A Case of Coil Embolization with Retrograde Stenting for Ruptured Vertebral Artery Dissecting Aneurysm Ipsilateral to Brachiocephalic Artery Occlusion

Seigo Kimura,¹ Shigeru Miyachi,² Ryokichi Yagi,³ Takuya Kanemitsu,³ Ryo Tamaki,¹ Daji Ogawa,¹ Tadashi Manno,¹ Hirokatsu Taniguchi,¹ and Toshihiko Kuroiwa³

Objective: We encountered a rare case of steal phenomenon via the vertebral artery due to occlusion of the brachiocephalic artery that developed dissecting aneurysm in the right vertebral artery and suffered subarachnoid hemorrhage.

Case Presentation: A 68-year-old woman was transported due to headache and disturbance of consciousness. Close examinations disclosed subarachnoid hemorrhage, dissecting aneurysm of the right vertebral artery, occlusion at the origin of the brachiocephalic artery, and consequent steal phenomenon. After a stent was placed retrogradely from the right posterior inferior cerebellar artery to the union of the two vertebral arteries via the left vertebral artery, coil embolization was performed.

Conclusion: For ruptured vertebral artery dissecting aneurysm ipsilateral to occlusion of the brachiocephalic artery, coil embolization was performed after retrograde stenting. This procedure is considered to have been useful as a radical endovascular treatment to preserve the parent artery and prevent re-rupture of the aneurysm.

Keywords ► subclavian steal syndrome, stent-assisted coil embolization, intracranial dissecting aneurysm, subarachnoid hemorrhage

Introduction

In vertebral artery dissection, the intima is ruptured idiopathically, and dissection develops between layers of the vascular wall.¹ Usually, ascending hemodynamic stress is a cause of this condition.²,³ If a subclavian artery is occluded, little anterograde blood flow occurs in the ipsilateral vertebral artery, but this site may be retrogradely subjected to similar blood flow stress if there is steal from the contralateral side. In the rare case presented here, there was steal of blood flow via the vertebral artery due to occlusion of the brachiocephalic artery, dissecting aneurysm occurred in the right vertebral artery, which received retrograde blood flow, and subarachnoid hemorrhage was caused by its rupture. We performed stent-assisted coil embolization to preserve the blood flow of the vertebral artery, which was an important collateral vessel, and obtained a favorable outcome.

Case Presentation

The patient was a 68-year-old woman with histories of pulmonary emphysema and hypertension who had been cared for at home due to poor pulmonary function. She had complained of headache from 3 days before she suddenly showed deterioration of the level of consciousness and was emergently transported. The findings on arrival at our hospital were Japan Coma Scale (JCS)³, isocoria, positive light reflex, and left
arm and leg paresis. Head CT scan showed subarachnoid hemorrhage (Hunt & Kosnik grade III, World Federation of Neurosurgical Societies [WFNS] grade IV, Fisher group 2) (Fig. 1), and head CTA performed immediately thereafter disclosed dissecting aneurysm of the right vertebral artery distal to the right posterior inferior cerebellar artery. In addition to the above findings, emergency angiography revealed occlusion at the origin of the brachiocephalic artery and right common carotid artery and, due to consequent subclavian steal, there was blood flow from the right vertebral artery to the right internal carotid artery via the anastomosis to the right occipital artery with reflux to the brachial artery (Fig. 2). Following angiography, we decided to perform emergency endovascular treatment of the dissecting aneurysm of the right vertebral artery (Figs. 3 and 4A). The vertebral artery was an important collateral vessel to the right arm and right internal carotid artery, and as its preservation was absolutely necessary, we performed coil embolization of the aneurysm alone with stenting despite the acute phase of rupture.

Under general anesthesia, a 6 Fr long sheath was inserted to the right inguinal artery. Navigation to the right vertebral artery was attempted using a 6 Fr guidecatheter (Roadmaster; GOODMAN CO., LTD., Aichi, Japan), but as it was difficult, the guide system was substituted for 6 Fr shuttle sheath (Cook Medical, Bloomington, IN, USA) + 6 Fr Cerulean (Medikit Co., Ltd, Tokyo, Japan) using a stiff wire (Radifocus; Terumo Corporation, Tokyo, Japan) to increase the support force. The 6 Fr Cerulean was placed at the level of the second cervical vertebra, and, by guiding with a sharply curved microguidewire (GT12 double angle; Terumo Corporation), SL-10 (Stryker, Kalamazoo, MI, USA), and Headway STR (MicroVention Terumo, Tustin, CA, USA) were advanced for coiling and stenting, respectively, from the left to the right vertebral artery across their union (Fig. 4B). After the SL-10 was placed at the aneurysm, LVIS Jr. 2.5 × 23 mm (MicroVention Terumo) was placed in a standby position through the Headway. Since the Headway tended to approach the dome side of the aneurysm, the direction of the catheter was adjusted first by placing a 6 mm × 15 mm coil (Orbit Galaxy Fill; Codman & Shurtleff, Johnson & Johnson, Raynham, MA, USA) (Fig. 4C), and the LVIS Jr was deployed from a point distal to the right posterior inferior cerebellar artery to the union (Fig. 4D). As a result of embolization using a total of eight coils through the SL-10 placed in the jail lumen, the aneurysm was obliterated, and the retrograde blood flow of the right vertebral artery was maintained adequately. However, on subsequent confirmation angiography, thrombus formation was noted in the stent (Fig. 4E). Therefore, drip infusion of ozagrel Na at 80 mg was immediately performed, followed by the administration of aspirin at 300 mg and clopidogrel at 300 mg through the stomach tube, and continuous administration of argatroban was also initiated. Since the thrombus regressed after 15 minutes, the treatment was terminated (Fig. 4F). On the day after the treatment, also 300 mg of clopidogrel and 300 mg of Bayaspirin were administered transnasally through the stomach tube. From 2 days after the treatment, the treatment was changed to 75 mg of clopidogrel and 100 mg of Bayaspirin.

While diffuse cerebral infarction was demonstrated on postoperative imaging of the head, no clear occlusion of major vessels or associated cerebral infarction was observed in the subsequent course (Fig. 5). No exacerbation of neurological findings or symptomatic intracranial vasospasm was noted. As paralysis was alleviated, the condition recovered nearly to the level before admission, and the patient was discharged to a rehabilitation facility 60 days after the onset.

Discussion

Although subclavian steal syndrome, in which brain ischemia is caused by stenosis or occlusion of the subclavian artery, is widely recognized as a pathological entity, is widely recognized as a pathological entity.
A Case of IVR for VADA Ipsilateral to BCA Occlusion

The re-rupture rate of ruptured dissecting aneurysm of the vertebral artery is extremely high at 30%–71%, and re-rupture is known to often occur within 24 hours. In addition, as the mortality due to re-rupture reaches 47%, radical treatment is performed at the earliest possible time. Usually, trapping of the parent artery including the aneurysm is performed endovascularly, but, in our patient, preservation of the vertebral artery was attempted.

Fig. 2 (A) Early arterial phase of left vertebral artery angiography: A dissecting aneurysm was observed in the right vertebral artery distal to the right posterior inferior cerebellar artery. (B) Late arterial phase of left vertebral artery angiography: The origin of the brachiocephalic artery and right common carotid artery were occluded, and, due to the consequent subclavian steal, blood flow from the right vertebral artery to the right internal carotid artery via the anastomosis to the right occipital artery was observed, with reflux to the brachial artery. White arrow: aneurysm. White arrowhead: anastomosis between the vertebral artery and external carotid artery. Black arrow: site of drainage to the brachial artery.

Fig. 3 3D DSA

reports that patients with this disorder developed subarachnoid hemorrhage due to vertebral artery dissection are rare. According to the only report by Strozyk et al., the relationship of vertebral artery dissection with subclavian steal syndrome was not clear, but dissection was speculated to have been caused by “hemodynamic stress” due to retrograde blood flow. In our patient, also, the systolic blood pressure in the brachium of the normal side (left) exceeded 200 mmHg, and there was a pressure gradient of 100 mmHg or more compared with the affected side. Since blood flow that ascends linearly in the left vertebral artery turns sharply to the caudal direction at the union, turbulent flow is considered likely to occur at this site. Moreover, to maintain the perfusion of the arm and right internal carotid artery territory, a large load of blood flow is considered to have been exerted on the right vertebral artery, probably contributing to its dissection.

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Fig. 4  Left vertebral artery angiography. Working angle (A). SL-10 and Headway STR were advanced from the left to the right vertebral artery across the union, the SL-10 was placed at the aneurysm, and LVIS Jr. $2.5 \times 23$ mm was placed in a standby position through the Headway (B). A $6 \times 15$ mm coil was placed in the aneurysm (C). The LVIS Jr was deployed from a site distal to the right posterior inferior cerebellar artery to the union (D). After embolization was performed using a total of eight coils from the SL-10, the aneurysm was obliterated, but thrombus formation was noted in the stent (E). The thrombus regressed 15 minutes after the administration of antiplatelets (F). White arrows: ends of the stent. White arrowhead: thrombosed area. Headway STR: MicroVention Terumo, Tustin, CA, USA; LVIS Jr.: MicroVention Terumo; SL-10: Stryker, Kalamazoo, MI, USA.

Fig. 5  While diffuse cerebral infarction was observed on postprocedural imaging examination of the head, there was no clear occlusion of major vessels or associated cerebral infarction during the subsequent course.
by stenting as it was an important collateral vessel. Concerning stent-assisted coil embolization for dissecting aneurysm of the vertebral artery in the acute phase of rupture, Chen et al.\(^9\) reported that favorable outcomes were obtained in seven of the eight patients with posterior inferior cerebellar arteries (PICA) involved type lesions.

In our patient, we approached the right vertebral artery from the left vertebral artery via the union. An advantage of this approach is that the catheter can be manipulated along the anterograde blood flow if the stent can be placed at an appropriate point. Disadvantages are that extremely careful manipulation is necessary when the catheter is guided across the sharply angled union and, immediately after this, through the neck of the dissecting aneurysm, and that positioning of the proximal end of the stent (on the opposite side of the vertebral artery [VA] union) is difficult. In the past cases, advantages of the ascending approach from the right brachial artery to the right vertebral artery (against the direction of blood flow)\(^2\) are the simplicity of placement of the guide catheter and the ease of positioning of the distal end of the catheter. Disadvantages include loading of the dissecting aneurysm due to congestion of blood flow caused by the placement of a thick guide catheter. In consideration of these points, we selected an approach via the left vertebral artery, which was intact.

In our patient, the greatest problem was posed by the extreme shortness of the distance between the distal end of the dissecting aneurysm and the union and the tendency of the catheter placed in a curved segment to straighten, causing shift of its tip to a deeper area of the aneurysm, where it was considered to be ruptured, and allowing it to hit the aneurysmal wall. The procedure is simplified by stenting before coil placement, but this may push the catheter to a deeper area and cause loss of freedom of catheter movement and exertion of excessive stress on the aneurysmal wall by the loop of the coil. Therefore, to avoid this, we first placed one coil and then deployed the LVIS Jr. by jacking it up. The semi-jail technique\(^10\) was also a possible option, but as this technique required delicate adjustment of the position not to allow it to protrude into the left vertebral artery, we decided to deploy the entire device while sufficient visual monitoring of the stent was possible. In addition, although the anterior spinal artery could not be identified, the dissected area may have been very close to the union, and its origin may have been involved. Also, a penetrating branch sprang to the medial direction from the opposite side of the aneurysm. For these reasons, preservation of the parent artery by stenting was considered necessary not only because of its importance as a collateral vessel, but also for the preservation of the penetrating branch.

In endovascular treatment for dissecting aneurysm of the vertebral artery, stent-assisted coil embolization may also be selected when there is hypoplasia of the contralateral vertebral artery or a penetrating branch springing from around the dissected area,\(^9\) but the placement of the devices without antplatelet preloading may invite periprocedural or delayed thrombosis,\(^11\) so the indication must be evaluated carefully. In the present case, stent thrombosis also occurred after stenting probably due to the inadequacy of intraprocedural anticoagulant or antplatelet therapy but could fortunately be controlled by rapid addition of anticoagulant and antplatelet therapy. However, ischemia of the bilateral cerebral and left cerebellar hemispheres observed on postoperative MRI is considered to have been a complication of the complicated intraprocedural manipulations. In acute phase patients, such as ours, attention to the risk of ischemic complications is always necessary. However, there have been reports that antiplatelets (clopidogrel at 150 mg, aspirin at 200 mg) were administered 2 hours before coil embolization for ruptured intracranial aneurysm, resulting in a favorable outcome,\(^12\) and that acetylsalicylic acid (ASA) was administered at 250 mg after the placement of the first coil for ruptured intracranial aneurysm, resulting in a decrease in thrombotic events.\(^13\) Therefore, further evaluation is necessary concerning the timing of the initiation of antplatelet therapy.

In parent-artery-preserving treatment as performed in our patient, procedures, such as coil embolization performed by anterogradely or retrogradely guiding a microcatheter into the aneurysm by the trans-cell technique and, for more radical treatment, parent artery occlusion of the right vertebral artery by the transbrachial approach should be considered in the event of future recurrence although these procedures involve the risk of re-enlargement of the aneurysm.

### Conclusion

For ruptured dissecting aneurysm of the right vertebral artery, which was an important collateral vessel to the internal carotid artery and the brachium, in a patient who showed steal of blood flow associated with occlusion of the brachiocephalic and common carotid arteries, stent-assisted coil embolization was performed by an approach from the intact left vertebral artery. This procedure is
considered to have been useful as a radial endovascular treatment for the preservation of the parent artery and prevention of re-rupture.

Disclosure Statement

Neither the first author nor any of the coauthors have any conflicts of interest.

References