Endovascular One-stage Bilateral Vertebral Artery Occlusion for a Patient with Atlanto-axial Fracture Associated with Bilateral Vertebral Artery Injury

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Objective: We report a patient who underwent one-stage bilateral vertebral artery (VA) occlusion to prevent recurrent ischemic stroke after atlanto-axial fracture with traumatic bilateral VA injuries (VAIs).

Case Presentation: A 78-year-old male with cervical pain and horizontal nystagmus after head injury as he fell down at the stairs. Cervical CT revealed atlanto-axial fracture without severe dislocation. MRI showed acute ischemic stroke in bilateral cerebellar hemisphere. Emergent cerebral angiography revealed bilateral VAIs. Based on the findings of the balloon test occlusion, one-stage bilateral VA occlusion was performed without any complication. After the procedure, there was no new neurological symptom or ischemic lesion on MRI.

Conclusion: For patients with traumatic VAIs, treatments should be considered based on both the presence of ischemic symptoms and angiographic morphologies of lesions.

Keywords ▶ traumatic, vertebral artery injury, ischemic stroke, one-stage, bilateral vertebral artery occlusion

Introduction

Traumatic vertebral artery injury (VAI) was reported in approximately 0.53% of patients with blunt head trauma requiring admission. In addition, the incidence of ischemic stroke in the acute phase of VAI was 24%, with a mortality rate of 8%.1) Therefore, it is important to prevent stroke after VAI. Clinically, VAI is divided into two types: symptomatic and asymptomatic. The latter is incidentally detected on imaging. In patients with symptomatic VAI, several studies reported that antithrombotic therapy was useful for preventing ischemic stroke. On the other hand, endovascular treatment of VAI in the acute phase remains controversial. Although there were several reports on the long-term natural history of asymptomatic VAI, no definite consensus regarding the necessity of therapeutic intervention for asymptomatic lesion has been available. In this paper, we report a patient who underwent one-stage bilateral vertebral artery (VA) occlusion to prevent recurrent ischemic stroke after atlanto-axial fracture with traumatic bilateral VAIs in the acute phase leading to a good outcome. We also review literatures regarding the treatment of VAI.

Case Presentation

Case: A 78-year-old male.

Chief complaint: Severe cervical pain after head trauma
Past history: Osteoporosis

Present illness: He fell down at the stairs at home, and hit the occipital region. He had no loss of consciousness immediately after injury. Subsequently, he was alert, and neither numbness nor paresis of the limbs was noted. However, severe cervical pain persisted, and he was brought to our emergency outpatient department by ambulance.
Laboratory investigations: No abnormalities.
Physical examination on admission: He was alert. Horizontal nystagmus and severe cervical pain were observed. There were no other neurological deficits.
Neuroradiological findings: Head CT did not reveal any abnormal intracranial findings. Cervical CT showed fractures involving the right posterior arch of the atlas, right lateral mass of the atlas, and right foramen transversarium (Figs. 1A and 1B), as well as fracture of the superior articular surfaces of the left and right atlas (Fig. 1C). Diffusion-weighted MRI showed multiple ischemic lesions in the bilateral cerebellar hemispheres in the territories of the bilateral posterior inferior cerebellar arteries (PICA) (Figs. 1D and 1E). In contrast to the pre-injury normal MRI and MRA findings, signal intensities of the verteobasilar arteries revealed abnormal at the admission (Fig. 1F). The left VA occlusion was confirmed. The anterograde blood flow of the right VA decreased and retrograde blood flow via the left posterior communicating artery fed to the upper basilar artery (BA). Emergency cerebral angiography of the right VA revealed severe stenosis and wall irregularity of the right VA proximal to the PICA suggesting VAI (Figs. 2A and 2C). The left VA was completely occluded at the level of the craniovertebral junction (Fig. 2B). The left internal carotid arteriography demonstrated that the upper BA was filled with the retrograde blood flow via the left posterior communicating artery (Fig. 2D).

Treatment: Continuous intravenous administration of heparin was started after MRI on the day of admission, with a prolonged activated partial thromboplastin time (APTT) of 38.2 seconds, targeting a 1.5 to 2.0 fold of the initial value. External fixation of the cervical vertebrae with a halo vest was conducted the day after admission (Day 1). Ischemic lesions detected on the initial MRI may have occurred immediately after injury, but repeated MRIs for evaluation of the effect of antithrombotic therapy could not be frequently performed. Based on the findings of improvement of clinical symptoms, we considered that anticoagulant therapy prevented recurrent stroke. Clinically, the ischemic symptoms were mild, but the subsequent orthopedic surgery, if necessary, might lead to either the recanalization of the occluded left VA or the deterioration of narrowing right VA resulting in another ischemic complications. After extensive discussion with orthopedic surgeon about the treatment option for the patient, coil embolization of the bilateral vertebral arteries was planned on day 2. Before the procedure, balloon test occlusion of right VA was conducted for evaluation of the tolerance.

Endovascular treatment: Under local anesthesia, a 6 French (Fr) long sheath was inserted into the right femoral artery, and a 5 Fr long sheath into the left femoral artery. A 3000 units of heparin were intravenously administrated, and continuously infused at 1000 units/hour thereafter. A 6 Fr Roadmaster (Goodman, Aichi, Japan) was inserted into the left VA, and an Excelsior 1018 straight (Stryker, Kalamazoo, MI, USA) was introduced to an area adjacent to the occlusion using an Asahi Chikai 14 (Asahi Intec, Aichi, Japan). The VA was occluded using four Orbit Galaxy coils (Codman Neuroendovascular, Johnson & Johnson, Miami, FL, USA) and three Guglielmi detachable (GDC) 18 coils (Stryker). The guiding catheter was then guided into the right VA, and a Scepter XC balloon catheter 4 mm × 11 mm (MicroVention TERUMO, Tustin, CA, USA) was placed...
there were no new neurological deficits, and his nystagmus disappeared at the time of discharge. On the 6th postoperative day, the vertebrobasilar arteries and the bilateral PICAs were clearly visualized via the left posterior communicating artery on 3D-CT angiography. On the 31st postoperative day, the patient was referred to another hospital for rehabilitation with the halo vest. After 4 months, the halo vest was removed after confirmation of the good bone healing in the outpatient clinic. He remained in good condition following 1 year.

**Discussion**

The present case suggests that coil embolization of the bilateral vertebral arteries in one stage is useful for treating bilateral symptomatic VAIs. However, surgical intervention remains controversial, and treatment strategy of the present case cannot be applied for all VAI patients. As for the indication of surgical interventions for VAI, the current standards of treatment are discussed as follows.

As the ischemic stroke following VAI is one of the most important prognostic factor,11 therapeutic intervention is performed for symptomatic VAI patients with ischemic stroke. On the other hand, it is difficult to evaluate whether
or not therapeutic intervention should be conducted for patients with asymptomatic VAI, which is evaluated based on imaging findings alone. Ischemic complications after VAI are assumed to be induced by slow thrombus formation related to vascular endothelial injury; therefore, antithrombotic therapy is effective.\(^1\) Inamasu et al.\(^3\) reported the literature review by quoting guidelines in the United States and other studies and concluded that antithrombotic therapy was effective for asymptomatic VAI. According to the previous reports, medical treatment should be considered as first line and standard treatment for both symptomatic and asymptomatic VAI in acute phase.

In comparison with medical treatment, surgical interventions, including coil embolization, remain controversial. Coil embolization of the VA adjacent to the VAI may be theoretically effective to prevent the distal embolism from injured blood vessels. Surgical interventions should be indicated for patients whom antithrombotic therapy is contraindicated and those with progressive symptomatic VAI in spite of the antithrombotic therapy. On the other hand, surgical intervention for asymptomatic VAI or symptomatic VAI without neurological deterioration remains controversial. Biff et al.\(^5\) reported the clinical course of patients with cerebrovascular injury, including VAI, according to the Denver grading scale:\(^5\) the morphological classification of injured blood vessels using cerebral angiography (Grade I: stenosis rate of injured blood vessels, ≤25%; Grade II: stenosis rate, ≥25%; Grade III: pseudoaneurysm; Grade IV: vascular occlusion; and Grade V: vascular dissection or arteriovenous fistula). According to their study, 8 (8.6%) of 93 blood vessels showed a change from Grade I to II or higher, 17 (45.9%) of 37 blood vessels showed a change from Grade II to III or higher, and 1 (3.3%) of 30 blood vessels showed a change from Grade III to IV. Furthermore, they indicated that the incidences of stroke in Grade I, II, III, and IV VAI patients were 6, 38, 27, and 28%, respectively.\(^6\) The subjects of their study included patients for whom antithrombotic therapy was not performed. In addition, those in whom follow-up was impossible due to an unfavorable prognosis were excluded. However, their study reported that the morphology of injured vessels serially changed in some cases, suggesting that the incidence of morphological change depends on the grade of cerebrovascular injury. In addition, there were also grade-related differences in the incidence of stroke after cerebrovascular injury. Thus, the indication of surgical interventions for asymptomatic or non-progressive symptomatic VAI should be evaluated based on the grade assessment of injured vessels.

In the present case, the grade of left VAI was evaluated as grade IV (vascular occlusion), and coil embolization of the VA was performed after external fixation for cervical vertebral fracture. In patients with mechanical occlusion of the VA related to cervical vertebral subluxation, recanalization following the vertebral repair may induce thromboembolic complications. For prevention of the thromboembolic complications following the vertebral repair, coil embolization of the occluded vessel in the acute phase was reported in case series.\(^6\) However, in patients without surgical repair of the vertebrae, prophylactic coil embolization of occluded vessels for the prevention of thromboembolic complications remains debatable. As for the natural course of VAI with occlusion, Scott et al.\(^7\) investigated 43 patients with VAI (Grade IV), with a mean follow-up of 67 days (7–240 days). In their study, recanalizations were observed in 15 patients (35%) out of 43 patients. Stroke occurred in the acute phase in three patients (7%); it may have developed before the start of antithrombotic therapy. In subacute phase, there was no stroke reported, including patients with recanalization, suggesting that recanalization in the subacute phase was not a risk factor for stroke. They performed coil embolization for 11 patients (26%) in the initial phase of their series. However, after 2008, prophylactic coil embolization has not been applied, as the efficacy of prophylactic coil embolization of injured vessel was unclear. On the other hand, in another study, surgical treatments were performed for occlusive lesions. Hagiha et al.\(^8\) conducted coil embolization in six of eight blood vessels with Grade IV of VAI, and reported that there were no ischemic complications. Their study suggested a possible beneficial effect of coil embolization of Grade IV of VAI. However, surgical interventions of occlusive lesions (Grade IV) still remain controversial at present.

In the present case, antithrombotic therapy after coil embolization was omitted for the possible subsequent orthopedic surgery, while it was applied routinely following usual coil embolizations. The postoperative cerebral angiography of the present case showed that sufficient retrograde blood flow of the BA came into the bilateral PICAs and that the stump of the VA was very short. Therefore, a possibility of postoperative thromboembolic complications was not supposed to be high according to the above-mentioned angiographic findings. However, it might be better to administrate antithrombotic drugs following the procedure.

In summary, medical treatment involving antithrombotic therapy is recommended regardless of the neurological symptoms as an initial standard treatment for VAI. For
patients with neurological deterioration or those whom antithrombotic drugs are contraindicated, surgical interventions may be indicated. For patients with asymptomatic VAI or those with non-progressive symptomatic VAI, the indication of the surgical treatment should be considered based on the morphological classification of injured vessels.

Conclusion

We report a patient who underwent one-stage bilateral VA occlusion to prevent recurrent ischemic stroke after atlantoaxial fracture with traumatic bilateral VAIs. Based on the results of a literature review of VAI, treatment should be considered based on the ischemic symptoms and angiographic morphology of lesions.

Disclosure Statement

There is no conflict of interest for the author and coauthors.

References


