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Case Report

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Posterior Inferior Cerebellar Artery Infarction Originating at C1-2 after C1-2 Fusion

Donghyun Won [1], **Ja Myoung Lee** [1], **In Sung Park** [1], **Chul Hee Lee** [1], **Kwangho Lee** [1], **Ji-yoon Kim** [2], **and Young Seok Lee** [1]

[1]Department of Neurosurgery, Gyeongsang National University School of Medicine, Jinju, Korea
[2]Department of Anesthesiology and Pain Medicine, Gyeongsang National University School of Medicine, Jinju, Korea

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Address for correspondence:
Young Seok Lee
Department of Neurosurgery, Gyeongsang National University Hospital, 79 Gangnam-ro, Jinju 52727, Korea.
E-mail: leeys1026@hanmail.net

ORCID iDs
Donghyun Won
https://orcid.org/0000-0001-6155-9551
Ja Myoung Lee
https://orcid.org/0000-0002-6041-8455
In Sung Park
https://orcid.org/0000-0002-8084-8401
Chul Hee Lee
https://orcid.org/0000-0001-8024-4192
Kwangho Lee
https://orcid.org/0000-0001-8366-0669
Ji-yoon Kim
https://orcid.org/0000-0001-7998-8936
Young Seok Lee
https://orcid.org/0000-0002-6881-812X

Conflict of Interest
The authors have no financial conflicts of interest.

ABSTRACT

Vertebral artery injuries associated with C1 lateral mass screw insertion rarely occur during C1-2 fusion. The posterior inferior cerebellar artery (PICA) is uncommonly located at the C1 lateral mass insertion position. A 71-year-old woman with atlanto-axial subluxation and cord compression underwent C1-2 fusion. Sixth nerve palsy and diplopia were detected postoperatively, and decreased consciousness occurred on postoperative day 4. Brain magnetic resonance image (MRI) and computed tomography (CT) revealed PICA infarction. In the preoperative CT angiography, the PICA originated between the C1 and C2 level. In the postoperative CT scan, the PICA was not visible. The patient was treated conservatively for two weeks and recovered. PICA originating between the C1 and C2 level comprises 1.1–1.3% of cases. Therefore, vertebral artery anomalies should be evaluated prior to C1-2 fusion to prevent vessel injuries.

Keywords: Atlanto-axial fusion; Brain infarction; Vertebral artery; Posterior inferior cerebellar artery

INTRODUCTION

A vertebral artery (VA) injury is a serious complication that can occur during upper cervical spine surgery and lead to brain infarction, which may cause neurologic deficit or death.[1-3,15] The VA injury rate in cervical spine surgery is reportedly 0.07–1.4%[7-9,12,14] The VA is divided into four segments where C1-2 is included in the V3 segment and occasionally shows anatomical variants and causes congenital or acquired osseous lesions.[18] Computed tomography (CT) or magnetic resonance angiography (MRA) should be performed preoperatively to screen for vessel variations and prevent perioperative VA injury.

The posterior inferior cerebellar artery (PICA) originates intracranially from the first branch originating in the VA.[17] The extracranial PICA, which originates from the foramen magnum, accounts for 5–20% of all PICA origins.[5] Among these extracranial origins, those at the C1-2 level are even rarer, accounting for 1.1–1.3% of all PICA origins.[11,16,18] Here, we report a case of cerebellar infarction due to C1 lateral mass screw insertion during C1-2 fusion in a patient with a PICA originating at C1-2.

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CASE REPORT

This study was approved by the Institutional Review Board (IRB) of Gyeongsang National University Hospital (IRB No. 2019-09-010). Due to the retrospective design of the study, consent was neither required by the IRB nor by the study team.

A 71-year-old woman presented with a 3-year history of posterior neck pain and a tingling sensation on the bilateral hands. A physical examination revealed normal motor power and a positive Hoffman sign on the left side. Atlanto-axial instability with canal involvement was evident on C-spine plain radiography, and cord compression with right foraminal stenosis at C1-2 was visible on magnetic resonance image (MRI). CT angiography of the brain with the C-spine was taken to confirm the VA anatomy prior to the surgery (**FIGURE 1**). Considering the VA origin, a pars screw on right C2, a pedicle screw on left C2, and both C1 lateral mass screws were inserted. C1 laminectomy was performed for decompression of the spinal cord, and rods were fixed (**FIGURE 2**). On the first postoperative day, the patient showed left sixth nerve palsy and diplopia. A brain MRI revealed no significant abnormalities. Four days later, the patient's mental status deteriorated to drowsy. A follow-up diffusion and perfusion MRI demonstrated an acute infarction in the left cerebellum. The previous images were retrospectively reviewed. On the preoperative CT angiography, the left posterior inferior cerebellar artery was visible at the C1-2 level but the same was not seen on the postoperative CT angiography (**FIGURE 3**). The patient was treated conservatively in the intensive care unit and regained consciousness after several hours. The diplopia, left sixth nerve palsy, and dizziness gradually recovered over 2 weeks; she was then discharged.

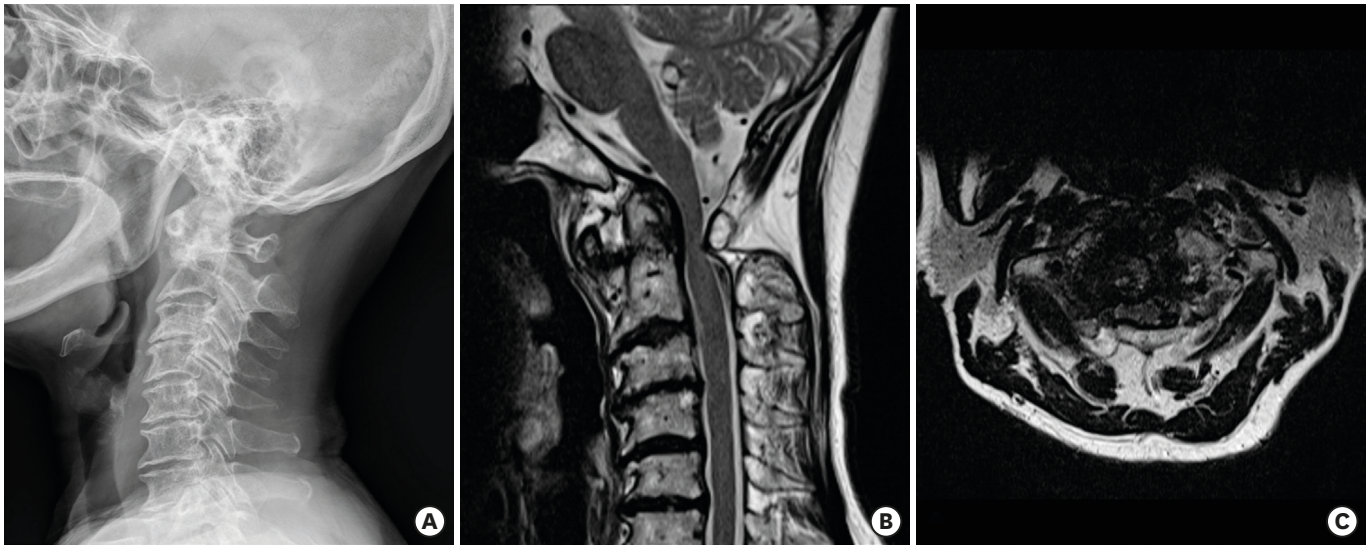

FIGURE 1. Preoperative images. (A) C-spine plain radiography, lateral view (ADI = 5 mm, PADI = 10.4 mm). (B, C) C-spine magnetic resonance image T2 sagittal and T2 axial view showing cord compression with right foraminal stenosis on C1-2.
ADI: atlanto-dens interval, PADI: posterior atlanto-dens-interval.

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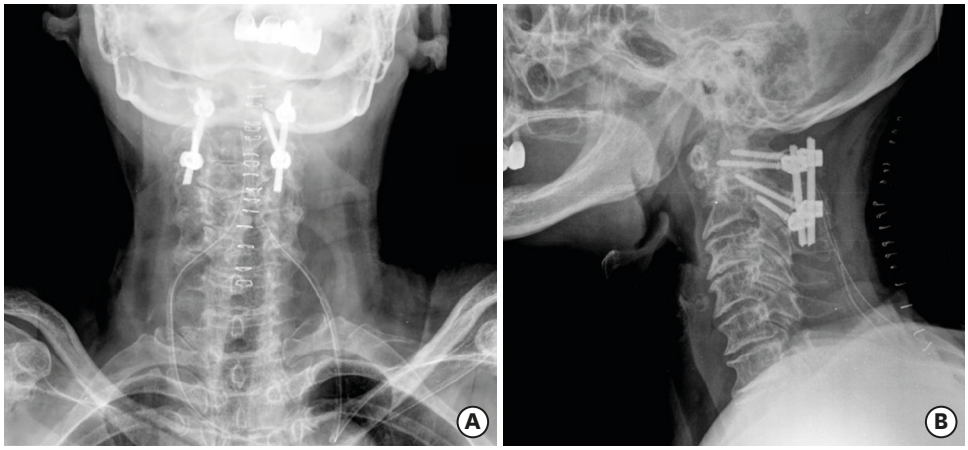

FIGURE 2. Postoperative plain radiographics. (A) Anteroposterior view and (B) Lateral view.

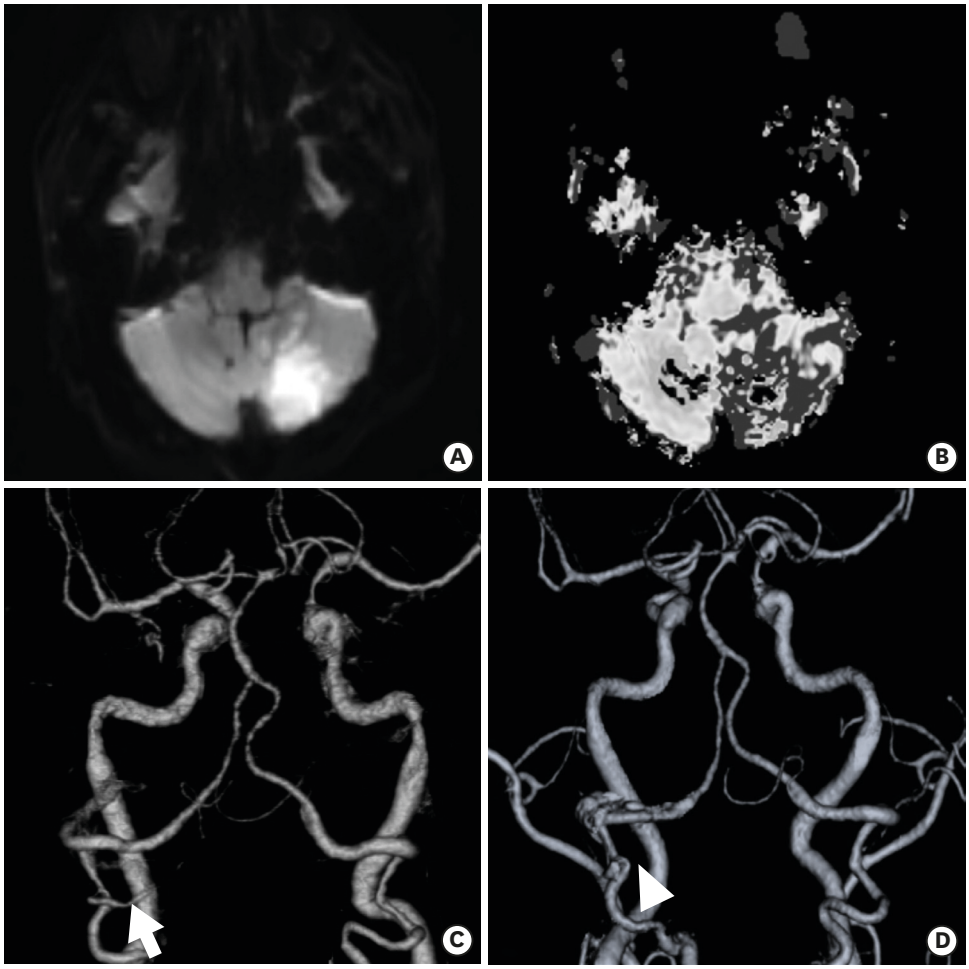

FIGURE 3. Postoperative brain magnetic resonance images and computed tomography angiography images taken on postoperative day 4. (A) Diffusion-weighted image, (B) Mean transit time image showing acute infarction at the left cerebellum, and (C, D) Comparison with preoperative image (arrow). The left posterior inferior cerebellar artery is not shown (arrowhead).

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DISCUSSION

The reported incidence rates of VA injuries vary. Previous studies reported the incidence of VA injury in cervical spine surgery from 0.07–1.4%.[7-9,12,14] Most studies reported that posterior cervical spine approaches are more prone to the risk of VA injuries than anterior approaches.[7,8,12] Especially in posterior C1-2 instrumentation, the rates are higher than total VA injuries, reportedly between 1.3% and 8.2%.[8,10,12,19] The studies about vertebral artery injury incidence are summarized in **TABLE 1**.

VA anomalies in the V3 segment are common in acquired disorders such as rheumatoid arthritis and in congenital disorders such as Down syndrome or Klippel-Feil syndrome.[18] However, our patient did not have any acquired nor congenital disorders. The VA variations observed at the C1-2 level include persistent first intersegmental artery (FIA), fenestration of the VA above and below C1 (FEN), PICA from C1-2, and high-riding VA (HRVA) (**FIGURE 4**).[18] FIA, in which the VA enters the spinal canal at the C1-2 intervertebral space, comprises 1.8–3.2% of all VA cases.[16,18] FEN, in which the VA is divided into C1 above and below, accounts for 0.9–1.3% of all cases. PICA originating between C1 and C2 comprises 1.1–1.3% of all extracranial PICA cases.[16,18] PICA is usually of intracranial origin, arising from the VA, but 5–20% of PICAs are of extradural origin.[5] An HRVA seen in approximately 10% of all VA involves the VA loop running more medial, posterior, and cranial than normal.[18]

In our case, postoperative CT angiography did not reveal the left PICA. After the surgery, we compared pre- and postoperative CT angiography, and the patient's left PICA was discovered, which originated at the C1-2 level (**FIGURE 4C**). Although no arterial bleeding occurred during dissection or screw insertion, the PICA may have been injured or compressed by the left C1 lateral mass screw insertion (**FIGURE 5**).

Other studies reported that stroke and its sequelae were observed in 12.7–25.6% of the cases after VA injury.[6,9,13] Our patient completely recovered without any sequelae. We considered that the patient recovered by conservative treatment alone due to the following reasons: The location of the vascular injury was PICA rather than VA. If VA injury occurred, brain infarction including the brain stem would be more severe and the patient might have serious sequelae. Another reason is that the range of infarction was small, and therefore, the swelling was not severe. The patient was able to recover without further invasive treatments, such as external ventricular drainage or decompressive suboccipital craniectomy.

TABLE 1. A summary of previous studies on vertebral artery injury incidence

Study	Year	Name of surgery	No. of vertebral artery injuries	No. of cases	Incidence (%)
Madawi et al.[10]	1997	C1-2 transarticular screw fixation	5	61	8.2
Wright and Lauryssen[19]	1998	C1-2 transarticular screw placement	54	1,318	4.1
Rampersaud et al.[14]	2006	Cervical spine surgery	3	212	1.4
Neo et al.[12]	2008	Cervical spine surgery	8	5,641	0.14
		Posterior atlantoaxial transarticular screw fixation	2	149	1.3
Lunardini et al.[9]	2014	Cervical spine surgery	111	163,324	0.07
		Posterior instrumentation of the upper cervical (C1-2) spine surgery	36	-	-
Hsu et al.[7]	2017	Cervical spine surgery	14	16,582	0.08
Lee et al.[8]	2019	Cervical spine surgery	13	15,582	0.08
		C1-2 posterior screw fixation	7	518	1.35

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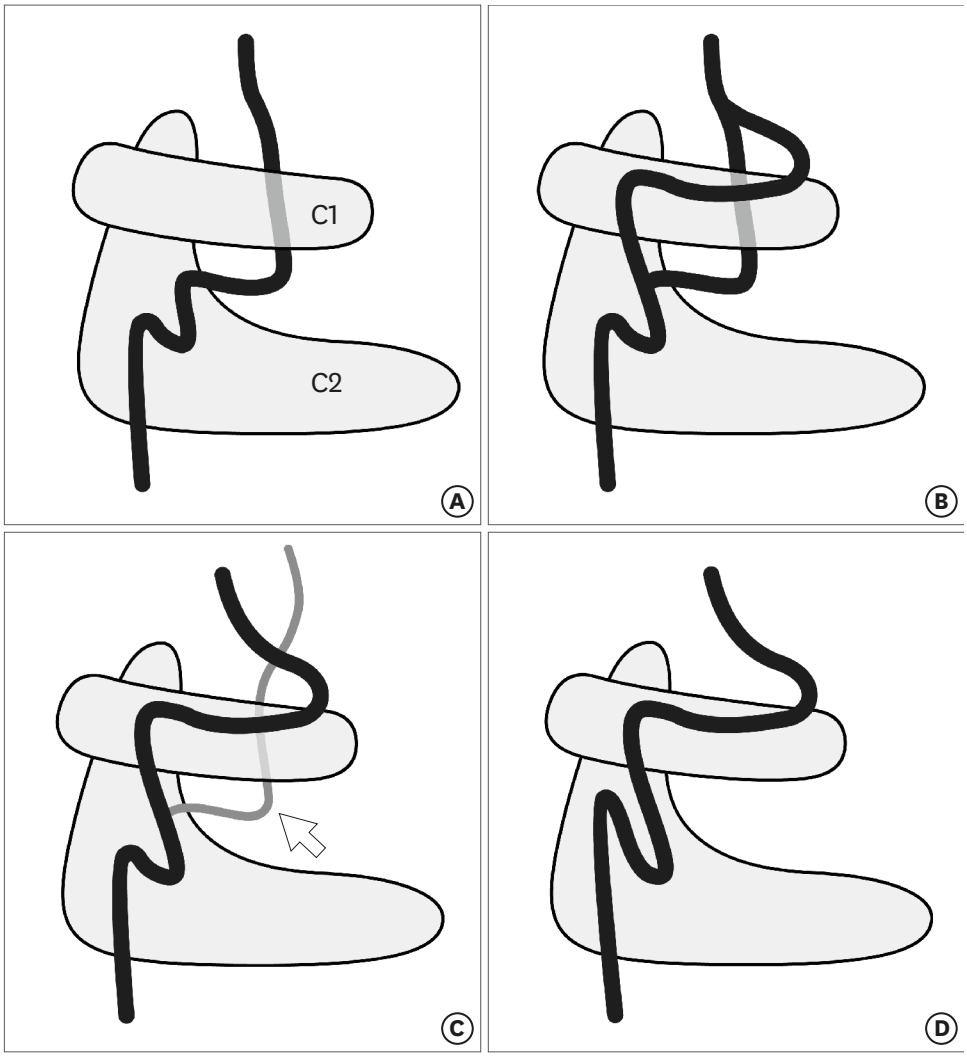

FIGURE 4. Schemas of vertebral artery variation observed at the C1-2 level (left lateral view). (A) Persistent first intersegmental artery, (B) Fenestration of the vertebral artery above and below C1, (C) Posterior inferior cerebellar artery (white arrow) originating from the C1-2 level, and (D) High-riding vertebral artery.

Previous studies showed that the use of preoperative CT angiography scans might help minimize vascular injury when determining the artery's location and path, as well as the appropriate screw trajectory.[4] Prior to C1-2 fusion, preoperative CT angiography of the brain and neck should always be performed to determine the relationship between the vessel and bony structures and confirm the various VA variations.

CONCLUSION

During C1 lateral mass screw insertion, vascular injury may occur due to rare VA variations such as C1-2 origin PICA. Therefore, the patient's VA anatomy and origin of PICA should be confirmed prior to C1-2 fusion, and precise methods for screw fixation are important to prevent vessel injuries during C1-2 fusion.

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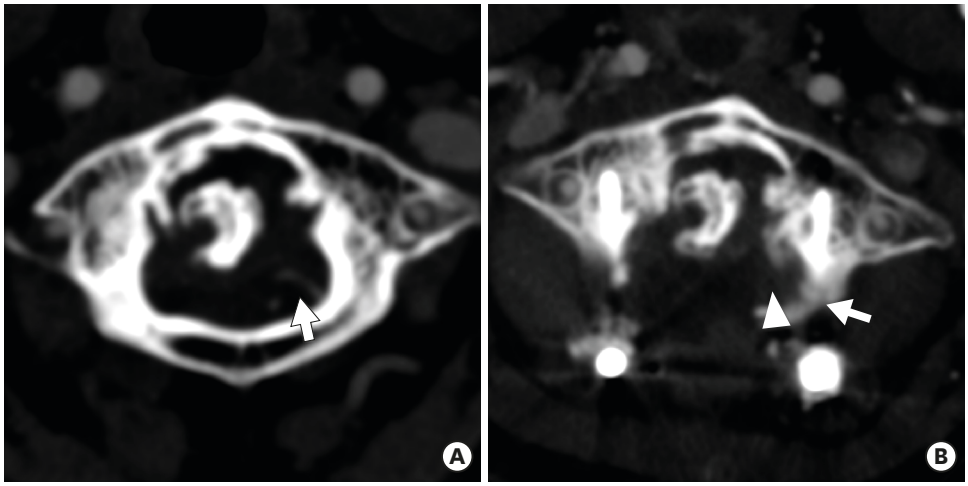

FIGURE 5. Comparisons between preoperative and postoperative images (day 4) of computed tomography angiography. (A) The left posterior inferior cerebellar artery begins between the C1-2 and progresses cephalad towards the cerebellum in the preoperative image (white arrow). (B) The left posterior inferior cerebellar artery may be injured or compressed by the left C1 lateral mass screw (white arrow), and the artery is not seen on the postoperative image (white arrowhead).

REFERENCES

1. Garcia Alzamora M, Rosahl SK, Lehmberg J, Klisch J. Life-threatening bleeding from a vertebral artery pseudoaneurysm after anterior cervical spine approach: endovascular repair by a triple stent-in-stent method. Case report. **Neuroradiology 47**:282-286, 2005
PUBMED | CROSSREF
2. Burke JP, Gerszten PC, Welch WC. Iatrogenic vertebral artery injury during anterior cervical spine surgery. **Spine J 5**:508-514, 2005
PUBMED | CROSSREF
3. Cosgrove GR, Théron J. Vertebral arteriovenous fistula following anterior cervical spine surgery. Report of two cases. **J Neurosurg 66**:297-299, 1987
PUBMED | CROSSREF
4. Currier BL, Todd LT, Maus TP, Fisher DR, Yaszemski MJ. Anatomic relationship of the internal carotid artery to the C1 vertebra: a case report of cervical reconstruction for chordoma and pilot study to assess the risk of screw fixation of the atlas. **Spine 28**:E461-E467, 2003
PUBMED | CROSSREF
5. Fine AD, Cardoso A, Rhoton AL Jr. Microsurgical anatomy of the extracranial-extradural origin of the posterior inferior cerebellar artery. **J Neurosurg 91**:645-652, 1999
PUBMED | CROSSREF
6. Fink KR, Fink JR, Cohen WA. Cervical collaterals may protect against stroke after blunt vertebral artery injury. **Emerg Radiol 18**:545-549, 2011
PUBMED | CROSSREF
7. Hsu WK, Kannan A, Mai HT, Fehlings MG, Smith ZA, Traynelis VC, et al. Epidemiology and outcomes of vertebral artery injury in 16 582 cervical spine surgery patients: an AOSpine North America multicenter study. **Global Spine J 7**:21S-27S, 2017
PUBMED | CROSSREF
8. Lee CH, Hong JT, Kang DH, Kim KJ, Kim SW, Kim SW, et al. Epidemiology of iatrogenic vertebral artery injury in cervical spine surgery: 21 multicenter studies. **World Neurosurg 126**:e1050-e1054, 2019
PUBMED | CROSSREF
9. Lunardini DJ, Eskander MS, Even JL, Dunlap JT, Chen AF, Lee JY, et al. Vertebral artery injuries in cervical spine surgery. **Spine J 14**:1520-1525, 2014
PUBMED | CROSSREF
10. Madawi AA, Casey AT, Solanki GA, Tuite G, Veres R, Crockard HA. Radiological and anatomical evaluation of the atlantoaxial transarticular screw fixation technique. **J Neurosurg 86**:961-968, 1997
PUBMED | CROSSREF

https://doi.org/10.13004/kjnt.2019.15.e27

11. Nassr AN, Swann PP, Huston J 3rd, Abdelfatah MM, Rose PS, Currier BL. Aberrant posterior inferior cerebellar artery injury with C1 lateral mass screw placement: a case report and review of the literature. **Spine J 14**:e7-e14, 2014
PUBMED | CROSSREF
12. Neo M, Fujibayashi S, Miyata M, Takemoto M, Nakamura T. Vertebral artery injury during cervical spine surgery: a survey of more than 5600 operations. **Spine 33**:779-785, 2008
PUBMED | CROSSREF
13. Park HK, Jho HD. The management of vertebral artery injury in anterior cervical spine operation: a systematic review of published cases. **Eur Spine J 21**:2475-2485, 2012
PUBMED | CROSSREF
14. Rampersaud YR, Moro ER, Neary MA, White K, Lewis SJ, Massicotte EM, et al. Intraoperative adverse events and related postoperative complications in spine surgery: implications for enhancing patient safety founded on evidence-based protocols. **Spine 31**:1503-1510, 2006
PUBMED | CROSSREF
15. Smith MD, Emery SE, Dudley A, Murray KJ, Leventhal M. Vertebral artery injury during anterior decompression of the cervical spine. A retrospective review of ten patients. **J Bone Joint Surg Br 75**:410-415, 1993
PUBMED | CROSSREF
16. Uchino A, Saito N, Watadani T, Okada Y, Kozawa E, Nishi N, et al. Vertebral artery variations at the C1-2 level diagnosed by magnetic resonance angiography. **Neuroradiology 54**:19-23, 2012
PUBMED | CROSSREF
17. Uchino A, Saito N, Ishihara S. Double origin of the posterior inferior cerebellar artery diagnosed by MR angiography: a report of two cases. **Neuroradiol J 28**:187-189, 2015
PUBMED | CROSSREF
18. Wakao N, Takeuchi M, Nishimura M, Riew KD, Kamiya M, Hirasawa A, et al. Vertebral artery variations and osseous anomaly at the C1-2 level diagnosed by 3D CT angiography in normal subjects. **Neuroradiology 56**:843-849, 2014
PUBMED | CROSSREF
19. Wright NM, Lauryssen C; American Association of Neurological Surgeons/Congress of Neurological Surgeons. Vertebral artery injury in C1-2 transarticular screw fixation: results of a survey of the AANS/CNS section on disorders of the spine and peripheral nerves. **J Neurosurg 88**:634-640, 1998
PUBMED | CROSSREF

https://doi.org/10.13004/kjnt.2019.15.e27