

Ruptured Basilar Artery Dissection Diagnosed Using Magnetic Resonance Vessel Wall Imaging and Treated with Coil Embolization with Overlapping LVIS Stents: A Case Report

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The diagnosis and treatment of patients with ruptured basilar artery dissection (rBAD) are often difficult. We present a case of rBAD diagnosed with magnetic resonance vessel wall imaging (MR-VWI) and treated with coil embolization with overlapping low-profile visualized intraluminal support (LVIS) stents. The case is of a 49-year-old woman with subarachnoid hemorrhage. digital subtraction angiography (DSA) showed irregularity in an anterior wall of the middle portion of the basilar artery, indicating the presence of a false lumen. MR-VWI showed local enhancement in an arterial wall, which was consistent with the wall irregularity observed in DSA. Overlapping stents (two LVIS stents) was performed in the basilar artery and coils were placed in the false lumen. The false lumen was completely thrombosed, and antegrade blood flow of the basilar artery was preserved. Dual antiplatelet therapy was administered, and the patient underwent an uneventful postoperative course. DSA performed 6 months later showed a white-collar sign. MR-VWI has attracted attention as a useful modality for detecting a ruptured lesion in patients with subarachnoid hemorrhage. This is the first report, to the best of our knowledge, describing the practical use of MR-VWI for rBAD. MR-VWI is suggested to improve diagnostic accuracy for rBAD. There are no established treatments for rBAD; reconstructive endovascular treatments comprising stent placement and coil embolization of a false lumen are promising. The LVIS stent has a braided design and high metal coverage ratio and is considered to be reasonable for use in rBAD. Coil embolization of a false lumen with overlapping LVIS stents may be effective for rBAD.

Keywords: ruptured basilar artery dissection, magnetic resonance vessel wall imaging, three-dimensional fast spin-echo, coil embolization, overlapping LVIS stents

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Introduction

The diagnosis and treatment of patients with ruptured basilar artery dissection (rBAD) are often difficult. Magnetic resonance vessel wall imaging (MR-VWI) has attracted attention as a useful modality to detect ruptured sites and dissecting sites of vessels.¹⁾ We present a case of rBAD diagnosed with MR-VWI and treated with coil embolization with overlapping low-profile visualized intraluminal support (LVIS) stents (MicroVention, Tustin, CA, USA).

Case Report

A 49-year-old woman with no medical history and with a 30-year history of smoking 20 cigarettes a day was found unconscious at home and transported by ambulance to Osaki Citizen Hospital. Her level of consciousness was Japan Coma Scale 10 and Glasgow Coma Scale E3, V5, M6. No other neurological deficits were observed. computed tomography (CT) revealed subarachnoid hemorrhage predominantly in the basal cistern and the ambient cistern and acute hydrocephalus (Fig. 1A). digital subtraction angiography (DSA) showed irregularity in an anterior wall of the middle portion of the basilar artery (Figs. 1B and 1C), which indicated a false lumen measuring 7.0 mm in length, 3.5 mm in width and 2.0 mm in height. The maximum lumen diameter of the basilar artery was 4.3 mm. Although the site was suspected to be the source of bleeding, MR-VWI was performed to obtain further diagnostic evidence. The scan was performed on a 3-T Skyra scanner (Siemens Healthcare, Erlangen, Germany) with a 16-channel head/neck coil. The protocol consisted of a single-slab three-dimensional T1-weighted fast spin-echo sequence. The acquisition parameters were as follows: repetition time, 600 ms; echo time, 34 ms; field of view, 10 × 16 cm; acquired matrix, 240 × 384; slice thickness, 1 mm; total slab thickness, 40 mm. The scans were performed before and after intravenous administration of gadolinium-diethylenetriaminepenta-acetic acid. MR-VWI revealed local enhancement in an arterial wall of the basilar artery (Figs. 2A–2C), which was consistent with the wall irregularity observed in DSA. Based on these findings, the patient was diagnosed with rBAD.

Stent-assisted coil embolization was performed. Heparin was continuously administered to achieve an intraprocedural activated coagulation time of 200 s, and 162 mg of aspirin and 300 mg clopidogrel were loaded via a nasogastric tube. A 7-Fr FUBUKI guiding catheter (ASAHI INTECC CO., LTD.,

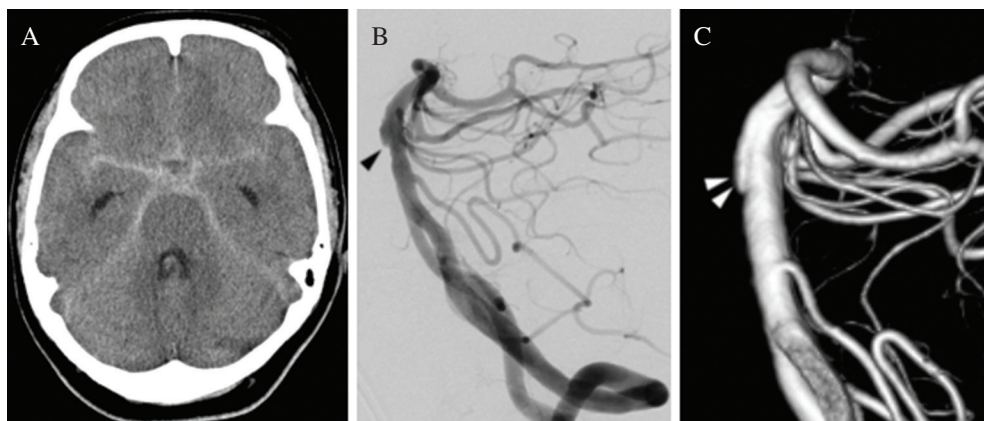


Fig. 1 (A) CT on admission revealed subarachnoid hemorrhage predominantly in the basal cistern and the ambient cistern and acute hydrocephalus. (B) Left vertebral angiogram and (C) three-dimensional reconstruction image show an irregularity in an anterior wall of the middle portion of the basilar artery (arrow-head in B and arrowheads in C).

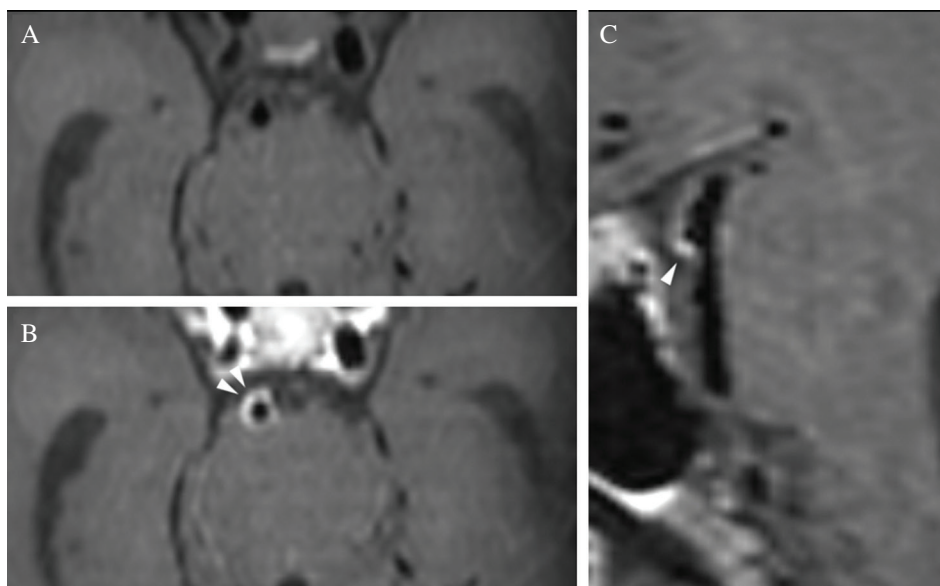


Fig. 2 Magnetic resonance vessel wall imaging performed before endovascular treatment. (A) Pre-contrast axial reconstruction image. (B) Contrast-enhanced axial reconstruction image. (C) Contrast-enhanced oblique reconstruction image along the basilar artery. Local enhancement was observed in an anterior wall of the middle portion of the basilar artery (arrowheads in B and arrowhead in C), which was consistent with the wall irregularity observed in DSA.

Seto, Aichi, Japan) was placed in the left vertebral artery. A Headway 21 microcatheter (MicroVention) was inserted into the left posterior cerebral artery and an Excelsior SL-10 microcatheter (Stryker, Kalamazoo, MI, USA) was placed in the false lumen. A 4.5 mm × 23 mm LVIS stent was deployed through the Headway 21 microcatheter to cover the lesion. After that, the Headway 21 was then removed. At the same time, the Excelsior SL-10 microcatheter was unintentionally advanced slightly. Although the patient’s vital signs were unchanged and there was no extravasation of contrast medium, the Excelsior SL-10 microcatheter could have penetrated the aneurysm wall, which could lead to fatal hemorrhage. Based on these concerns, a 4.5 mm × 18 mm LVIS stent was deployed using the stent-in-stent technique. Subsequently, blood flow in the basilar artery was blocked with a 4 mm × 11 mm Scepter XC balloon catheter (MicroVention) and two 1 mm × 20 mm Target Helical Nano (Stryker) were placed in the false lumen through the Excelsior SL-10 microcatheter. Then contrast agent no longer flowed into the false lumen. Anterograde blood flow of the basilar artery was preserved (Figs. 3A and 3B).

Following the procedures described above, heparin continuous administration was terminated, and spinal drainage was performed. Protamine was not administered. The postoperative CT revealed a small accumulation of contrast medium in the basal cistern. The following day, the patient’s consciousness was clear, and no other neurological deficits were observed. Dual antiplatelet therapy, comprising 81 mg/day of aspirin and 75 mg/day of clopidogrel, was continued from the following day to prevent in-stent thrombosis, and treatment for vasospasm with 80 mg/day of ozagrel and 90 mg/day of fasudil was initiated. The patient was discharged 33 days after procedure with a favorable postoperative course. DSA showed a white-collar sign after 6 months (Fig. 3C).

Discussion

The diagnosis of rBAD requires DSA, allowing not only delineation of the shapes of arteries, but also evaluation of flow in the vessels. The characteristic angiographical findings of the dissecting cerebral artery include intimal flap and a double lumen. These findings are often unclear, and DSA is insufficient for definitive diagnosis in such cases.²⁾

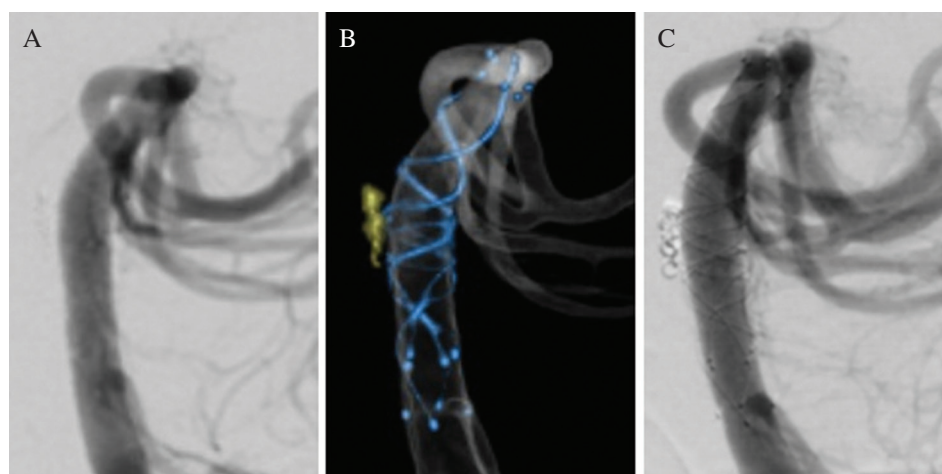


Fig. 3 (A) Postoperative left vertebral angiogram and (B) translucent three-dimensional reconstruction image. Overlapping stents with a 4.5 mm × 23 mm low-profile visualized intraluminal support (LVIS) stent and a 4.5 mm × 18 mm LVIS stent are performed in the basilar artery and coils are placed in a false lumen. Contrast agent does not flow into the false lumen; anterograde blood flow of the basilar artery was preserved. The radiopaque struts of the LVIS stents are shown in blue, and coils are shown in yellow. (C) DSA performed 6 months following the procedure showed a white-collar sign.

MR-VWI has been reported to be able to detect the dissecting vessel wall as an enhanced lesion and thought to contribute to improving accuracy in diagnosing cerebral artery dissection. There are some reports of applying MR-VWI to the diagnosis of ruptured vertebral artery dissection and unruptured basilar artery dissection.^{3,4} To the best of our knowledge, this is the first report of applying MR-VWI to the diagnosis of rBAD. In the case described herein, cerebral angiography revealed wall irregularity in the anterior wall of the basilar artery, and MR-VWI provided local enhancement of the wall irregularity. This finding resulted in a proper diagnosis, providing evidence that MR-VWI improves the diagnostic accuracy for rBAD. The exact mechanism of vessel wall enhancement in ruptured and dissecting site is unclear, although an inflammation in vessel wall is thought to be involved. MR-VWI may become a more useful modality by elucidating the mechanism. Further study remains to be done.

There are no established treatments for rBAD. The outcomes associated with conservative treatment are poor for rebleeding. Nakahara et al.⁵ reviewed 15 reports of rBAD treated conservatively, in which three cases caused rebleeding and died; Kim et al.⁶ reported three cases of rBAD treated conservatively, in which all three cases caused rebleeding and two of them died.⁶ Therefore, early measures to prevent rebleeding are required. However, treatment options for rBAD remain limited. Direct approach to the lesion, including clipping and wrapping, is challenging due to the lesion being deep and fragile; only a limited number of successful cases treated by direct approach have been reported.⁷ Trapping would result in severe ischemic complications, as there are many perforating arteries branching off from basilar artery to brain stem. Proximal vessel occlusion may also result in severe ischemic complications and is pointed out to be insufficient to prevent rebleeding for structural reason.⁸ Only three cases of rBAD have been reported where proximal vessel occlusion was effective to prevent rebleeding and caused no ischemic complication;^{9–11} on the other hand, Steinberg et al.¹² reported 46 symptomatic basilar trunk ruptured/unruptured aneurysms treated by proximal vessel occlusion, in which two cases caused

subarachnoid hemorrhage and six cases caused brain stem infarction. While these treatment options face each challenge, several recent studies have suggested that reconstructive endovascular treatment, where the false lumen is thrombosed and anterograde blood flow of basilar artery is preserved, is promising for rBAD.

In recent years, reconstructive endovascular treatment with flow diverter with/without coil have been reported. So far, 12 case series of ruptured dissecting aneurysms or ruptured blood blister-like aneurysms treated in acute phase with flow diverter have been reported.^{13–24} In these reports, 115 ruptured site (68 internal carotid artery, six middle cerebral artery, one anterior cerebral artery, 26 vertebral artery, six basilar artery, two posterior cerebral artery, three anterior inferior cerebellar artery, three posterior inferior cerebellar artery) were treated; 101 were treated with only flow diverter, 14 with flow diverter and coil. In these 115 cases, no rebleeding from ruptured site and 10 symptomatic thrombotic events were observed after procedure. Major intraparenchymal bleeding after procedure except those due to intraprocedural wire penetration were reported in four cases: one external ventricular drainage associated bleeding, one ventriculo-peritoneal shunt associated bleeding, two other bleedings. Out of 115 aneurysms, 87 were followed-up by cerebral angiography; 80 showed complete obliteration, four showed a reduction in aneurysm diameter, three showed no reduction or an increase in aneurysm diameter. As seen in these reports, results of reconstructive treatment with flow diverter is much better than those of previous treatments: flow-diverting effect is indicated to contribute to the treatment of dissecting aneurysm. Although reconstructive treatment with flow diverter may become the standard treatment for ruptured dissecting cerebral aneurysms in the future, it is not always available currently due to facility limitation.

On the other hand, reconstructive endovascular treatment with neck bridge stent can be performed in many facilities at present. Several successful cases of rBAD treated with neck bridge stent have been reported.^{6,25,26} In these reports, single or multiple neck bridge stent were placed, and a false lumen is thrombosed with coil embolization. In this procedure, neck bridge stent is expected to produce a flow-diverting

effect and to prevent coil protrusion out of a false lumen. Coil embolization of a false lumen contributes to immediate thrombosis and should be performed if possible, because neck bridge stent placement without coil is associated with an increased risk of rebleeding. A false lumen may not be sufficiently embolized with coil because it may be small, irregular, and unclear, hence, neck bridge stent placement requires a higher flow-diverting effect.

The LVIS stent has a braided design and high metal coverage ratio. These properties allow for the devices to be resheathable, provide better retention of a small coil, and have a higher flow-diverting effect than the other available neck bridge stents.²⁷⁾ Two overlapping LVIS stents placement by stent-in-stent technique has been reported to have a higher flow-diverting effect than a single flow diverter placement.²⁸⁾ Based on these observed properties, the LVIS stent may be reasonable for use in ruptured dissecting aneurysm.

While reconstructive endovascular treatment with neck bridge stent or flow diverter is an effective for prevention of rebleeding, thrombotic event should be cared. Periprocedural antithrombotic therapy is controversial. In the 12 case-series of reconstructive treatment with flow diverter mentioned above, most patients were administered dual antiplatelet therapy (DAPT) including clopidogrel with loading dose before procedure, some patients were administered glycoprotein IIb/IIIa inhibitors in addition to DAPT or as an alternative to clopidogrel before procedure, most patients were administered heparin before or after stent placement to achieve an intraprocedural activated coagulation time of over 200 or 250 s, some patients administered glycoprotein IIb/IIIa inhibitors were not heparinized, single antiplatelet therapy for more than 6 months or DAPT for 1–6 months was continued with maintenance dose after procedure. Antiplatelet drugs were mainly aspirin and clopidogrel; ticlopidine, ticagrelor and prasugrel are considered as alternatives. Some other reports described effectiveness of ozagrel and argatroban for stent thrombosis occurred immediately after coil embolization with neck bridge stent placement for a ruptured dissecting aneurysm in acute phase.²⁹⁾ Thus, periprocedural antithrombotic therapy has not been established.

In the case described herein, two overlapping LVIS stents placement with coil embolization of the false lumen was performed for rBAD in acute phase. Intraprocedural heparin administration and periprocedural DAPT administration resulted in no rebleeding nor thrombotic event. The postoperative course was good and stable over a long period, suggesting that the treatment performed in this patient may be effective for rBAD. However, it is important to note that antiplatelet therapy is required, despite the patient being in the acute phase of subarachnoid hemorrhage, to prevent in-stent thrombosis. In addition, concerns regarding medical finances require consideration during treatment planning, as treatment of subarachnoid hemorrhage in the acute phase with stents is not covered under insurance in Japan at present. Further assessment with more cases is required.

Conclusion

Magnetic resonance vessel wall imaging is suggested to improve diagnostic accuracy for rBAD. Coil embolization of

a false lumen with overlapping LVIS stents may be effective for rBAD.

Conflicts of Interest Disclosure

All authors confirm that they have no conflicts of interest.

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