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Case Report

Stenting Combined with Coil Embolization of a Dissecting Aneurysm after Traumatic Vertebral Artery Injury

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Objective: We report a case of dissecting aneurysm developed after traumatic vertebral artery dissection (VAD) treated by stenting combined with coil embolization.

Case Presentation: A 47-year-old man was injured in a fall and presented with left VAD associated with central spinal injury due to C2 fracture. One week after admission, magnetic resonance imaging (MRI) demonstrated contralateral VAD with a dissecting aneurysm. Due to bilateral VAD, we employed coil embolization and stenting for the dissecting aneurysm to prevent rupture and embolic events, and to maintain the patency of the dominant right VA. There were no complications during the perioperative period. The follow-up angiogram 6 months after embolization confirmed obliteration of the dissecting aneurysm and patency of the parent artery.

Conclusion: Stenting combined with coil embolization is an effective treatment for traumatic VAD with a dissecting aneurysm.

Keywords ▶ vertebral artery, pseudoaneurysm, traumatic dissection, coil embolization, stenting

Introduction

The incidence of cerebral artery injury in patients with head trauma has been reported to be 1.11%–1.7%, including 0.13%–2.0% of traumatic vertebral artery injury (tVAI). Although tVAI is rare,[1–4] it is increasing because of improvement in the accuracy of screening. VAI become symptomatic, due to cerebral infarction or hemorrhage in some cases. However, optimal indications and timing of treatment for tVAI are still controversial. We herein report a case of dissecting aneurysm associated with tVAI treated by endovascular treatment to preserve the vertebral artery (VA), and review the literature.

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Case Presentation

A 47-year-old male fell down from a station platform after drinking alcohol, and developed weakness of the bilateral upper limbs and numbness. On admission to our hospital, his Glasgow Coma Scale (GCS) score was 14 (E4V4M6), a bruise involving the face to forehead and several abrasions on the limbs were observed. Muscular weakness of the bilateral upper arms (MMT 4/5) and bilateral forearms/areas distal to them (MMT 3/5) was noted. Paresthesia was observed at the periphery of the bilateral forearms.

Neuroradiological findings

Computed tomography (CT) scan of the head and neck demonstrated fracture of the root of nose without intracranial traumatic change. Cervical vertebral CT revealed fracture of axis (Hangman's fracture) and the inferior pole of fifth cervical vertebral body. Contrast-enhanced cervical CT angiography (CTA) showed the interruption of the left VA at high axis (C2) level of fracture site, suggesting traumatic change. On the other hand, the right VA was patent with no traumatic change (**Fig. 1**).

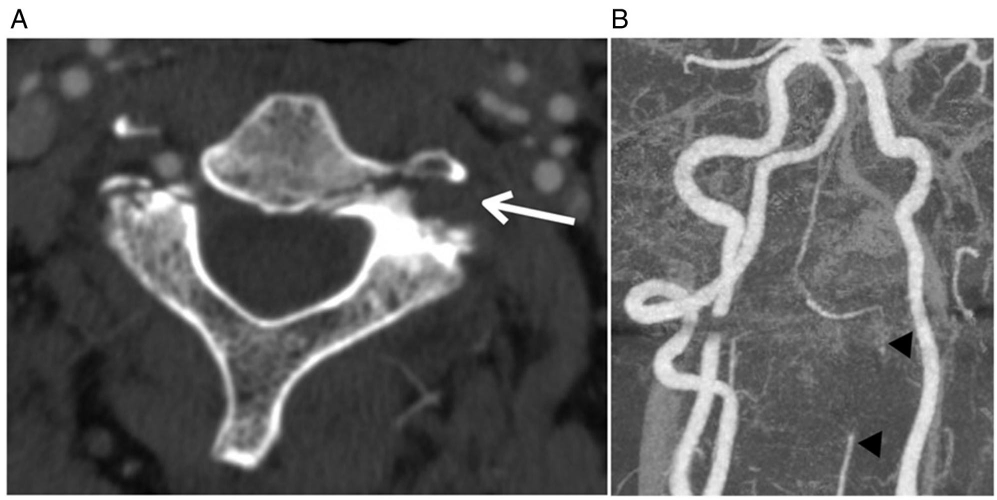

Fig. 1 (**A**) Axial view of CTA showed a filling defect consistent with left VA occlusion (arrow) at admission. (**B**) 3D-CTA showed the occluded segment (arrowhead) of the left VA and no traumatic changes at the right VA. CTA: computed tomography angiography; VA: vertebral artery

On cervical vertebral magnetic resonance imaging (MRI), at high C5 level, a snake-eye sign was noted, suggesting central spinal cord injury.

Course after admission

Under a diagnosis of multiple cervical vertebral fractures and central spinal cord injury, the patient was admitted to the department of orthopedics. However, emergency reposition for cervical vertebral fractures was considered to be unnecessary, and conservative treatment was performed. Basi-parallel anatomical scanning (BPAS) and CTA findings after admission suggested hypoplasia of the left VA, and occlusion related to VAI at the site of fracture.

Although there was no deterioration of neurological symptoms, MRI/magnetic resonance angiography (MRA) 1 week after admission revealed irregularity and localized dilatation in both V3 region of the right VA and right posterior inferior cerebellar artery (PICA) proximal portion, suggesting a new dissecting aneurysm (**Fig. 2**). On the other hand, recanalization of the left VA was confirmed. On fat-suppressed T1-weighted imaging, a hematoma was found around the aneurysm in the right V3 region. However, in the right PICA proximal portion, there was no flap or false lumen formation despite wall irregularity. There was no continuity between the V3 and V4 regions. Angiography on the following day revealed dissection with an aneurysm measuring 6 mm in maximum diameter in the right V3 region, as well as irregularity with partial dilation involving PICA and anterior spinal artery (ASA) in the right V4 region (**Fig. 3**). Left vertebral arteriography (VAG) showed that dissecting change still remained, but antero-grade flow was improved.

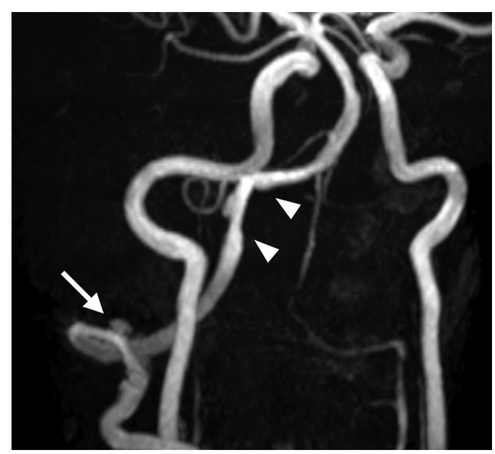

Fig. 2 One-week follow-up MRA showed pseudoaneurysm formation associated with the dissection of the right extracranial VA (arrow). MRA also demonstrated right PICA proximal VA dissection (arrowheads). MRA: magnetic resonance imaging angiography; PICA: posterior inferior cerebellar artery; VA: vertebral artery

Initially, the treatment for V3 aneurysmal change was given the highest priority because of considering the risk of rupture based on angiography and MRI findings. On the other hand, regarding the V4 lesion involving ASA and PICA, we adopted a strategy to consider treatment if there was worsening in the shape while continuing close follow-up. At this time, surgical treatment for cervical vertebral fracture was not selected. Thus, stenting combined with coil

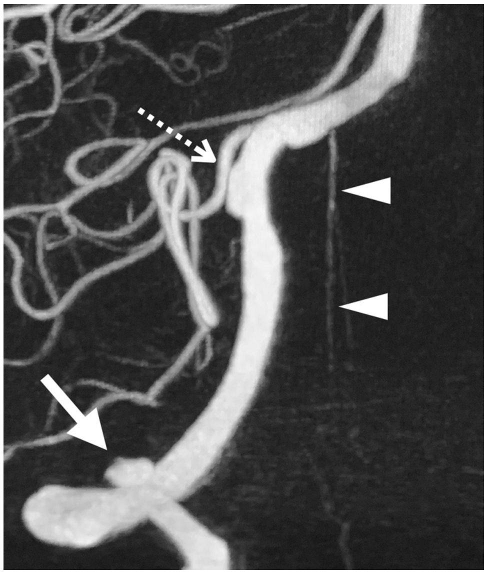

Fig. 3 Preoperative 3D-RA of the right VA showed vessel irregularity from the proximal PICA to the anterior spinal artery (arrowheads) consistent with dissection (dot arrow). The arrow indicates extracranial VA dissection with the pseudoaneurysm. PICA: posterior inferior cerebellar artery; VA: vertebral artery; 3D-RA: three-dimensional rotation angiography

embolization was planned under administration of the dual antiplatelet agents.

Treatment procedures

Daily clopidogrel 75 mg and aspirin 100 mg were started 1 week before endovascular treatment. On the 18th day after admission, stenting combined with aneurysmal coil embolization was performed under general anesthesia. A 7-Fr sheath was inserted through the right femoral artery, and a 4-Fr sheath through the left femoral artery. A 7-Fr guiding balloon catheter (Optimo, Tokai Medical Products, Aichi, Japan) was guided into the right VA, and a 4-Fr diagnostic catheter into the left VA for test occlusion of the right VA. The right VA was retrogradely visualized via the union through the left VA, and right VA occlusion was considered to be possible in the case of an unexpected event. Under road mapping, an SL-10 STR (Stryker, Kalamazoo, MI, USA) for stenting was guided to the distal portion of the right VA aneurysm using a Traxcess (MicroVention, TERUMO, Tustin, CA, USA). And then, an SL-10 pre-shaped S was carefully advanced into the aneurysm. An Axium PRIME 3D 3.5 mm × 8 cm (Medtronic, Minneapolis, MN, USA) was inserted as the first coil, and then 12 coils with 36 cm in length were carefully inserted with piecemeal technique, leading to complete occlusion of the aneurysm. After removing the SL-10 pre-shaped S, a Neuroform Atlas 4.5 × 30 mm (Stryker, Kalamazoo, MI, USA) was deployed to cover the dissecting lesion (**Fig. 4**). Cone-beam CT was performed to confirm stent fitting to the parent artery. DWI MRI the day after the treatment showed a single spot in the right cerebellar hemisphere; however, there was no any neurological symptoms. Angiography 2 weeks after treatment demonstrated complete disappearance of the treated aneurysm with patency of the parent artery. In addition, the dilated right V4 dissecting lesion had already been almost healed (**Fig. 5B**). Because muscular weakness of the bilateral upper limbs related to central spinal cord injury persisted, the patient was referred to another hospital for rehabilitation on the 36th postoperative day. Follow-up angiography 6 months after treatment confirmed that the V4 lesion was normalized (**Fig. 5C**) and the right VA was patent with complete disappearance of the V3 dissecting aneurysm (**Fig. 6**). The clinical course has been favorable, and follow-up is still being conducted at the outpatient clinic.

Discussion

In patients admitted due to blunt trauma, the incidence of cerebral artery injury is reportedly 1.11%–1.7%, being rare.[3,4] TVAI is also relatively rare,[1–3] of which incidence is 17.2%–25.5% in patients with blunt trauma of the head and neck. However, it ranges from 70% to 88% in patients with intervertebral joint dislocation or transverse foramen fracture, and from 50% to 67% in those with spinal cord injury, cerebrovascular injury may occur with high frequency if there are some changes in bone structure.[3,5] Pathologically, disruption of the internal elastic membrane results in the formation of a false lumen between the intima and media. Extension of false lumen can cause occlusion of branching vessels or true lumen. If dissection involving the media side leads to the loss of vascular support, rupture may occur through aneurysm formation. It also has a possibility that intra-aneurysmal blood flow stagnation may cause thrombosis.

The most common cause of tVAI is traffic accidents. The most frequent site is V3, followed by V2. As screening on the initial examination, CTA is routinely performed. Eastman et al. reported that the sensitivity and specificity of CTA were 96.1% and 100%, respectively.[6,7]

Regarding natural history, the incidence of cerebral infarction was reported to be 5%–24%,[8–10] and the mortality rate was 8%–18%.[11–13] However, several factors, such

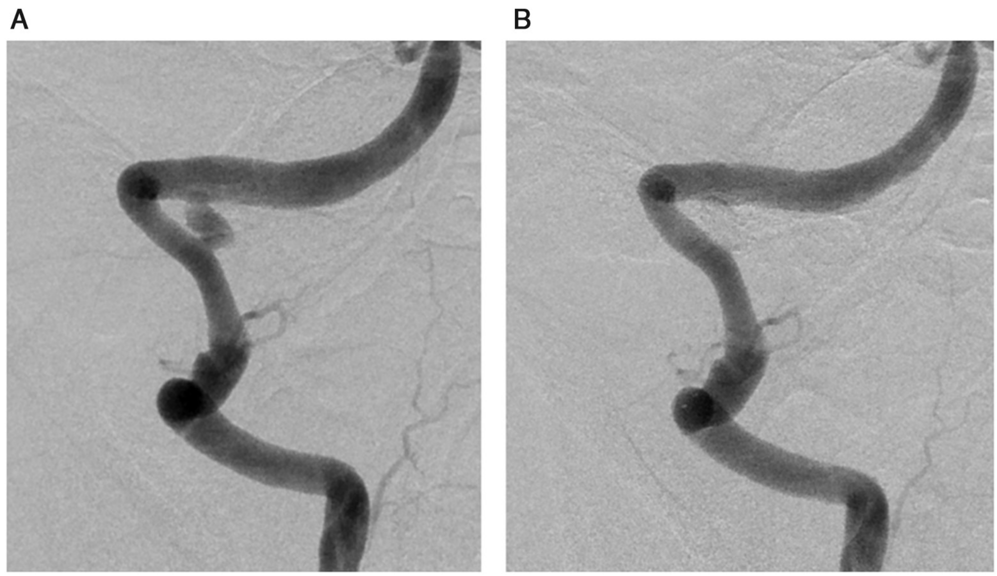

Fig. 4 (**A**) Preoperative right VA angiogram demonstrated pseudoaneurysm formation. (**B**) Postoperative angiogram revealed complete occlusion of the pseudoaneurysm and patency of the VA. VA: vertebral artery

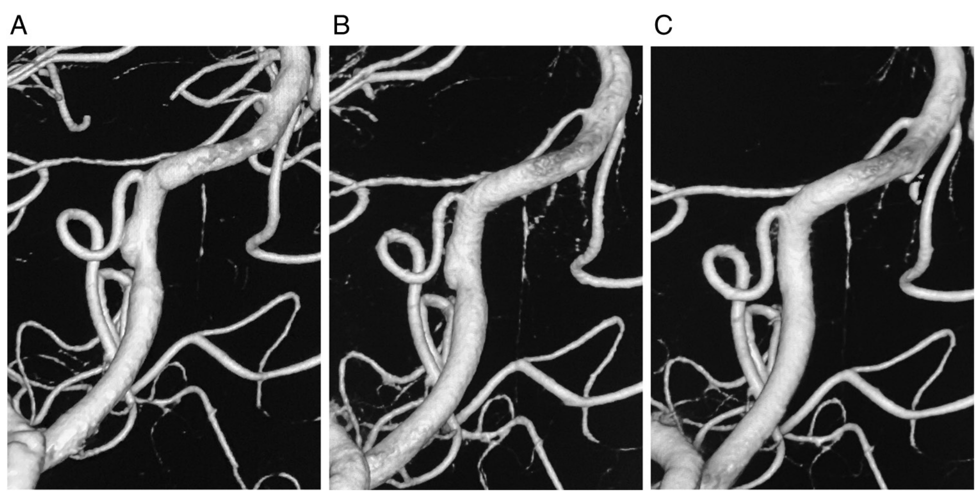

Fig. 5 3D-RA of the right VA. Pre-treatment (**A**), 2 weeks (**B**), and 6 months after treatment (**C**). (**B**): The distal PICA part of the VAD healed, although VAD slightly remained. (**C**): The affected vessel was normalized. PICA: posterior inferior cerebellar artery; VA: vertebral artery; VAD: vertebral artery dissection; 3D-RA: three-dimensional rotation angiography

as the severity of dissection and presence of antithrombotic therapy after injury, may influence the outcome. For risk assessment based on imaging findings, Denver's radiological grading scale[14] is routinely used. Biffl et al. evaluated 97 tVAI lesions using this scale. They performed angiography 7–10 days after injury on low-grade patients in whom the grade was evaluated as I or II at the time of injury, and reported that pseudoaneurysms were detected in 8% and 43%, respectively, requiring endovascular treatment.[11] They reported careful follow-up should be necessary regardless of the severity of dissection. Regarding the rupture of pseudoaneurysms, however, Akiyama et al. reported a patient with a traumatic extracranial internal carotid artery aneurysmal rupture measuring 4 cm, this condition is considered to be rare.[15]

The indication of endovascular intervention for tVAI should be considered include the progress of luminal stenosis-related ischemic events or pseudoaneurysm enlargement. The presence of collateral blood flow via Pcom and dominancy of VA are also important factors.[5,16] Interventional options include stenting, coil embolization of pseudoaneurysm, or occlusion of VA. According to a systematic review

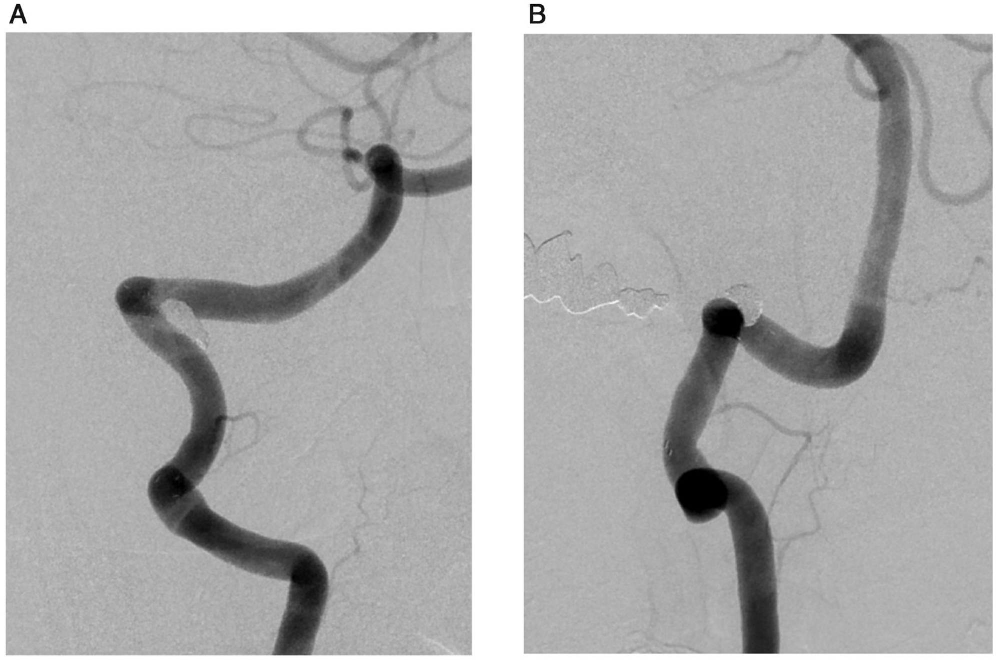

Fig. 6 Follow-up angiogram 6 months after treatment (long axis view (**A**), barrel view (**B**)) demonstrated complete occlusion of the pseudoaneurysm and patency of the right vertebral artery.

published by Pham et al., stenting was possible in all 12 patients with VAI, including 7 with traumatic VAI, without any complications.[16] Ansari et al. performed stenting treatment using Neuroform on seven patients with symptomatic V3-V4 VAI, and reported that treatment was completed for all patients including three patients treated with combined coil embolization with no perioperative complications.[17] Another study also presented similar treatment results,[18] endovascular treatment for VAI may be highly effective and safe. Although treatment using a flow-diverting (FD) stent has also been reported, long-term results should be investigated in a larger number of patients.[19,20]

In the present case, several coils were first inserted into the pseudoaneurysm with piecemeal technique after conducting an occlusion test in consideration of intraoperative rupture. And then, a Neuroform Atlas was placed at the dissecting VA to expect the promotion of healing for traumatic dissection. Neuroform, which is self-expandable open stent with a low radial force, was seemed to have advantage of fitting for vessel wall with more reduction of the load on the vessel wall. On the other hand, the FD effect may be lower than that of braided stents or FDs. Thus, stenting combined with coil embolization was performed to promote intra-aneurysmal thrombosis. As a result, follow-up DSA 6 months after the treatment demonstrated complete aneurysmal obliteration with normalization of the dissecting VA. Although the treatment for extracranial lesion using Neuroform Atlas is now off label, it may be a good option for the present case, based on the characteristics of this stent such as the accuracy of deploying the stent, and the adequate fitting on the vessel wall. However, when inserting the stent to the movable site of the cervical vertebrae, careful followed-up should be necessary whether stent fracture can occur or not. Furthermore, in the patients with tVAI, multiple traumas, which require the surgical treatments including orthopedic treatment, are often concomitantly observed. Because the administration of antiplatelet drugs is essential for stenting, stabilization of the general condition and hemorrhage control must be achieved as preconditions. Therefore, the timing of the treatment or therapeutic strategies should be carefully evaluated in cooperation with the corresponding departments.

Conclusion

We report a patient in whom stenting combined with coil embolization of a dissecting aneurysm, which developed during tVAI treatment, led to a favorable course. For endovascular treatment using a stent, perioperative antithrombotic therapy is necessary; therefore, the necessity of invasive surgery and the general condition related to multiple traumas should be sufficiently evaluated.

Disclosure Statement

We declare no conflict of interest.

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