Case Report

Reconstructive embolization for contralateral vertebral artery dissecting aneurysm that developed after internal trapping of ruptured vertebral artery dissection: A case report and literature review

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ABSTRACT

Background: It is not well-known that contralateral vertebral artery dissecting aneurysms (VADA) may be newly revealed after parental artery occlusion for unilateral VADA. However, the optimal treatment strategies and perioperative management have not been established. In this report, we present the case of a patient who required reconstructive embolization in the subacute stage for contralateral VADA developed after endovascular internal trapping of the ruptured VADA.

Case Description: A 61-year-old man developed subsequent disturbance of consciousness. Head CT showed a diffuse and symmetrical SAH. 3DCT revealed a fusiform aneurysm of the left intracranial vertebral artery with bleb formation. We performed emergency endovascular parent artery occlusion of the left vertebral artery. A digital subtraction angiography on postoperative day 16 showed continued occlusion of the left VA, and a fusiform aneurysm was noted at the right VA. We performed reconstructive embolization and the patient eventually recovered with minimal persistent symptoms.

Conclusion: Since the outcomes of contralateral VAD complicated by infarction or hemorrhage are poor, and most cases develop within 7–14 days after endovascular internal trapping for unilateral VAD, performing bilateral radiographic reinspection within this time frame is recommended for early detection and preventive treatment of possible contralateral VADs.

Keywords: Parent artery occlusion, Stent-assisted coiling, Subarachnoid hemorrhage, Vertebral artery dissection

INTRODUCTION

Intracranial vertebral artery dissection (VAD) or vertebral artery dissecting aneurysm (VADA) is occasionally discovered bilateral sides simultaneously.[9] Furthermore, there are rare cases of a *de novo* or progressed VAD on the contralateral side that appeared after the treatment of the primary VAD. However, the natural history and pathophysiology of bilateral or subsequent contralateral VAD remain unknown since only a few reports have been published.[2] Consequently, the optimal treatment strategies and perioperative management have not been

established, including an imaging follow-up protocol of VAD focusing on the possible subsequent appearance or progression of a contralateral lesion. In this report, we present a case of contralateral VADA that developed shortly after endovascular internal trapping for a ruptured VADA. Hence, additional stent-assisted coil embolization in the subacute stage was required. Furthermore, we reviewed the existing literature on VADAs.

CASE REPORT

A 61-year-old man developed a sudden-onset headache and subsequent disturbance of consciousness while at work. On admission to a nearby hospital, his Glasgow Coma Scale score was 9 (E2V2M5), although pupil size and light reflexes were bilaterally intact. His medical history included hypertension, diabetes (HbA1c 6.5%), and Stanford Type B aortic dissection (treated conservatively), but he had currently no symptom. There was no family history of subarachnoid hemorrhage (SAH). Head computed tomography (CT) showed a diffuse and symmetrical SAH distributed mainly in the posterior cranial fossa [Figure 1a]. Three-dimensional (3D) CT revealed a fusiform aneurysm of the left intracranial vertebral artery with bleb formation; the right distal vertebral artery and basilar artery were poorly depicted [Figure 1b]. The patient was then transferred to

our hospital due to difficulties in treatment at the initial site. We performed digital subtraction angiography (DSA). The left vertebral angiography showed a VADA of the left vertebral artery on the V4 segment, proximal to the origin of the posterior inferior cerebellar artery (PICA) [Figure 1c]. The right vertebral angiography showed a pearl-and-string sign on the right vertebral artery proximal to the PICA origin, suggesting another dissection [Figure 1d]. Based on these and other angiographical findings [Figure 1e and f], we focused on the rupture on the left side. We performed emergency endovascular parent artery occlusion (PAO) of the left vertebral artery, proximal to the PICA origin, using 15 detachable platinum coils under general anesthesia and systemic heparinization (activated clotting time 2–3 times above baseline). The left PICA was well preserved at the end of the procedure. When the patient awoke from anesthesia on postoperative day (POD) 1, he presented dysphagia, ataxia, and Horner's syndrome. Magnetic resonance imaging diffusion-weighted imaging (DWI) showed areas of high-intensity signal on the left cerebellar hemisphere and the left lateral medullary area.

On POD 10, follow-up magnetic resonance angiography and time-of-flight imaging demonstrated patency of the right vertebral artery and the double-lumen sign, although the right vertebral artery diameter was not increased
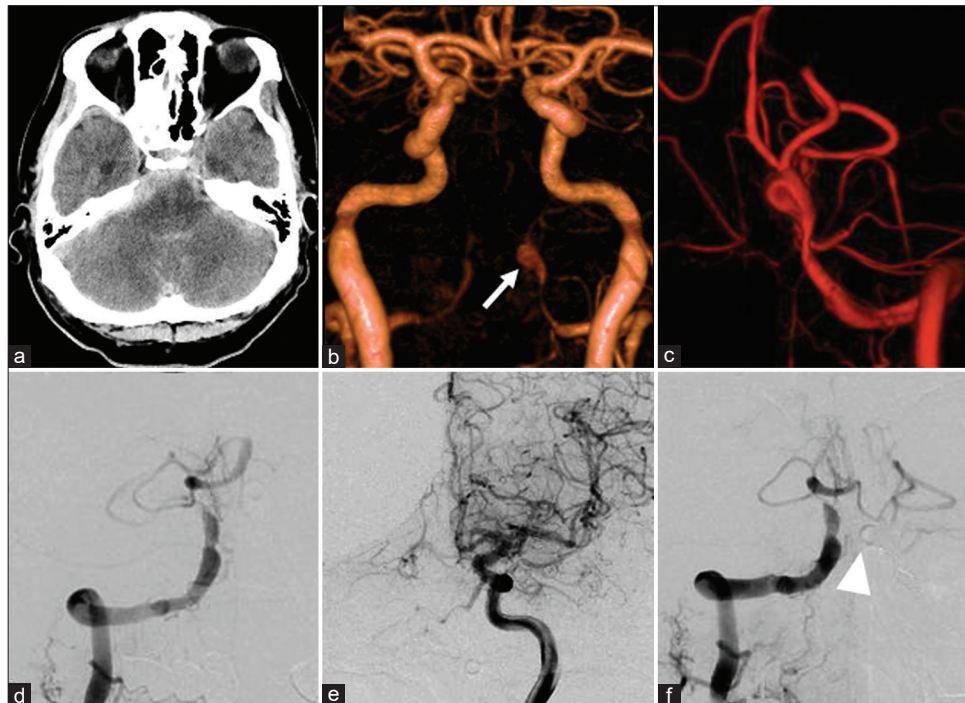

Figure 1: (a) Plain CT shows diffuse subarachnoid hemorrhage, mainly in the prepontine cistern. (b) 3DCTA shows dissecting aneurysm in the left intracranial VA (arrow) and poor depiction of the right VA. (c) Three-dimensional DSA shows wall irregularity and aneurysm formation of the left intracranial VA. (d) The right VAG showed a pearl and string sign on his right VA proximally to PICA origin suggesting dissection. (e) The left internal carotid angiography describes basilar artery and right AICA through posterior communicating artery. (f) The right vertebral angiography shows that the left PICA is patency after parent artery occlusion (arrowhead).
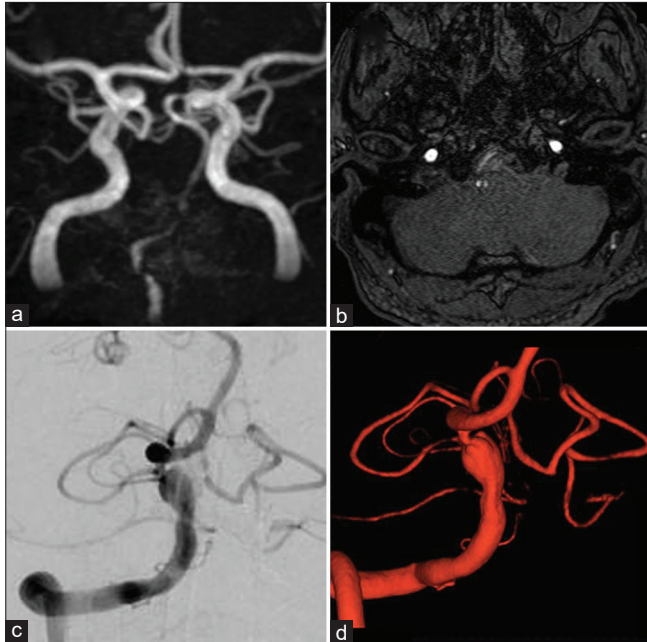
Figure 2: (a) MRA after PAO shows patency of basilar artery. (b) TOF imaging after PAO demonstrated patency of the right VA and double-lumen sign suggesting dissection, though there was no expanded diameter suggesting aneurysm formation of the right VA. (c and d) The right vertebral angiography POD16 shows that left PICA patency and right VADA progressing revealed.

Figure 3: Schema of the coil embolization with balloon-in-stent technique. (a) After secure distal by stent delivery catheter, wrap coil incompletely. (b) Deploy the stent. (c) Inflate balloon inside stent securing patency and insert coil with jail technique.

Figure 4: (a) Angiography shows that LVIS blue stent is deployed after wraps coil incompletely. (b) Angiography shows that the balloon in stent is inflated and the coil is embolized. (c) The right VA angiography after stent-assisted coil embolization shows patency of the right VA and BA. (d) MRI shows no DWI high-intensity area.

[Figure 2a and b]. However, repeat DSA on POD 16 showed that the left vertebral artery remained occluded, and a fusiform aneurysm (8 × 6 mm) was noted at the right V4 segment proximal to the stenosis [Figure 2c and d]. Based on these findings, we planned a stent-assisted coil embolization for the right VADA to prevent rupture; thus, we started simultaneous aspirin (100 mg/day) and clopidogrel 75 mg/day as prophylaxis. On POD 30, the endovascular treatment was performed through the left femoral artery approach. A 5 Fr FUBUKI guiding sheath (ASAHI Intec, Aichi, Japan) was placed in the right distal vertebral artery under general anesthesia and systemic heparinization. Headway 21 (Terumo Corp., Tokyo, Japan) was initially guided into the right vertebral artery distal to the aneurysm, and Excelsior XT-17 (Stryker Corp., Kalamazoo, MI, USA), shaped like a nautilus, was positioned inside the aneurysm. A framing coil (7 mm × 20 cm) was inserted partially through XT-17 [Figure 3], and an LVIS blue stent (4.5 × 10 mm) (MicroVention, Aliso Viejo, CA, USA) was deployed through Headway 21 into the right V4 segment distal to the aneurysm. Then, a Scepter C balloon catheter (4 × 10 mm) (Terumo Corp., Tokyo, Japan) was guided into the stent by exchanging the Headway 21. Detachable platinum coils were inserted stepwise through the jailed XT-17, while the intravascular lumen was secured by intermittent inflation of the balloon inside the stent [Figure 4a and b]. Finally, intra-
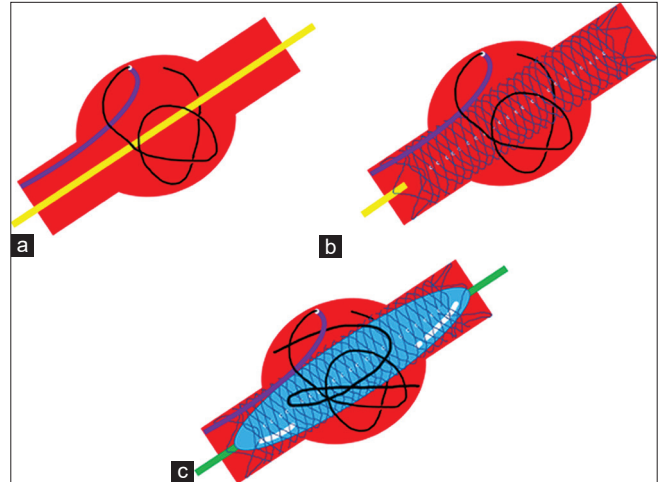
aneurysmal embolization was completed using 10 coils, and a residual filling of the dome was confirmed on postoperative DSA [Figure 4c]. Postoperative DWI revealed no significant acute thromboembolism [Figure 4d], and no additional neurological symptoms were observed, while the existing symptoms were unchanged. The patient received neurologic rehabilitation at another hospital and his symptoms resolved

almost completely. He returned to work 3 months after the second treatment, with a modified Rankin scale score of 2.

Ethical approval for this study was granted by the Yokohama City University Human Ethics Committee (B191200034) in accordance with the research guidelines. The patient provided written informed consent for publication and use of the data in this report.

DISCUSSION

We report the case of a patient with the progression of an existing wall irregularity of the contralateral vertebral artery shortly after the surgical occlusion of a ruptured VADA. To the best of our knowledge, only 17 other cases of progressing or *de novo* contralateral vertebral artery wall irregularity in patients with initial unilateral VAD or VADA have been reported [Table 1].[3,5,6,8,10,12-15] Interestingly, 17 cases (including the current one) were reported from Japan and one from Korea. We reviewed the first event and its treatment, progress, secondary event, the interval before the secondary event, category (*de novo* or progressing), and outcomes from the 18 reports. Endovascular PAO or trapping by direct surgery was performed in 15 of these cases. The other three cases were treated conservatively; in two of them, the dissected vertebral artery occluded spontaneously before the contralateral VAD was discovered. The last patient presented with bleeding despite the patent unilateral vertebral artery when the contralateral VADA appeared *de novo*.

There are several treatment options for ruptured VAD or VADA. Reconstructive treatment is possible with two methods: stent-assisted coil embolization and flow diversion with multiple stents or flow diverter. In contrast, deconstructive treatment can be performed with endovascular PAO or surgical trapping, with or without the bypass technique. The appropriate treatment strategy must be chosen depending on individual factors,[4] for example, based on the dominant side of the vertebral artery, ruptured side, and location of the PICA. In the present case, we decided to employ endovascular PAO for the left VADA initially and then conducted imaging studies on the right VAD, monitoring it closely for several reasons. First, we assumed that the left VADA was the source of the bleeding based on imaging features, such as the bleb structure.[7] Second, the left vertebral artery was proximal to the PICA and the right vertebral artery was stenotic; however, the perfusion of the posterior circulation was secured by the right vertebral artery and left internal carotid artery. Third, reconstructive treatment using intraluminal stents usually requires antiplatelet therapy for preventing thromboembolism. However, antiplatelet therapy might be inappropriate in the acute stage because of the risk of rebleeding after treatment. Finally, we prioritized preventing rebleeding from the ruptured VADA over the risk of progression of the contralateral vessel wall irregularity due to hemodynamic stress. We avoided a one-step approach by performing repeated imaging in a short period to respond promptly to the wall irregularity if necessary.

The hemodynamic stress after ipsilateral VA occlusion is a potential cause of contralateral VAD or VADA.[9] In the present case, we assume that the increasing hemodynamic stress after the initial endovascular PAO led to the progression of the coexisting contralateral VAD. However, a subsequent VAD on the contralateral side may occur even if the initially injured vertebral artery is not occluded. This fact suggests that there might be other pathophysiological mechanisms in addition to hemodynamic stress. Ro *et al.* studied 58 medicolegal autopsy cases of ruptured intracranial VAD among 553 nontraumatic fatal cases of SAH. They reported that 25 cases (43.1%) already had previous latent dissections when the first bleeding occurred. Moreover, seven of these cases revealed a previous latent dissection contralateral to the ruptured side, and 10 of 25 cases had bilateral dissections.[11] These findings may suggest that patients who develop VAD have general arterial wall vulnerability, and minor dissections could remain undetectable by imaging studies. Therefore, it is advisable to observe any imaging changes in the vertebral artery morphology in patients with bilateral vertebral artery wall irregularities at presentation and those with only a unilateral lesion on imaging. This careful observation is recommended regardless of the surgical intervention.

Based on our review, contralateral VADs were diagnosed due to symptomatic ischemic or bleeding events in 10 of 18 cases (55.6%), and five of these patients subsequently died or remained severely disabled [Table 1]. In addition, these events occurred within 2 weeks after onset in seven of 10 cases, with a particularly high incidence in the first 7 days (71.4%). In light of these findings, it would be preferable to perform a radiographic reinspection at least within 1 or 2 weeks after the primary VAD treatment to examine whether the vascular morphology of the contralateral vertebral artery is preserved.

In this case, the right VADA progressed rapidly after PAO for the left VADA, and prevention of rupture by reconstructive immediately complete embolization was necessary. We adopted a stent-assisted coil embolization with balloon-in-stent technique (BIST) for the secondary treatment. This technique has several advantages.[1] First, the inflated balloon within the deployed stent prevents the protrusion of a coil loop into the parent artery through the stent struts and stent deformation into the luminal side due to the compression by the coil mass. BIST may be useful to preserve the parent artery more reliably, especially in cases of fusiform aneurysms in which proper working angles are difficult to secure. Second, immediate temporary interruption of the parent artery by placing a balloon catheter is advisable if bleeding from the aneurysm occurs during the procedure; this approach is helpful to obtain rapid hemostasis. Using these advantages,

Table 1: Summary of the cases with the progression of contralateral VA wall irregularity after unilateral VAD or VADA was reported.

Author, year	Case	Age, sex	First event	First treatment	Interval	Second event	CWI	Second treatment	mRS
Mizutani, 1994	1	47, F	Severe headache	Proximal clipping	7 years	Enlargement, facial spasm	Progressing	No description	N/A
Yasui, 1998	2	44, M	SAH	Trapping	4 months	Ischemia	Progressing	None	6
Kubo, 1998	3	49, F	SAH	Occlusion with a detachable balloon	3 weeks	Enlargement, no symptom	Progressing	No description	N/A
Otawara, 2002	4	49, M	SAH	Trapping, PICA-PICA bypass	2 days	Bleeding	Progressing	None	6
	5	62, M	SAH	Resection, interposition of the vein graft	6 days	Bleeding	Progressing	None	6
	6	51, F	SAH	Trapping, PICA-PICA bypass	1 month	Enlargement, no symptom	*De novo*	Observation, conservative	N/A
Inui, 2006	7	36, M	Brain stem ischemia	Conservative (spontaneous occlusion: 2 weeks)	13 months	Ischemia	*De novo*	None	6
	8	45, M	SAH	Endovascular occlusion	11 days	Ischemia	*De novo*	Anticoagulation	5
Inoue, 2008	9	64, F	SAH	Endovascular occlusion	2 months	Enlargement, no symptom	Progressing	Parent artery occlusion	N/A
Sakamoto, 2008	10	54, M	Headache	Endovascular occlusion	7 days	Headache	Progressing	Blood pressure control	1
Katsuno, 2009	11	39, M	SAH	Trapping, OA-PICA bypass	8 h	Bleeding	*De novo*	None	6
Sanada, 2012	12	46, M	Mass effect	Trapping	2 days	Bleeding	Progressing	Trapping, OA-PICA bypass	2
Yoon, 2012	13	44, F	SAH	Endovascular occlusion	8 months	Enlargement, no symptom	Progressing	Stent-assisted coil embolization	3
Komoribayashi, 2013	14	44, M	No symptom	Conservative (spontaneous occlusion: 31 days)	26 months	Bleeding	*De novo*	Observation, none	6
Kato, 2015	15	55, M	SAH	Trapping, OA-PICA clipping	7 days	Bleeding	Progressing	None	6
Kidani, 2017	16	55, F	SAH	Parent artery occlusion	3 months	Enlargement, no symptom	*De novo*	Stent-assisted coil embolization	2
Tsuji, 2019	17	52, M	Brain stem ischemia	Conservative	9 days	Bleeding	*De novo*	Parent artery occlusion	1
Present case	18	61, M	SAH	Endovascular occlusion	16 days	Enlargement, no symptom	Progressing	Stent-assisted coil embolization	2

CWI: Contralateral wall irregularity, mRS: modified Rankin scale, N/A: Not applicable

we can pack coils into the aneurysm aggressively and safely, resulting in adequate obliteration of the aneurysmal dome. On the other hand, BIST has some potential disadvantages that must be considered to ensure the effectiveness and safety of the procedure. First, BIST requires multiple devices and processes that may complicate the procedure and increase the risk of thromboembolism. Second, the surgeon should deflate the balloon intermittently to restore the blood flow and simultaneously confirm that the coil loops remain in place with the vessel open. Third, overinflation of the balloon should be avoided because of the risk of stent shortening or migrating into the aneurysm. In summary, when performing BIST, it is essential to obtain sufficient intraoperative anticoagulation, use a balloon catheter with the appropriate size and shape, and avoid prolonged blood flow interruption. In the present case, we were unable to obtain the down-the-barrel view during the procedure; however, BIST allowed us to perform coil insertion while ensuring the patency of the parent artery.

The small sample size of this review is a limitation. We studied 18 cases, including the present case. Large-scale studies are needed to elucidate further the pathophysiology of contralateral VAD developing after the occlusion of a primary VAD.

CONCLUSION

We were able to successfully treat a case of contralateral vertebral artery dissecting aneurysm that developed after internal trapping of ruptured vertebral artery dissection. Imaging reinspection of vascular morphology within 7-14 days after treatment of unilateral VAD may allow early detection and prophylactic treatment of newly developed contralateral VADs.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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