Endovascular Treatment of Vertebral Artery Injury during Cervical Posterior Fusion (C1 Lateral Mass Screw)

A Case Report

KYEONG-WOOK YOON, JUNG-HO KO, CHUN-SUNG CHO, SANG-KOO LEE, YOUNG-JOON KIM, YOUNG JIN KIM

Department of Neurosurgery, Dankook University College of Medicine; Cheonan, Chungnam, South Korea

Key words: vertebral artery injury, endovascular, cervical fusion

Summary

We describe two cases of vertebral artery injury during posterior cervical fusion.

We treated both cases by an endovascular technique.

The vertebral artery injury may result in catastrophic situations, such as, infarction, massive blood loss and even death.

Our clinical outcome was good and we prove that endovascular treatment is an effective and less invasive way to treat vertebral artery injury.

Introduction

Vertebral artery (VA) injury may occur in various situations, such as cervical trauma or iatrogenic injury, during surgery.

Several posterior cervical fusion techniques have been introduced, including the C1 lateral mass screw technique.

The C1 lateral mass screw method has some complications reported in the literature, including lower cranial nerve injury, dural injury, C2 nerve root injury, infection, and iatrogenic VA injury¹⁻³.

VA injury may result in asymptomatic or symptomatic neurologic deficit, such as transient ischemic attacks, stroke, or even deaths¹. Herein, we describe two cases of VA injury during C1 lateral mass screw fixation, which resulted in good clinical outcomes after endovascular treatment.

Case Report

Case 1

A 20-year-old woman without any other medical history visited our department. She had suffered motor weakness and radiating pain in both arms for three weeks prior to her visit. Sensory change and pain had progressed. An initial physical examination showed decreased motor power, grade 4 in both arms, no Babinski signs, and no clonus. The deep tendon reflex was slightly increased at the knee and elbow. We performed a gadolinium-enhanced cervical MRI, and a tumor was revealed from the C1 to C6 level. The patient underwent tumor removal and posterior fusion from C1 to C5 and surgical biopsy revealed ependymoma. During screw positioning of the left C1, fresh pulsatile blood pumped out from the screw hole. We tried to stop the bleeding by hemostatic material but failed. We were suspicious of a VA injury and decided to perform emergency cerebral angiography; meanwhile, the bleeding had not stopped even with the use of compression with gauze packing. The patient was moved to the angiography room beside the operation room without completion of her initial surgery and a conventional cerebral angiogram was performed. The study revealed an iatrogenic VA injury at the V3 segment, near the left C1 screw hole (Figure 1A,B). Bleeding was ongoing and we feared that the patient would experience unstable vital signs due to blood loss. We considered endovascular VA occlusion and

Figure 1 A) Conventional cerebral angiography shows VA injury on the V3 segment (arrow). B) 3-dimensional reconstructed angiography shows a small bleb, which is considered an iatrogenic pseudoaneurysm.

Figure 2 A) Coil embolization begins from the distal part of the lesion to the proximal part. B) Immediate postoperative angiography shows total occlusion of the parent artery.

Figure 3 Contralateral VA angiography after total occlusion shows an intact posterior circulation, including the ipsilateral PICA.

performed contralateral VA angiography and found no flow abnormality. Then, we performed a balloon occlusion test and no neurologic change was observed. The patient woke up from the anesthesia during the intervention procedure, but we maintained mild sedation and intubation. She was well cooperative even during the intubation state and we asked some closed question during the occlusion test, in which she answered 'yes or no' by grasping the hand. Endovascular VA occlusion was started from below the origin of the posterior inferior cerebellar artery and covered the full injured segment by using commercially available detachable coils (five GDCs, Boston Scientific/ 4 MicroPlex coils, Microvention) (Figure 2A,B). We used postoperative contralateral VA angiography that showed good collateral circulation of the left PICA and no contrast media filling at the injured segment (Figure 3). After returning to the operation room, the surgery was completed without both side C1 screw and C1 laminectomy because we were afraid of right side VA injury.

Case 2

A 60-year-old man was referred to our department from a local clinic for unstable C1 fracture. The patient had no neurologic deficits, but cervical computed tomography (CT)

demonstrated an unstable Jefferson fracture. We planned a C1-2 posterior fusion with C1 lateral mass screw, and performed preoperative vertebral artery CT angiography. CT angiography revealed a hypoplastic right side VA (Figure 4). During positioning of the left side C1 lateral mass screw, no arterial blood was detected, however, woozy fresh color blood was found during a soft tissue dissection. With caution, we anticipated that the arterial blood flow would stop soon after completion of the latter procedure. After surgery, we demonstrated the arterial injury using conventional angiography. The left side VA injury was revealed on cerebral angiography (Figure 5) and the flapping of the inner wall of the injury site was observed on serial angiography. Comparing the initial CT angiography and diagnostic conventional angiography, we decided that it was a stenotic change by injury rather than pre-existing arteriosclerotic lesion. Finally, we decided to perform the 'stent-in-stent' technique to reconstruct the intimal flap to attach to the inner wall by using a radial force of expandable stents. We used two self-expandable Neuroform (Boston Scientific/Target, Fremont, CA, USA. size: 4.5 mm × 20 mm and 4.0 mm × 20 mm) stents and postoperative angiography showed that the distal flow was intact (Figure 6A,B), but the collapsed lumen remained. We considered the covered stent but were afraid

Figure 5 Pre-procedural 3-dimensional reconstructed angiogram shows stenotic change of the left side VA.

Figure 6 A) Postoperative 3-dimensional reconstructed transparent image shows proximal and distal markers of Neuroform stents. B) Postoperative 3-dimensional reconstructed angiogram shows that distal flow is intact, but the stenotic lesion remains.

of PICA (posterior inferior cerebellar artery) violation because the lesion is close to the PICA origin. At the end of the procedure, we checked no contrast media leakage from the injury site. Systemic heparinization was performed for one day and aspirin was prescribed for three months after surgery. The patient had no neurologic change after interventional surgery and was discharged without further complications.

Discussion

Lateral mass screw fixation of the C1-2 fusion is becoming more popular since it was first described by Harms et al.⁴ VA injury may occur during cervical fusion, especially C1 screw placement. The rate of VA injury during lateral mass screw of C1 was reported with a variable range from 0% to 5.8%⁵. Yeom et al. recommends a 10 to 15 degree medial angulation of

C1 lateral mass screw to compensate C1 axial rotation, which can result in a decreased iatrogenic violation of the VA⁶. In case of fracture, which may violate the VA foramen in the cervical spine or in the old age group, preoperative CT angiography or MR angiography may be useful for cervical posterior fusion. However, the authors did not demonstrate this routinely in young non-traumatic patients.

VA injury may result in arteriovenous fistula, narrowing, occlusion, or dissection⁷. Furthermore, persistent bleeding loss may encounter hemodynamic instability¹. Immediate postoperative cerebral angiography is recommended when VA injury is suspicious. Detection of vascular injury and confirmation of a collateral circulation are very important for proper postoperative management⁸.

The treatment of VA injury can be classified into two methods. Surgical ligation of the distal and proximal ends of an injured lesion can be one optional treatment. However, this causes sacrifice of the injured VA and may result in brain stroke when contralateral collateral VA flow is not sufficient. Surgical treatment is relatively difficult because of anatomical inaccessibility⁹. Unilateral VA ligation results in brainstem infarct and the incidence of complication is 3.1% for the left side and 1.8% for the right¹⁰. Generally, the rate of hypoplastic change is 5.7% in the left side VA and 8.8% in the right⁸. Endovascular treatment is also available in the case of VA injury. Endovascular occlusion can be performed only with patients who have enough collateral VA flow on cerebral angiography or who do not present

with symptoms during a balloon occlusion test¹¹. Endovascular stent deployment is another alternative choice for iatrogenic VA injury. It can be safer and more effective than surgical ligation in the case of inadequate collateral circulation such as contralateral hypoplastic VA or in a patient with life-threatening hemorrhage^{10,12,13}. Introduction of an intracranial stent has been difficult to apply for VA injury due to stiffness and poor navigability, but these disadvantages were overcome at the present time⁹.

Clinical and radiologic follow-up is very important after not only total occlusion of the VA, but in the placement of stents, because there have been reports of recurrent pseudoaneurysm¹³. We perform follow-up angiography after 12 months in both permanent occlusion and stenting. Aspirin is used as maintenance therapy for the duration of six months. When any transient ischemic attack occurs, we add Plavix® or demonstrate angiography.

Conclusions

VA injury is a rare complication of C1 lateral mass screw fixation, but its consequence is catastrophic in some cases. Endovascular intervention is a very effective and less invasive procedure than open ligation surgery. We described two cases of successful clinical outcomes with endovascular treatment for VA injury during C1-2 fusion. However, long-term follow-up angiography should be performed to check the integrity of the parent artery.

References

- 1 Coric D, Branch CL Jr, Wilson JA, et al. Arteriovenous fistula as a complication of C1-2 transarticular screw fixation. Case report and review of the literature. *J Neurosurg.* 1996; 85: 340-343.
- 2 Madawi AA, Casey AT, Solanki GA, et al. Radiological and anatomical evaluation of the atlantoaxial transarticular screw fixation technique. *J Neurosurg.* 1997; 86: 961-968.
- 3 Prabhu VC, Patil AA, Hellbusch LC, et al. Magnetic resonance angiography in the diagnosis of traumatic vertebrobasilar complications: a report of two cases. *Surg Neurol.* 1994; 42: 245-248.
- 4 Harms J, Melcher RP. Posterior C1-C2 fusion with polyaxial screw and rod fixation. *Spine (Phila Pa 1976).* 2001; 26: 2467-2471.
- 5 Lall R, Patel NJ, Resnick DK. A review of complications associated with craniocervical fusion surgery. *Neurosurgery.* 2010; 67: 1396-1402.
- 6 Yeom JS, Buchowski JM, Park KW, et al. Undetected vertebral artery groove and foramen violations during C1 lateral mass and C2 pedicle screw placement. *Spine (Phila Pa 1976).* 2008; 33: E942-949.
- 7 Mendez JC, Gonzalez-Llanos F. Endovascular treatment of a vertebral artery pseudoaneurysm following posterior C1-C2 transarticular screw fixation. *Cardiovasc Intervent Radiol.* 2005; 28: 107-109.
- 8 Choi JW, Lee JK, Moon KS, 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).* 2006; 31: E891-894.
- 9 Katsaridis V, Papagiannaki C, Violaris C. Treatment of an iatrogenic vertebral artery laceration with the Symbiot self expandable covered stent. *Clin Neurol Neurosurg.* 2007; 109: 512-515.
- 10 Islamoglu F, Posacioglu H, Memis A, et al. Endovascular transcatheter occlusion for traumatic vertebral artery pseudoaneurysm. *Eur J Vasc Endovasc Surg.* 2000; 20: 576-578.
- 11 Halbach VV, Higashida RT, Dowd CF, et al. Endovascular treatment of vertebral artery dissections and pseudoaneurysms. *J Neurosurg.* 1993; 79: 183-191.
- 12 Horowitz MB, Miller G III, Meyer Y, et al. Use of intravascular stents in the treatment of internal carotid and extracranial vertebral artery pseudoaneurysms. *Am J Neuroradiol.* 1996; 17: 693-696.
- 13 MacKay CI, Han PP, Albuquerque FC, et al. Recurrence of a vertebral artery dissecting pseudoaneurysm after successful stent-supported coil embolization: case report. *Neurosurgery.* 2003; 53: 754-759; discussion 760-751.

Young-Jin Kim, MD, PhD.
 Department of Neurosurgery,
 Dankook University College of Medicine
 201 Manghyang-ro Dongnam-gu
 Cheonan 330-715, Chungnam Republic of Korea
 Tel: +82-41-550-3979
 Fax: +82-41-552-6870
 E-mail: spine1225@naver.com