CASE REPORT
Korean J Neurotrauma 2017;13(1):39-44

pISSN 2234-8999 / eISSN 2288-2243
https://doi.org/10.13004/kjnt.2017.13.1.39

Vertebral Artery Injury in C2-3 Epidural Schwannoma Resection: A Case Report and Literature Review

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The incidence of vertebral artery (VA) injury (VAI) in posterior approach tumor resection surgery is extremely rare, but it can lead to serious complication. In this case, a 57-year-old man underwent surgery for resection of the tumor involving left epidural space and neural foramen at C2−3 level. Iatrogenic VAI occurred suddenly during tumor resection procedure using pituitary forceps. Immediate local hemostasis and maintaining of perfusion for reducing the risk of posterior circulation ischemia were performed. Intraoperative angiogram of both VA and emergent trapping embolization were done as well. It may reduce the risk of immediate postop complication, and further delayed occurrence. The patient had no complication after VAI by appropriate intraoperative management. Preoperative angiographic work up and preparation of endovascular team cooperation are positively necessary as well as a warning for the VAI during cervical spine surgery.
(Korean J Neurotrauma 2017;13(1):39-44)

KEY WORDS: Vertebral artery injury · Cervical spine surgery · Schwannoma · Embolization.

Introduction

Vertebral artery (VA) injury (VAI) during cervical spine surgery is a rare, but it can be serious complication with the potential to cause massive bleeding, permanent neurologic impairment, and even death. Most reports of VAI are related to anterior surgical exposure or screw placement in the posterior cervical spine and the overall incidence during cervical spine surgery ranges from 0.20 to 1.96%.[1-3,7,10,12] VAI during posterior approach surgery has been incurred during the instrumentation phase, but VAI during the posterior exposure or decompression phase is extremely rare.

The management and subsequent outcome of patients with iatrogenic VAI are controversial. In this paper, we report the endovascular embolization case of VAI in posterior approach epidural tumor resection surgery. The purpose of this report is review the prevention and management of iatrogenic VAI during cervical spine surgery.

Received: October 1, 2016 / **Revised:** December 24, 2016
Accepted: December 29, 2016
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Case Report

A 57-year-old man complained of left upper back (scapular area) pain for eight years. Several kinds of conservative therapies were done at local clinic, but they were ineffective. After cervical spine magnetic resonance imaging (MRI) at another hospital, he had been diagnosed cervical neurogenic tumor and visited our hospital for tumor resection surgery. His neurological exam was without deficit and the pain is the only symptom he has.

MRI with gadolinium demonstrated a 2.4-cm lobulated enhancing mass with internal cystic change involving left epidural space and neural foramen at C2−3 level, and widening of bony intervertebral foramen. The mass compressed spinal cord without signal change and abutted to left VA. In the vertebral angiographic computed tomography (CT), there was no evidence of abnormal steno-occlusive lesion or anatomic variation, bilateral vertebral arteries. But Left vertebral artery was pushed out to anterior lateral direction

at C2−3 level by the tumor mass (Figure 1).

For the operative approach and resection, the patient was lying concorde position and his head was fixed with mayfield 3-pin head clamp. After subcutaneous tissue and paravertebral muscle were dissected, left partial hemilaminectomy at C2−3 level was done. The tumor was exposured then, showing yellowish, soft mass with well defined, encapsulated, and mild bleeding tendency. We removed it piecemeal with Cavitron Ultrasonic Surgical Aspirator. For more extensive resection, we use pituitary forceps in the di-

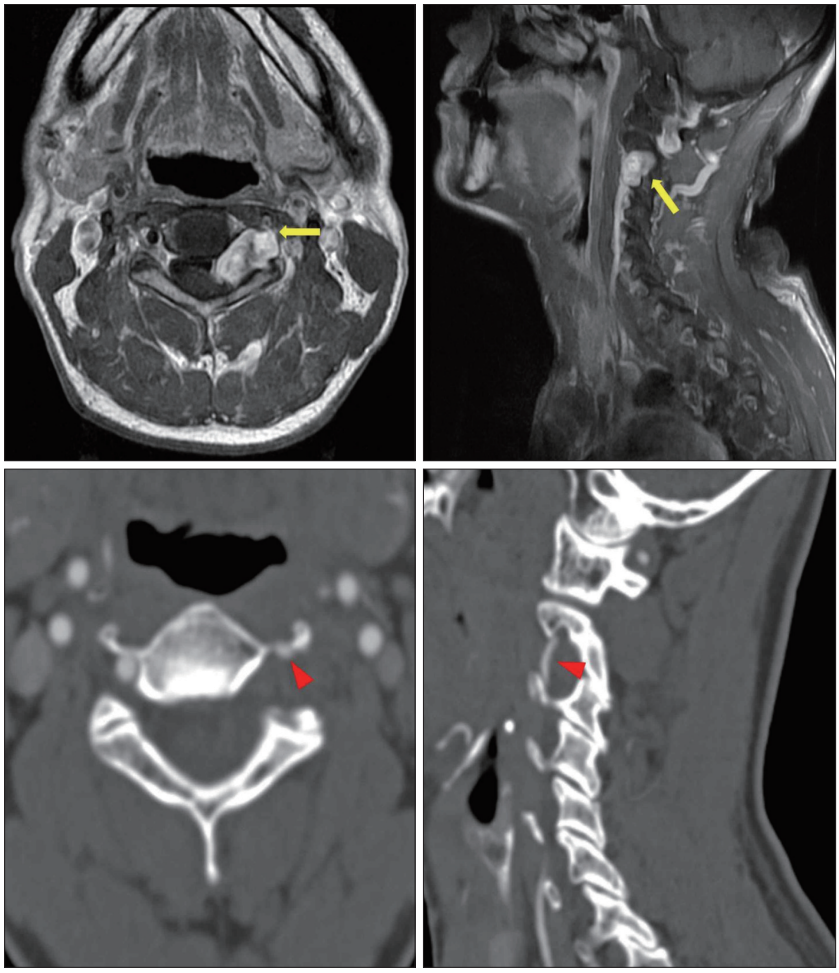

FIGURE 1. A 2.4-cm lobulated enhancing mass with internal cystic change involving left epidural space and neural foramen at C2−3 level, and widening of bony intervertebral foramen (Upper, magnetic resonance imaging). Left vertebral artery is pushed out to anterior lateral direction at C2−3 level by the tumor mass, and it is not encapsulated by tumor (Lower, computed tomography angio).

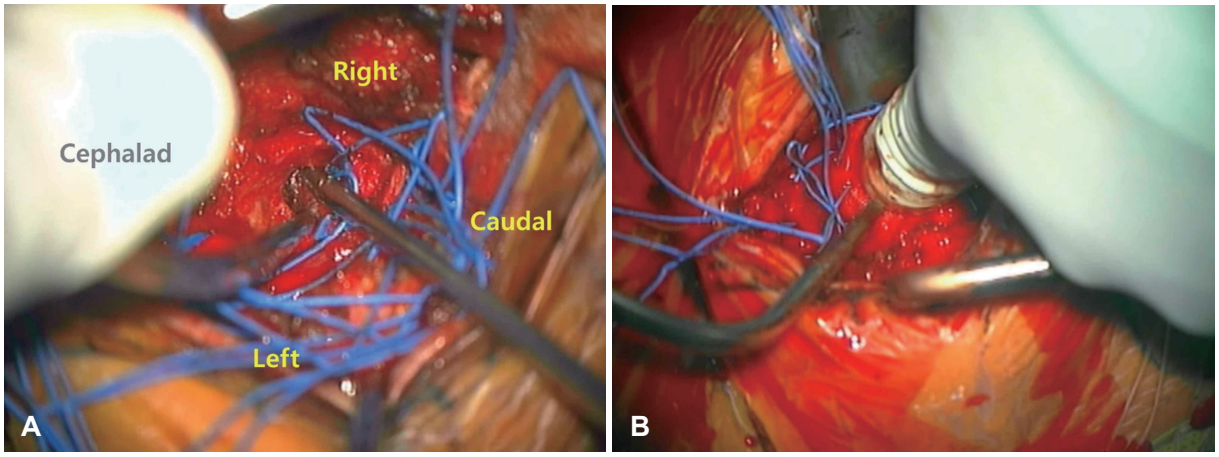

FIGURE 2. (A) Pituitary forceps resection in the lateral side of C2−3 left foramen for extensive tumor removal. (B) After sudden bleeding, immediately gauze packing and manual compression were began.

rection of C2−3 left foramen. During the procedure, active pulsating massive bleeding occurred suddenly (Figure 2).

Immediate gauze packing and manual compression were begun and fluid resuscitation and phenylephrine injection were done as well. Maintaining perfusion and reducing the risk of posterior circulation ischemia were done through increasing mean blood pressure (MBP) range 90 to 100 mmHg. Furthermore, we started mega-dose steroid therapy just as in case of cord injury. The patient was transferred to angiography room under endotracheal general anesthesia after temporary wound closure with gauze packing by assuring control hemorrhage, following 30 minutes manual compression. There was no significant change in evoked potential monitor in the meantime.

In angiographic findings of both vertebral arteriogram, left VA was non-dominant in comparison with right one. At C2−3 level, left VA was focally narrowed due to extrinsic compression and leakage through arterial perforation with pseudoaneurysm was seen. Meanwhile, right VA has dominancy enough to fill left VA retrograde below C2 level. Segmental embolization of Left VA directly below C2 level foraminal segment was done by using multiple pushable coil (MWCE-18-14-4-NESTER 2EA, MWCE-18-14-3-NESTER 1EA). And then, we confirmed the interruption of antegrade flow on left VA and retrograde filling up to left C2 level from right VA as well, through each side final control angiogram (Figure 3). Finally, the patient return to operation room, and the temporally closed wound was re-

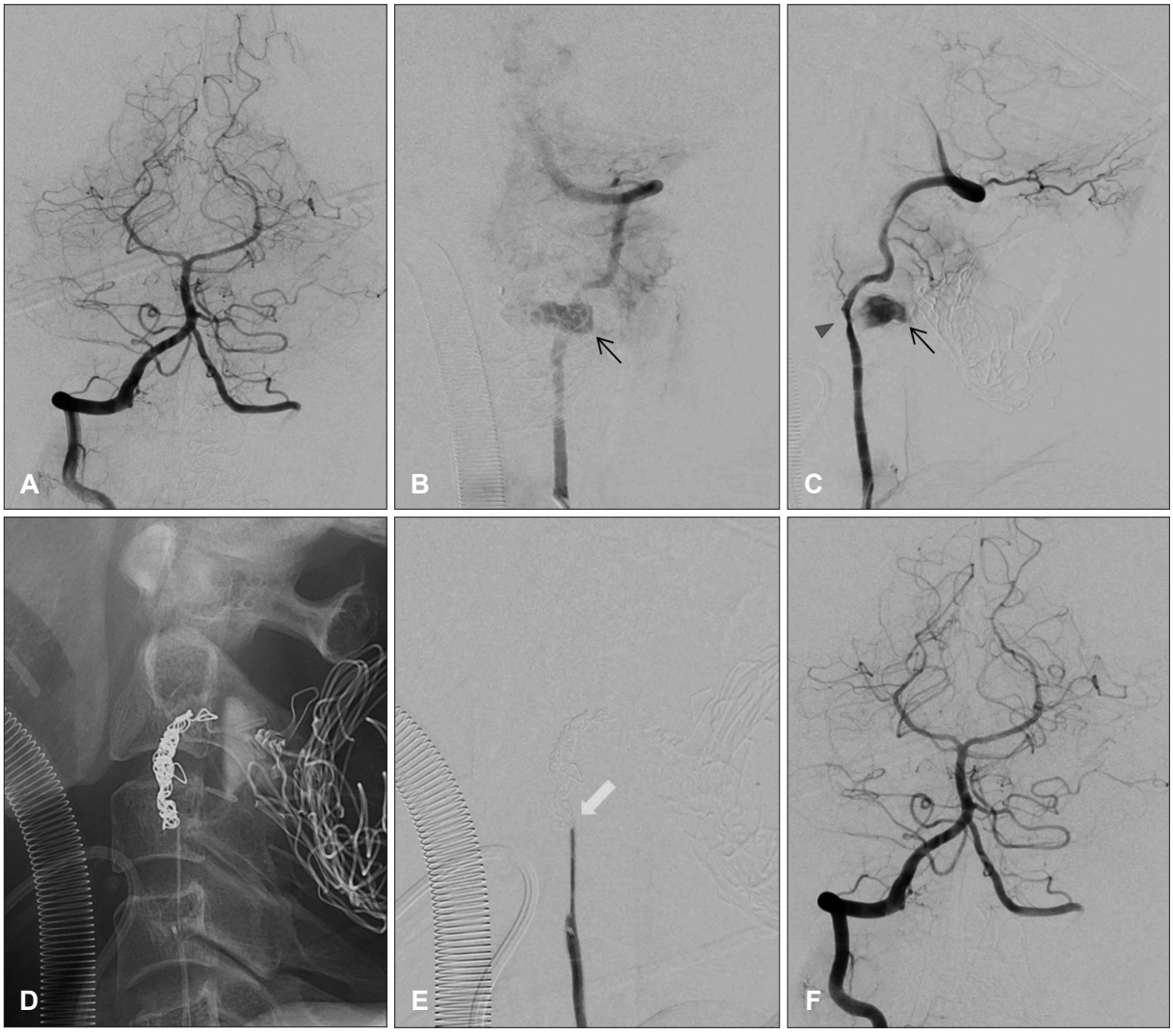

FIGURE 3. (A-C) Initial control angiogram: (A) Anterior posterior (AP) view of right vertebral artery (VA). Right dominant flow is filling retrograde left VA to C2 level. (B) AP view of left VA show posterior aspect pseudoaneurysm (black arrow) (C) Lateral view of left VA show pseudoaneurysm (black arrow) and focal spasm or narrowing due to extrinsic compression, leakage from direct arterial perforation (arrowhead). (D-F) Final control angiogram: (D) Segmental embolization from C2 level, successful trapping of the non-dominant left VA at C2−3 level. (E) Lateral view of left VA confirming antegrade flow interruption of left VA (arrow). (F) AP view of right VA confirming the retrograde filling of left VA.

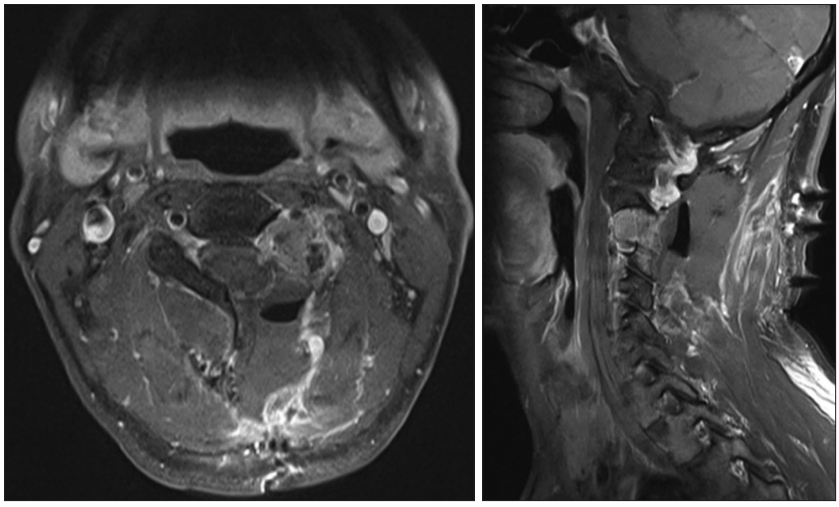

FIGURE 4. Post-operative follow up magnetic resonance imaging: no definite enhancing lesions at left epidural space and neural foramen at C2–3 level means no gross evidence of residual mass.

opened. Microscopic exploration was done for check the bleeding.

In the postoperative course, the patient had no focal neurologic deficit but the left upper back pain remained. Its severity and character were similar to preoperative symptom. The tumor was gross totally resected according to postoperative MRI (Figure 4) and the final pathologic diagnosis was schwannoma. He discharged at eight days after surgery without any complication and had no complication at six-week-follow-up in outpatient department as well.

Discussion

VAI is a rare but serious complication of cervical spine surgery. Potential to cause massive bleeding, neurologic deficit, and even death. Complications of VAI are arteriovenous fistula, late-onset hemorrhage, pseudoaneurysm, thrombosis with embolic incidents, cerebral ischemia, stroke, and death. Vascular complications can occur in immediately after the operation or till after several years. Complete occlusion of the vessel makes immediate post op stage ischemia, and Emboli may cause partially occlusion at later.[17]

Referred from a survey of members of Cervical Spine Research Society, the group (141 surgeons) found that the overall incidence of injury was 0.07%. And the outcome were 90% were without permanent harm (to the patient), and 10% resulted in neurological injury or death.[13] Anyone can be faced with VAI during cervical spine surgery, even an experienced surgeon.

Reported rates of VAI in anterior cervical surgery were 0.2% to 0.5% and posterior C1–2 transarticular fixation for atlantoaxial instability were 0% to 8.2%.[9,13,15,16,19] Except in the case of screw instrumentation, VAI during posterior approach is extremely rare. To the best of our knowledge, only one case was reported previous literature. Neo et al.[15] did a retrospective survey of more than 5,600 Operations, and refer to the one case of a C2–3 rosary-like dumbbell schwannoma resection through a posterior approach. In that case, tight gauze packing more than 30 minutes and stopped the bleeding successfully. However, bleeding was recurred when the same operation field was re-opened to resect the residual tumors, and finally controlled by the ligation of the VA.

In this case, we approached the tumor through posterior exposure as routine procedure and it enable safe removal of both intradural and epidural intraspinal tumor components. Most cervical dumbbell tumors can be removed completely via midline incision and standard laminectomy. As is well known, the cervical paraspinal region is difficult to access anteriorly. Because the anatomy of anterior approach is confined in the narrow operation field, adjacent numerous neurovascular structures such as VA. However, some surgeons prefer the anterolateral approach for cervical schwannomas below C2 because the facet is preserved and the vertebral artery can be controlled early.[20] For prevention of VAI, it is very important that consider carefully preoperative imaging studies. It is very important to make the operation plan after confirming the position of the VA, its relation to bony and surrounding structures, especially, tumor boarder line by CT angiography and enhanced MRI. We checked right dominancy and no abnormality of VA. It was separated from the tumor capsule, that is, not encapsulation, but abutted only. This is necessary to help determine the extent of dissection.

If VAI occurs, proper manage must be immediately followed. The management should achieve following details. Hemorrhage should be locally controlled, immediate vertebrobasilar ischemia must be prevented, and cerebral em-

bolic complications must be avoided.[9] The anesthesiologist should be informed of the need for fluid resuscitation to maintain perfusion pressure to reduce the risk of posterior circulation ischemia.[17] However there is no definite consensus of management.

First, Intraoperative surgical management of VAI must begin with direct hemostatic tamponade. There is possibility of delayed hemorrhage, even if the bleeding controlled using hemostatic agents or gauze compression. The best treatment is primary repair, however it is hard to do practically in the situation of deep and narrow accessible field. Ligation is one of other alternatives. Before procedure, confirming the VA dominancy and enough retrograde collateral flow by intraoperative angiography is essential. Ligation of the VA is associated with significant morbidities of cerebellar infarction, isolated cranial nerve paresis and hemiplegia, and a reported mortality was 12%.[18]

The only 6% to 26% of patients has equal diameter of both VAs, and the left VA is often larger than the right VA.[11] The VA supply the posterior inferior cerebellar artery territory and injury of dominant VA with acute blood loss may lead to the medullary ischemia, even infarction. Therefore, we did fluid resuscitation with volume loading and increase MBP target range 90 to 100 mmHg with phenylephrine injection as soon after VAI. In fact, the infarction risk was low because the patient has right dominant VA in pre-operative CT angiography and right dominant flow with retrograde filling from left VA to C2 level, crucially, in intraoperative angiography (Figure. 3A).

Refer to previous studies, the purpose of angiography in VAI is to find the vascular complications, to confirm sufficient collateral blood supply to the brain, and to determine the patency of a surgically repaired vessel or to detect any stenosis. Furthermore, fistula or pseudoaneurysm can be occluded by use of endovascular procedure, such as embolization.[4,5,8,14] Peng et al.[17] recommended immediate conventional angiography when the VAI was managed by tamponade only or direct repair. Especially, if possible, intraoperative angiography helps the intraoperative decision making. The surgeon can decide the appropriate procedure among ligation, embolization or vessel repair, whether a patient has patent collateral VA or not. In the strict sense, our angiography and embolization are not totally intraoperative due to the spatial limitation of operation room. We transferred out the patient to the angiography room under the general anesthesia. In spite of immediate arrange of angiography room and endovascular team, it incurred the risk of patient transportation during operation, delayed decision making and operation time extension.

After angiographic confirming the adequate retrograde contralateral circulation from right VA, total occlusion of left VA by trapping embolization was done, final control angiography of occluded and collateral vessel, also Golfinos et al.[9] remarked that the injured VA can be totally occluded to prevent further complications. However, the possibility of later pseudoaneurysm formation cannot be excluded. Because rebleeding on days to years after surgery has been reported.[6] We will follow up radiologic study in a year after surgery for rule out the delayed pseudoaneurysm growing and the tumor recurrence by CT vertebral angiography and enhanced MRI. The patient has no symptom in last outpatient department visit at six weeks after surgery.

Conclusion

The incidence of VAI in cervical neurogenic tumor resection surgery is very rare, but it can happen to anyone. To prevent VAI, careful confirmation of the surgical anatomy on preoperative CT angiography and MRI is essential. When you encountered VAI during operation, first do local bleeding control with compression, and check the perfusion maintenance to avert ischemia. Treatment of choice is primary repair, and the alternative is endovascular embolization after intraoperative angiogram for verifying enough retrograde collateral flow. The situation happens unexpectedly, so it would be helpful to keep the procedure in mind.

■ The authors have no financial conflicts of interest.

REFERENCES

1) Bertalanffy H, Eggert HR. Complications of anterior cervical discectomy without fusion in 450 consecutive patients. **Acta Neurochir (Wien) 99**:41-50, 1989
2) Bilbao G, Duart M, Aurrecoechea JJ, Pomposo I, Igartua A, Catalán G, et al. Surgical results and complications in a series of 71 consecutive cervical spondylotic corpectomies. **Acta Neurochir (Wien) 152**:1155-1163, 2010
3) Burke JP, Gerszten PC, Welch WC. Iatrogenic vertebral artery injury during anterior cervical spine surgery. **Spine J 5**:508-514; discussion 514, 2005
4) Choi JW, Lee JK, Moon KS, Kim YS, Kwak HJ, Joo SP, et al. Endovascular embolization of iatrogenic vertebral artery injury during anterior cervical spine surgery: report of two cases and review of the literature. **Spine (Phila Pa 1976) 31**:E891-E894, 2006
5) Cosgrove GR, Théron J. Vertebral arteriovenous fistula following anterior cervical spine surgery. Report of two cases. **J Neurosurg 66**:297-299, 1987
6) Diaz-Daza O, Arraiza FJ, Barkley JM, Whigham CJ. Endovascular therapy of traumatic vascular lesions of the head and neck. **Cardiovasc Intervent Radiol 26**:213-221, 2003
7) Fountas KN, Kapsalaki EZ, Nikolakakos LG, Smisson HF, Johnston KW, Grigorian AA, et al. Anterior cervical discectomy and fusion associated complications. **Spine (Phila Pa 1976) 32**:2310-

2317, 2007
8) 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
9) Golfinos JG, Dickman CA, Zabramski JM, Sonntag VK, Spetzler RF. Repair of vertebral artery injury during anterior cervical decompression. **Spine (Phila Pa 1976) 19**:2552-2556, 1994
10) Graham AW, Swank ML, Kinard RE, Lowery GL, Dials BE. Posterior cervical arthrodesis and stabilization with a lateral mass plate. Clinical and computed tomographic evaluation of lateral mass screw placement and associated complications. **Spine (Phila Pa 1976) 21**:323-328, 1996
11) Jeng JS, Yip PK. Evaluation of vertebral artery hypoplasia and asymmetry by color-coded duplex ultrasonography. **Ultrasound Med Biol 30**:605-609, 2004
12) Katonis P, Papadakis SA, Galanakos S, Paskou D, Bano A, Sapkas G, et al. Lateral mass screw complications: analysis of 1662 screws. **J Spinal Disord Tech 24**:415-420, 2011
13) 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
14) Méndez JC, González-Llanos F. Endovascular treatment of a vertebral artery pseudoaneurysm following posterior C1-C2 transarticular screw fixation. **Cardiovasc Intervent Radiol 28**:107-109, 2005
15) 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 (Phila Pa 1976) 33**:779-785, 2008
16) Neo M, Sakamoto T, Fujibayashi S, Nakamura T. A safe screw trajectory for atlantoaxial transarticular fixation achieved using an aiming device. **Spine (Phila Pa 1976) 30**:E236-E242, 2005
17) Peng CW, Chou BT, Bendo JA, Spivak JM. Vertebral artery injury in cervical spine surgery: anatomical considerations, management, and preventive measures. **Spine J 9**:70-76, 2009
18) Shintani A, Zervas NT. Consequence of ligation of the vertebral artery. **J Neurosurg 36**:447-450, 1972
19) 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
20) Winn HR. Youmans neurological surgery, ed 6th. Philadelphia, PA: Saunders, 2011