CASE REPORT

A 70-year-old woman presented with neck pain radiating to her left upper limb, and numbness for 1 year, was referred to our hospital with the diagnosis of cervical neural sheath tumor, based on computed tomography (CT) scan, for possible resection. On clinical examination, no neurologic deficit was revealed. There was no history of hypertension or trauma.

CT showed widening of the left C5-6 intervertebral foramen and erosion of the adjacent bony structures (Fig. 1). T1 and T2-weighted axial, coronal and sagittal magnetic resonance (MR) images showed that the previously reported suspected neural sheath tumor was a signal-void vascular structure in the left C5-6 neural foramen compressing the left C6 nerve root. Another smaller vascular structure was also seen within the right C4-5 neural foramen (Fig. 2, 3, 4, 5). Magnetic resonance angiography (MRA) confirmed that both structures were representing vertebral artery loop formation (VALF) migrated into neural foramina at both levels (Fig. 6). The patient also had some spondylotic changes.

Her symptoms were resolved after conservative treatment.

DISCUSSION

Etiology and Demographics

Vertebral artery loop formation (VALF) is a rare anatomical variant capable of causing bony erosion, encroachment on cervical neural foramen, neurovascular compression, or vertebrobasilar insufficiency [1]. This case report aims at increasing the awareness of both clinicians and radiologists of this entity as a known rare cause of cervical radiculopathy. In suspected cases, magnetic resonance

angiography (MRA) is very helpful in visualization and diagnosis of VALF [1,2].

Hadley [3] was the first to describe VALF related bony erosions of cervical vertebrae in four out of 21 cadavers. Among 173 patients presented with symptoms of cervicobrachial pain, Paksoy et al. [4] reported an incidence of VALF of 7.51%.

The cause of VALF development is not clear. Oga et al. [5] reported that VALF develops in association with cervical spondylotic changes. Later, Sakaida et al. [6] suggested that narrowing of the disc space can cause elongation of the vertebral artery (VA), leading to VALF. Hemodynamic conditions such as hypertension and atherosclerosis were hypothesized as other possible causes [6,7]. Some other authors who reported cases suggested that cervical trauma might be a cause of VALF [8,9].

Among the VALF anomalies reported in literature (50 anomalies in 40 symptomatic patients), the symptomatic cervical levels involved were 10 at C3-4 , 16 at C4-5, 10 at C5-6, 8 at C6-7, and only 3 at C1-2 and 3 at C2-3. The lesions were uncommonly multiple (in 7 patients), and rarely bilateral (in 3 patients) [1].

Clinical and Imaging Findings

Vertebral artery loop formation (VALF) is one of the uncommon causes which can compress the cervical nerve root causing cervical radiculopathy. Other infrequent causes of radiculopathy include congenital, cystic, vascular and neoplastic conditions [1].

Our patient was referred to us with the diagnosis of cervical neural sheath tumor, based on CT scan. This common misdiagnosis was stated by Duthel et al. [10] and Ganiyusufoglu et al. [11] who certained that CT may show VALF as a contrast enhancing mass widening the intervertebral foramen. In our patient, this misdiagnosis could have led to a possible VA injury during surgery.

Although multislice computed tomographic Angiography (CTA) and conventional angiography can be useful in evaluating VALF; it is our opinion that Magnetic resonance imaging (MRI) & Magnetic resonance angiography (MRA), as non-invasive, non-contrast and non-ionizing radiation based procedures, are considered very useful diagnostic tools [1], and should always be the first choice in this regard. The classic diagnostic criteria go in hand with Epstein et al. [2] description of this pathological entity as they mentioned that VALF or other vascular malformations are displayed as signal void tubular structures on MRI, which necessitates MRA to differentiate these vascular lesions. If overlooked, serious complications like vertebral artery (VA) injury may occur during surgery or vertebrobasilar angiography, as well as cerebrovascular stroke during transforaminal cervical epidural steroid injections[1,12].

Treatment and Prognosis

Surgical procedures reported in the literature for VALF treatment include microvascular decompression, foraminotomy with sectioning of the compressed rootlet and vascular reconstruction. Although surgical treatment is an effective treatment option, several reported cases were successfully treated conservatively [1].

Differential Diagnoses

The differential diagnosis of VALF may include benign peripheral nerve sheath tumor, congenital absence / hypoplasia of pedicle, dural ectasia (like in Marfan syndrome, Ehlers-Danlos, or Neurofibromatosis), intra-spinal neoplasm, meningocele / arachnoid cyst and metastatic destruction of pedicle, as all may show widened neural exit foramen on radiographs. Although one may not be able to limit the diagnostic possibilities depending on radiographs alone, CT and MRI / MRA are capable of providing the necessary information for making the diagnosis with high confidence. Analyzing the pattern of vertebral bone deformity and the pattern of contrast enhancement can easily lead to the correct diagnosis in the vast majority of cases. Benign peripheral nerve sheath tumor typically appears as low CT density dumbbell shaped mass in typical nerve distribution, isointense to muscles on T1 WI, slightly hyperintense to fat on T2 WI, and shows uniform contrast enhancement on both CT and MRI. Congenital absence / hypoplasia of pedicle and dural ectasia both have characteristic appearances on CT scans and do not show solid or cystic masses on MRI. Dural ectasia is usually associated with posterior vertebral scalloping. Intra-spinal neoplasm may show bone erosion, yet with intra-spinal canal abnormal density / intensity mass lesion on CT and MRI respectively. Metastatic destruction of a pedicle may widen the exit neural foramen, but must show an abnormal lytic pedicle lesion on CT, abnormal pedicle signal intensity and possibly abnormal signal intensity extra-dural mass lesion on MRI images. Arachnoid cysts / diverticula are likely to widen the interpedicular distance and present as fluid like density / intensity extra-medullary cystic lesions in intra-spinal canal location, possibly with extension into neural canals on CT/ MRI images respectively[13].

TEACHING POINT

Although VALF (Vertebral Artery Loop Formation) is a rare cause of cervical radiculopathy, clinicians should keep this diagnosis in mind, especially when the plain radiograph or the CT scan of the cervical spine shows enlargement of the intervertebral foramen. If suspected, MRI / MRA can confirm the diagnosis if they show signal void / vascular structure within the widened foramen. If overlooked, serious complications like vertebral artery (VA) injury may occur during surgery or vertebrobasilar angiography, as well as cerebrovascular stroke during transforaminal cervical epidural steroid injections.

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FIGURES

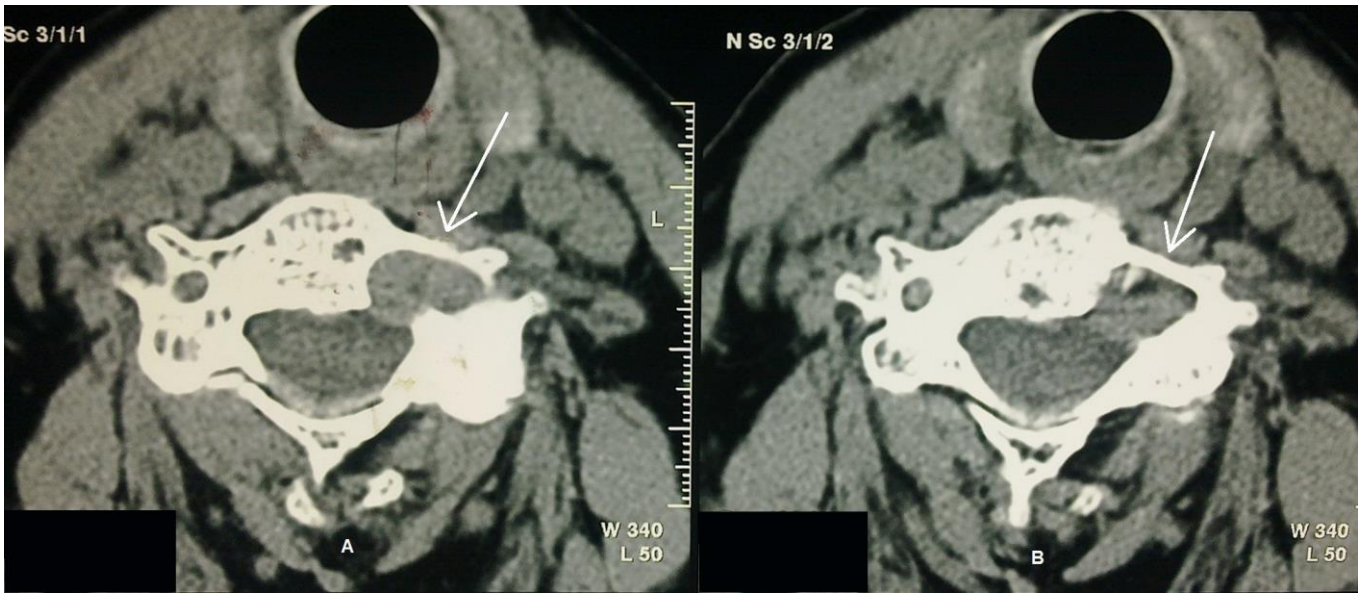

Figure 1: A 70-year-old woman with Vertebral Artery Loop Formation. Axial non contrast CT scan of the cervical spine obtained at the level C5-6 shows soft tissue density within the widened left intervertebral foramen and erosion of the adjacent bony structures (arrows in A and B). (Protocol: Philips Brilliance 16 multislice, KV 140, mA range 280-715, slice thickness 1.25 mm)

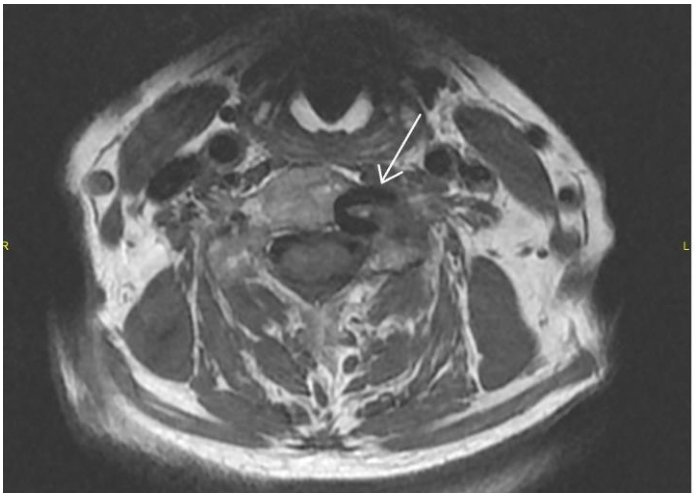

Figure 2 (left): A 70-year-old woman with Vertebral Artery Loop Formation. T1-weighted axial magnetic resonance image without contrast shows a signal-void vascular structure in the widened left C5-6 intervertebral foramen (arrow). (Protocol: GE Signa HD 1.5 T, TE 19 ms, TR 500 ms)

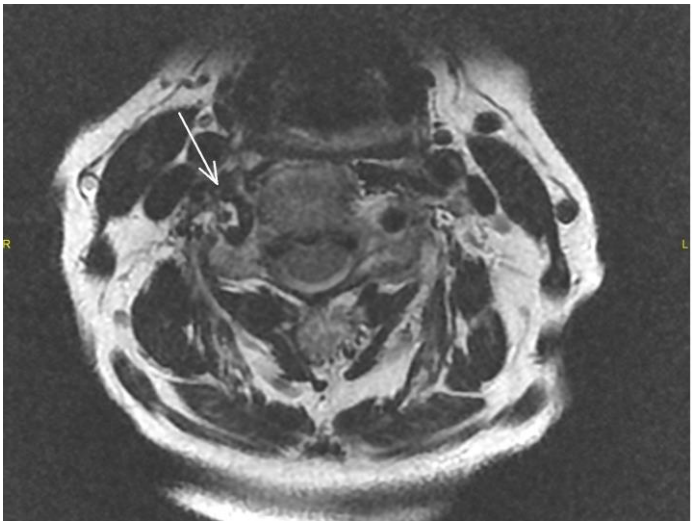

Figure 3 (left): A 70-year-old woman with Vertebral Artery Loop Formation. T2-weighted axial magnetic resonance image without contrast shows a signal-void vascular structure in the right C4-5 intervertebral foramen (arrow). (Protocol: GE Signa HD 1.5 T, TE 107 ms, TR 3820 ms)

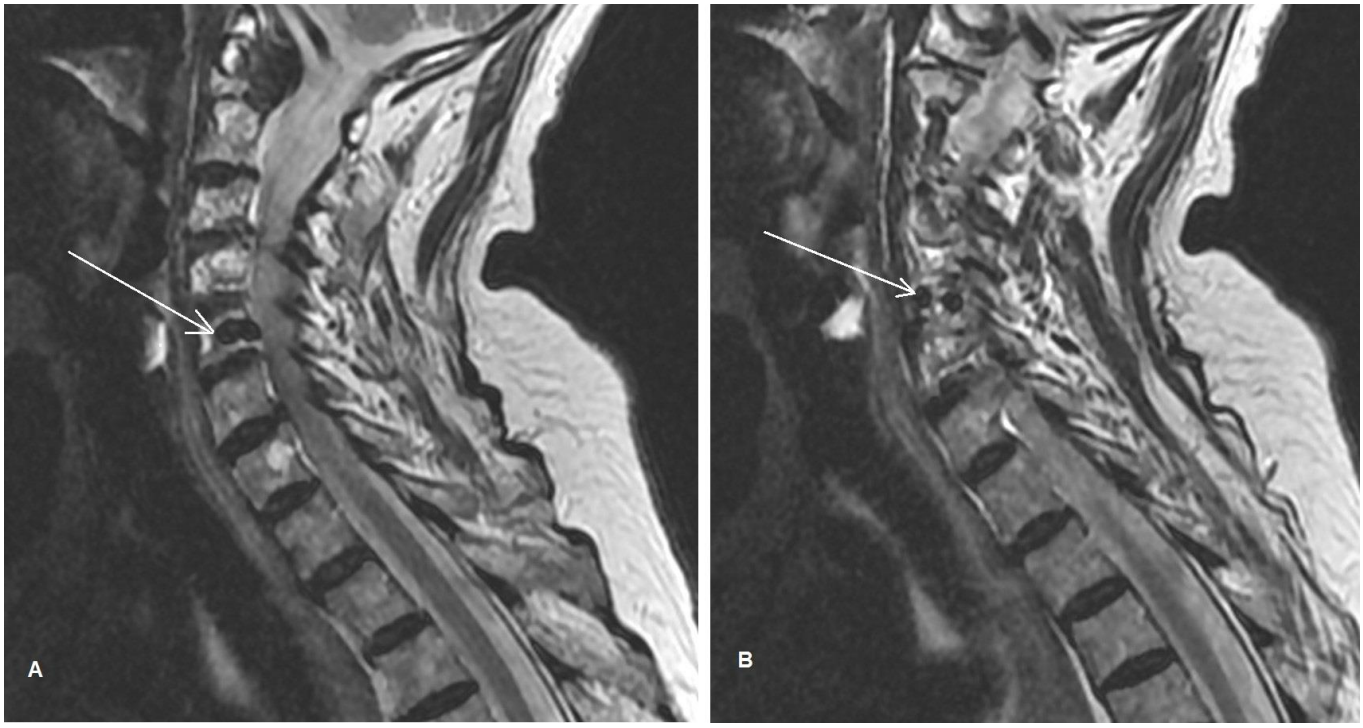

Figure 4: A 70-year-old woman with Vertebral Artery Loop Formation. T2-weighted sagittal magnetic resonance images without contrast show a signal-void vascular structure in the widened left C5-6 intervertebral foramen (arrows in A and B). (Protocol: GE Signa HD 1.5 T, TE 107 ms, TR 3820 ms)

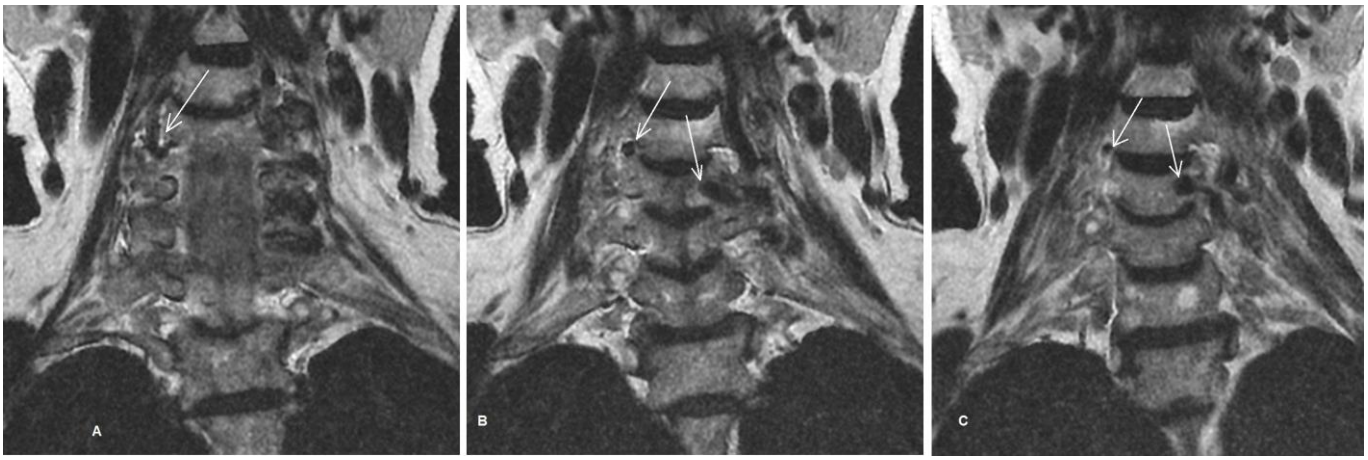

Figure 5: A 70-year-old woman with Vertebral Artery Loop Formation. T2-weighted coronal magnetic resonance images without contrast show a signal-void vascular structure in the left C5-6 intervertebral foramen (arrows in B and C), and another similar structure in the right C4-5 intervertebral foramen (arrows in A and B). (Protocol: GE Signa HD 1.5 T, TE 107 ms, TR 3820 ms)

Figure 6 (left): A 70-year-old woman with Vertebral Artery Loop Formation. Three Dimension Time Of Flight Magnetic Resonance Angiography without contrast (3D TOF MRA) with Maximum Intensity Projection (MIP) reconstruction shows bilateral vertebral artery loop formation (VALF) in C5-6 left intervertebral foramen and C4-5 right intervertebral foramen (arrows). (Protocol: GE Signa HD 1.5 T, TE 2.8 ms, TR 23 ms, FA 25, NEX =1)

Etiology	Not certainly known. Suggested etiologies are: congenital, traumatic, degenerative disc disease, and haemodynamic (hypertensive) causes.
Incidence	7.5 % of patients presented with cervicobrachial pain according to one study.
Gender ratio	No known significant male or female predominance.
Age predilection	Symptomatic Vertebral Artery Loop Formation mainly affects adults.
Risk factors	No known risk factors.
Treatment	Conservative, and surgical (microvascular decompression, foraminotomy with sectioning of the compressed rootlet and vascular reconstruction) options were reported.
Prognosis	Cervicobrachial pain, vertebrobasilar insufficiency
Findings on imaging	• Radiographs: widened neural foramen. • Computed Tomography: widened neural exit foramen, soft tissue density within wide foramen, with contrast enhancement on post IV contrast images. • Magnetic Resonance Imaging: signal void tubular structure within widened neural foramen on T1WI and T2WI. Vertebral artery loop within widened neural foramen is revealed on Magnetic Resonance Angiography (MRA).

Table 1: Summary table for Vertebral Artery Loop Formation

	Radiographs	Computed Tomography	Magnetic Resonance Imaging
Vertebral artery Loop Formation	Widened neural foramen	Widened neural exit foramen, soft tissue density within wide foramen, with contrast enhancement on post IV contrast images	Signal void tubular structure within widened neural foramen on T1WI and T2WI. Vertebral artery loop within widened neural foramen is revealed on Magnetic Resonance Angiography (MRA)
Benign peripheral nerve sheath tumor	•Widened neural foramen	•Widened neural foramen •Low density mass in typical nerve distribution	•Intradural and /or extradural mass extending into wide neural foramen •Dumbbell shaped mass •Mass is isointense to muscles on T1 WI, slightly hyperintense to fat on T2 WI •May show iso- to hypointense center (target sign) on T2 WI in neurofibromatosis •Uniform enhancement of the lesion
Congenital absence/ hypoplasia of pedicle	•Widened neural foramen	•Widened neural foramen •Pedicle absent or hypoplastic	•Widened neural foramen •Pedicle absent or hypoplastic •No solid or cystic mass lesion
Dural ectasia (Marfan syndrome, Ehlers-Danlos, Neurofibromatosis)	•Widened neural foramina •Wide interpedicular distances •Posterior vertebral scalloping •+/- Atlanto-axial translation (in Marfan)	•Widened neural foramina •Wide interpedicular distances •Posterior vertebral scalloping •+/- Atlanto-axial translation (in Marfan)	•Widened dural sac +/- nerve root sleeves
Intraspinal neoplasm	•Wide interpedicular distance/ bone erosion •+/- Widened neural foramen	•Wide interpedicular distance/ bone erosion •+/- Widened neural foramen •Intra spinal canal abnormal density mass lesion	•Abnormal intensity intra spinal canal mass lesion •Variable patterns of Gadolinium enhancement according to its type
Metastatic destruction of pedicle	•Lytic bone lesion affecting pedicle +/- vertebral body •+/- Widened neural foramen	•Lytic bone lesion affecting pedicle +/- vertebral body •+/- Widened neural foramen •+/- Abnormal density mass lesion	•Abnormal pedicle signal intensity on T1 and T2 WI. •+/- Widened neural foramen •+/- Abnormal intensity extradural mass lesion
Arachnoid cyst/ arachnoid diverticulum	•Widened interpedicular distance/ bone erosion •+/- Widened neural foramen	•Widened interpedicular distance/ bone erosion •+/- Widened neural foramen •Hypodense intra +/- extra spinal canal cyst	•Cerebrospinal fluid (CSF) like cystic lesion in extramedullary location •Intra-spinal canal +/- extend within neural canal •Displaced/ compressed spinal cord

Table 2: Differential diagnoses table for Vertebral Artery Loop Formation.

ABBREVIATIONS

CT = Computed Tomography
CTA = Computed Tomographic Angiography
FA = Flip Angle
IV = Intravenous
MRA = Magnetic Resonance Angiography
MRI = Magnetic Resonance Imaging
NEX = Number of Excitations
T = Tesla
TE = Time to Echo
TR = Repetition Time
VALF = Vertebral Artery Loop Formation
WI = Weighted Image

KEYWORDS

Vertebral artery loop formation; magnetic resonance angiography; cervical radiculopathy; neurovascular compression