



# Overlapping Stent Placement with Coil Embolization for Ruptured Growing Basilar Artery Dissecting Aneurysm: A Case Report

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**Objective:** We report a patient in whom overlapping stent placement with coil embolization was useful for treating a ruptured basilar artery (BA) dissecting aneurysm with rapid enlargement.

**Case Presentation:** A 50-year-old female presented with subarachnoid hemorrhage (SAH). On evaluation, a fusiform dilatation of the BA was noted, suggesting a dissecting aneurysm. Rapid enlargement of the aneurysmal dilatation was observed between days 9 and 16. On day 18, overlapping stent placement was performed in the dilated BA, and the aneurysmal dilatation was roughly embolized using coils. No neurologic deficit was observed in the postoperatively, and the patient was discharged with modified Rankin Scale (mRS) 0. Follow-up DSA at 8 months after the procedure showed the complete obliteration of the aneurysm with the remodeling of the BA. During the 29-month follow-up, there has been no recurrence.

**Conclusion:** Overlapping stent placement for a dissecting BA aneurysm was effective treatment leading to favorable vascular remodeling.

**Keywords** ▶ subarachnoid hemorrhage, basilar artery, ruptured dissecting aneurysm, flow diverting stent, endovascular treatment

## Introduction

Basilar artery dissecting aneurysms (BADAs) are frequent in young adults,<sup>1)</sup> and their incidence is 0.25/100,000 persons-year, accounting for 1.0% of all patients with subarachnoid hemorrhage (SAH).<sup>2)</sup> The prognosis of patients with this disease is unfavorable, and the anatomical location makes treatment difficult in many cases. In particular,

serially growing BADAs are rare, and conservative treatment is selected for many patients with ischemia due to treatment-related risks. In patients with hemorrhage, treatment is required to prevent additional hemorrhage, but direct approaches/endovascular treatment is still difficult.

In this study, we report a patient who developed SAH, and underwent overlapping stent therapy combined with coil embolization for a rapidly growing BADA in the subacute phase, leading to a favorable course.

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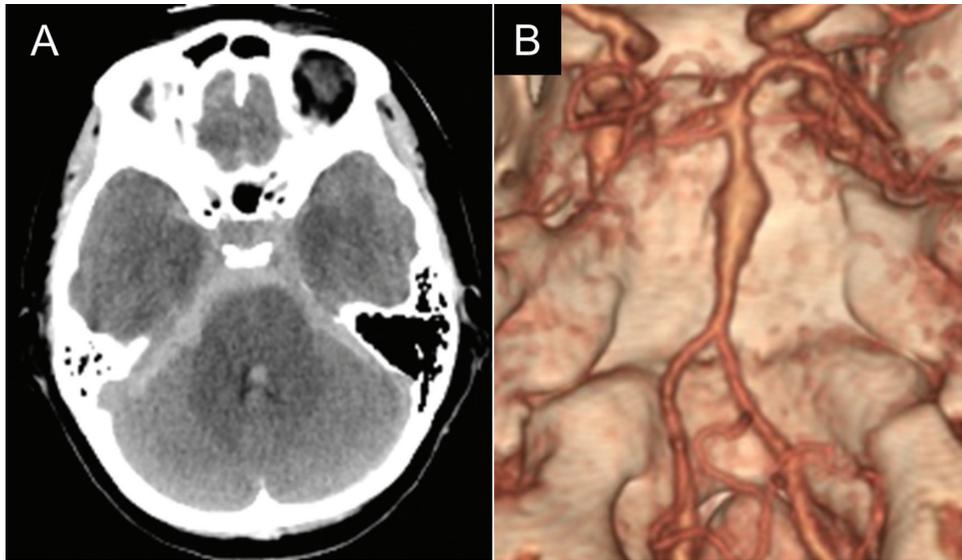


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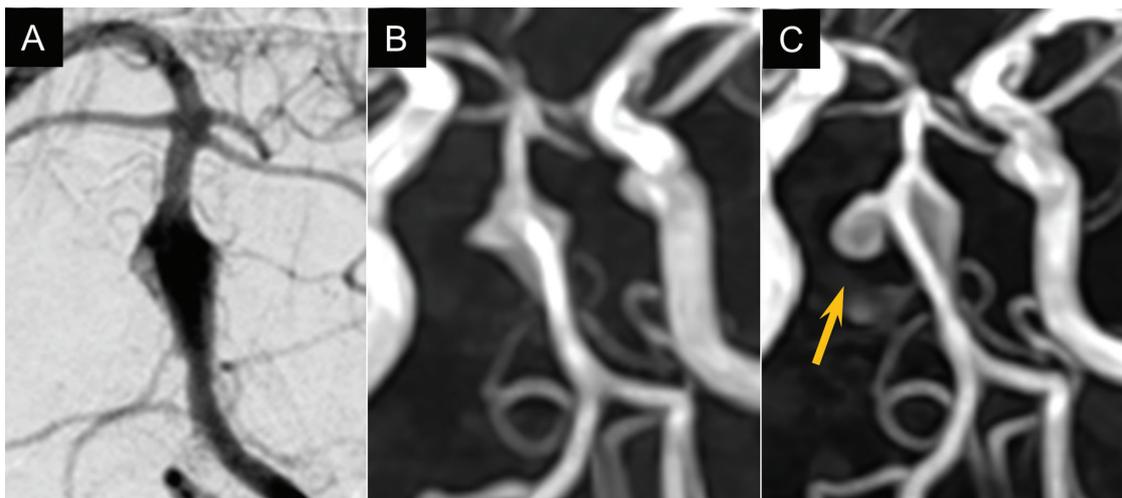
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## Case Presentation

A 50-year-old female. She was found fallen in a bathroom. On the initial consultation, the Japan Coma Scale score was II-30, and the Glasgow Coma Scale score was 10. CT revealed SAH. 3D-CTA showed fusiform dilatation of the basilar artery (BA), suggesting a dissecting aneurysm (**Fig. 1A** and **1B**). The Hunt and Hess grade was evaluated as 3, the World Federation of Neurological Surgeons grade as 4, and Fisher group as 3. DSA on day 2 showed similar findings (**Fig. 2A**), and acute-phase radical surgery was



**Fig. 1** (A) CT on admission showing diffuse subarachnoid hemorrhage. (B) 3D-CTA on admission showing a basilar artery fusiform aneurysm.



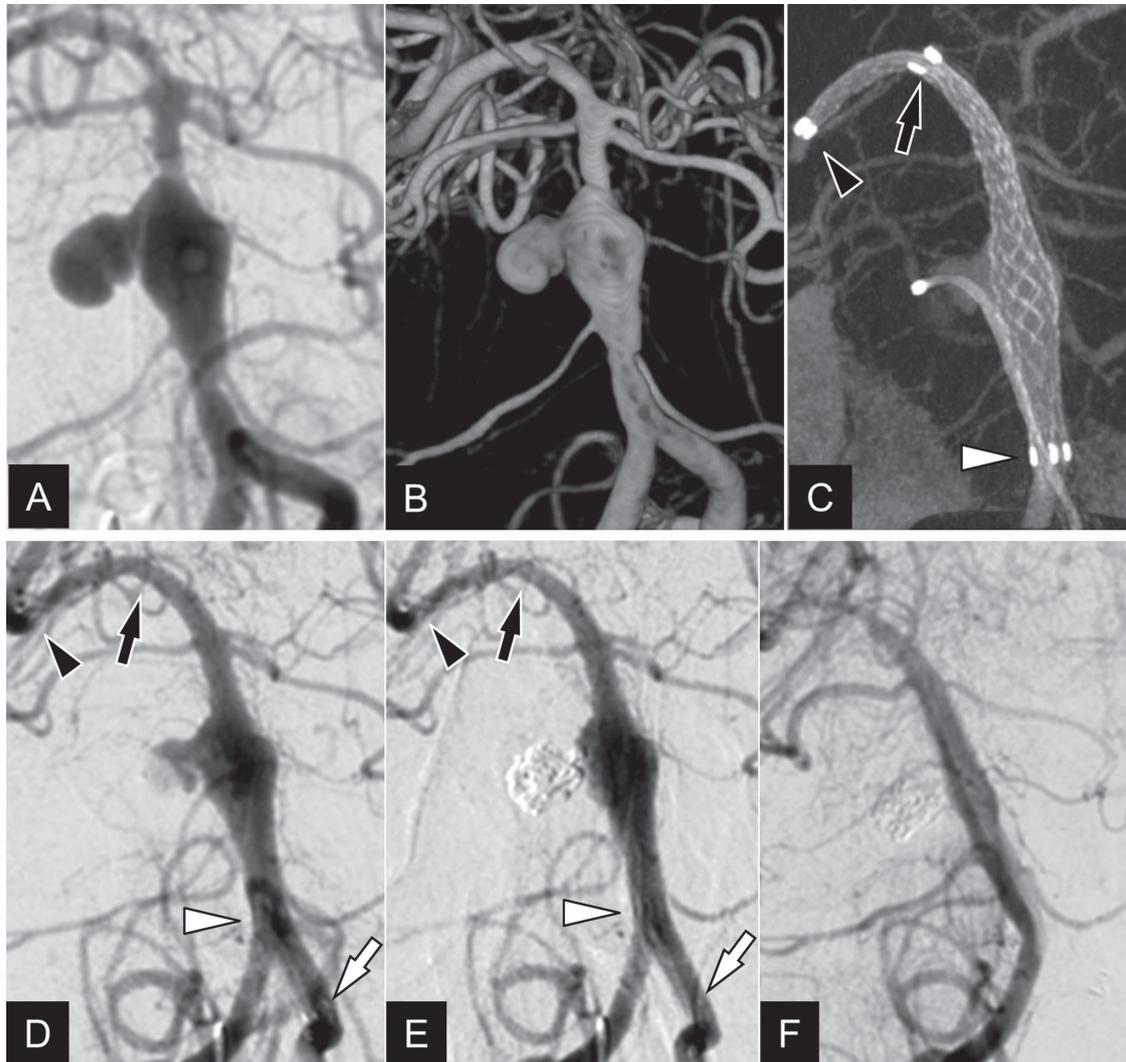
**Fig. 2** Follow-up images. DSA on day 2 (A) and MRA on day 9 (B) showing a basilar artery fusiform aneurysm. (C) MRA on day 16 showing a pseudoaneurysm on the right wall of the basilar artery (arrow).

considered to be difficult. Conservative treatment was started. Sedation with propofol and central venous alimentation were performed.

MRA on day 9 showed slight morphologic changes (**Fig. 2B**). However, MRA on day 16 revealed a further increase in the BA diameter and saccular enlargement on the right side (**Fig. 2C**). Considering the risk of re-rupture, endovascular treatment was performed on day 18 after obtaining informed consent. Clopidogrel 300 mg was orally administered the day before treatment.

**Endovascular treatment:** After general anesthesia was induced, systemic heparinization was conducted, and aspirin 300 mg was administered through a nasogastric tube.

Guiding catheters (6F, FUBUKI; Asahi Intecc Co., Ltd, Aichi, Japan) were inserted into the bilateral vertebral arteries (VAs) through the bilateral femoral arteries. DSA showed that the site of saccular enlargement measured 5.2 mm in maximum diameter, and that the BA trunk measured 5.7 mm in transverse diameter (**Fig. 3A** and **3B**). An Excelsior SL10 (straight; Stryker Neurovascular, Fremont, CA, USA) was guided into the right posterior cerebral artery (PCA) using a CHIKAI 10 (Asahi Intec Co., Ltd), and exchanged for a Prowler Select Plus (Johnson & Johnson Codman, Miami, FL, USA) using a Chikai 14 (Asahi Intec Co., Ltd.). Subsequently, another SL10 (J-shaped) was placed at an area slightly deeper than the center of the



**Fig. 3** Intraoperative images. Arrows indicate the margin of the first stent (white arrow: proximal marker, black arrow: distal marker), and arrowheads indicate the margin of the second stent (white arrowhead: proximal marker, black arrowhead: distal marker). Preoperative DSA (**A**) and 3D-RA (**B**) showing a basilar trunk fusiform aneurysm, from which a pseudoaneurysm, bilateral anterior inferior cerebellar arteries, and large perforating branches arose. (**C**) Cone-beam CT image showing two neck bridge stents deployed in the basilar artery by telescoping technique and a microcatheter placed into the pseudoaneurysm by jailing technique. (**D**) DSA after stent placement. The blood flow into the pseudoaneurysm decreased markedly. (**E**) Final angiogram showed complete obliteration of the pseudoaneurysm. The fusiform aneurysm was depicted through the overlapped stents. (**F**) Follow-up DSA at 8 months after the endovascular treatment showed no recurrence of the aneurysm. The irregular shape of the basilar artery trunk was remodeled with preservation of the branches.

enlarged site, using a CHIKAI 10 at the proximal region, and Silverspeed 10 (Medtronic, Minneapolis, MN, USA) at the lesion site. Using the Prowler Select Plus, Enterprise VRD 4.5 × 37 mm (Johnson & Johnson Codman Neuro) was inserted from the right PCA to the left VA (**Fig. 3C–3E**, white arrow: proximal marker, black arrow: distal marker). Subsequent DSA showed a slight reduction in contrast enhancement at the enlarged site. The Prowler Select Plus was again inserted into the right PCA through a stent using a CHIKAI 14, and the second Enterprise VRD of the same

size was overlapped (**Fig. 3C–3E**, white arrow head: proximal marker, black arrow head: distal marker). On DSA, the angle between the left VA and BA had been straightened, and contrast enhancement at the enlarged site was markedly reduced (**Fig. 3D**). Subsequently, to promote thrombosis, an under-size coil was placed. When inserting a HydroSoft 4 mm × 10 cm (Terumo Corporation, Tokyo, Japan), contrast enhancement at the enlarged site disappeared, and 4 HydroSoft coils (25 cm) were inserted while attempting rough packing so that there may be no

stress on the aneurysmal wall. DSA confirmed the complete disappearance of contrast enhancement at the site of enlargement. At the dilated site of the BA trunk, extra-stent contrast enhancement remained, but endovascular treatment was completed without adding a coil (**Fig. 3E**).

After the procedure, there was no new appearance of neurologic symptoms. DSA 1 month after treatment did not show any recurrence. After the patient was referred to a recovery-phase rehabilitation hospital due to disuse syndrome related to sedation in the acute phase, she was discharged in the absence of neurologic deficits (modified Rankin Scale: 0). DSA 8 months after treatment did not reveal any additional enlargement of the lesion, and the BA trunk diameter was normalized. On the other hand, main branches from the same site were maintained (**Fig. 3F**). At this point, clopidogrel administration was completed, and monotherapy with aspirin was continued. Subsequently, informed consent regarding DSA could not be obtained, and follow-up was continued using MRA, MR cisternography, and basi-parallel anatomical scanning. There were no changes 21 months after treatment. The patient is being treated at the outpatient clinic, with a post-treatment follow-up of 29 months.

## Discussion

Basilar artery dissecting aneurysms are rare, and the morbidity and mortality rates after conservative treatment are high, but direct approaches, such as clipping and wrapping, are difficult.<sup>1,3,4</sup> Parent vessel embolization or trapping exhibits potent hemostatic effects, but it is difficult to apply these options to BA lesions in many cases.<sup>5</sup> Many studies indicated that proximal BA embolization/flow reversal alone was ineffective.<sup>1,3–5</sup> Recently, reconstructive treatments in which parent vessel blood flow is maintained, such as stent-assisted coiling (SAC), stent-only therapy, and therapy with a flow diverter (FD), have been performed.<sup>1–9</sup>

In particular, serially growing BADAs are rare, and no treatment method has been established<sup>1,3</sup> although aggressive treatment is recommended for patients with hemorrhage or mass-effect-related progressive deterioration. According to a review in 2015,<sup>3</sup> 15 patients have been reported. Six of these were ruptured BADAs. In 14 (93%), conservative treatment was selected as initial treatment. The prognosis of patients who underwent additional treatment (direct approaches: three patients, endovascular

treatment: seven patients) later was favorable, whereas five of six patients treated by conservative treatment alone died. After 2003, endovascular treatment was primarily selected, and stents were used in all patients but one patient who underwent VA embolization. Of these, four patients underwent SAC, accounting for the highest percentage.<sup>3,7</sup> The other procedures included stent-only therapy in one patient<sup>1</sup>) and FD therapy in one patient.<sup>4</sup>) For all five patients with serial circumferential enlargement of the BA, conservative treatment was selected. Of these, four patients died. On the other hand, aggressive treatment was performed for 9 of 10 patients with saccular dilatation in one direction despite the wide-base site of serial enlargement, as demonstrated in the present case: clipping or coil insertion in which the site of enlargement was regarded as the point of rupture. Two patients, including one who underwent conservative treatment, died.

In the present case, overlapping stent therapy combined with coil embolization was performed to treat a growing BADA with hemorrhage, leading to a favorable long-term prognosis ( $\geq 2$  years). For coil embolization of BADAs, pseudo-aneurysms have no true aneurysmal wall, being extremely fragile; therefore, the risk of intraoperative rupture is high.<sup>2,7</sup> Furthermore, an irregular morphology or arising branches may result in incomplete occlusion.<sup>5</sup>) Coil embolization of pseudo-aneurysms alone may lead to early recanalization.<sup>2</sup>) SAC reduces hemodynamic stress by changing the vascular course, and exhibits endothelium-repairing effects through neogenetic intima formation along a stent strut in addition to the prompt hemostatic effects of a coil.<sup>5</sup>) The metal coverage of an Enterprise VRD is 10%, and that of an FD is approximately 30%–35%.<sup>9</sup>) Although the flow-diverting effects of neck bridge stents are limited,<sup>4</sup>) several studies adopted overlapping stent placement for BADAs in the acute phase of rupture to reduce porosity and increase stent thickness.<sup>5,10</sup>) In the present case, contrast enhancement at the site of enlargement reduced with the process of overlapping stent placement, and disappeared when a coil was placed. To reduce the risk of intraoperative rupture, we performed rough embolization with slightly small coils. However, if coil stability is obtained, it may be appropriate to consider coil insertion in the presence of catheter mobility before stent insertion. Furthermore, extra-stent contrast enhancement remained at the fusiform dilated site of the BA trunk, but additional coil insertion was avoided. DSA after 8 months showed the disappearance of wall irregularity

and normalization of the vascular diameter, whereas branches from this site were maintained. Overlapping stent placement may make it possible to avoid dense coil embolization, reducing the risk of intraoperative rupture or branch occlusion.

With respect to the selection of a neck bridge stent, closed-cell-type stents are advantageous for obtaining the vascular straightening effect, and open-cell-type stents may allow the strut end to affect the fragile wall of a dissecting aneurysm. When inserting a microcatheter again for second-stent insertion using another microwire (not the delivery wire of an inserted stent), closed-cell-type stents may also be appropriate to avoid interferences with a strut. In previous studies regarding SAC and stent-only therapy for BADAs, various open- and closed-cell-type stents were used.<sup>5,6,9)</sup> Concerning the stent length, it is difficult to determine the accurate extent of dissecting lesions; therefore, long, multiple-overlapping stents may be advantageous for accurately blocking inflow proximal to the site of dissection.<sup>6)</sup> In this study, to block inflow proximal to the lesion site, the first stent was inserted into the left VA as a normal proximal blood vessel. However, the distal stent end deviated to an area more proximal than planned; it was not located along curvature of the PCA. Therefore, as the second stent, a stent of the same size as the first stent was selected so that it might involve the area from the proximal BA to the PCA. On the other hand, if possible, the selection of a short stent, as the second stent, may reduce the influence on perforating arteries or branches. Concerning the stent diameter, some investigators recommend the use of large-diameter stents with a strong radial force to occlude the dissected space.<sup>6)</sup>

Even among studies of stent-only therapy without coil insertion, many studies have reported the use of multiple-overlapping stents (2 to 3 neck bridge stents).<sup>2,8,9)</sup> The occlusion rate was significantly higher than in the single stent group.<sup>8)</sup> However, neither stent-only nor FD therapies promptly show hemostatic effects. In particular, these therapies should be combined with coil embolization for patients with rupture if possible.<sup>2,5,6)</sup> The time required to occlude lesions is unclear,<sup>2)</sup> and embolization effects depend on the morphologies of aneurysms/parent blood vessels; they are difficult to predict. A study indicated that non-responders accounted for 36%.<sup>6)</sup> Concerning FD therapy, its results were favorable in case reports on ruptured BADAs in the acute/subacute phases,<sup>2)</sup> but a meta-analysis of posterior-circulation-system cerebral aneurysms showed that the results of FD therapy for ruptured/BA aneurysms were unfavorable.<sup>11)</sup> In Japan,

currently, FD therapy for acute-phase ruptured and posterior-circulation-system aneurysms is not covered by health insurance.

During the perioperative period of reconstructive therapy for BADAs, antithrombotic therapy with two antiplatelet drugs is necessary. In the acute phase of rupture, re-rupture/hydrocephalus treatment is particularly raised as an issue.<sup>4,8)</sup> However, a consensus regarding the timing of antiplatelet drug loading has not been reached, as reports on pre-/intra-/postoperative loading have been published.<sup>2,4)</sup> According to these reports, antiplatelet drug administration was started immediately before surgery in most patients. This may have been selected, considering the risk of additional hemorrhage. However, in patients in whom several stents may be inserted, sufficient antiplatelet therapy is important to prevent postoperative ischemic complications. In our patient, the start of antiplatelet drug administration was delayed until the subacute phase; if oral administration had been started a few days before treatment, it might have been safer. Furthermore, perforating artery/branch occlusion-related ischemic complications and lumen stenosis related to intimal hyperplasia in the chronic phase must be considered.<sup>6,9)</sup> Angiography for evaluating the treatment response should be performed at least 1 week after treatment and after 6 months. It is necessary to consider dose-reduction to a single antiplatelet drug 6 months after treatment,<sup>2)</sup> but it should be carefully determined in patients after the insertion of several stents into thin BA.

The use of an Enterprise VRD, as described in this article, is not covered by health insurance in Japan. In the present case, treatment was performed after obtaining informed consent regarding emergency care in the absence of other effective methods.

In the present case, overlapping stent therapy combined with coil embolization led to a favorable outcome, but vascular straightening effect may differ among patients. Furthermore, BADAs are heterogeneous with respect to the morphology, branching, collateral pathway, mode of onset, and timing of treatment; an optimal therapeutic strategy should be reviewed for individual patients.

## Conclusion

Overlapping stent therapy, involving the preservation of parent vessel blood flow, for growing BADAs may become a treatment option. The long-term prognosis remains to be clarified, and careful follow-up is needed.

## Disclosure Statement

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

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