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Case Report

Tandem Lesions of the Vertebrobasilar System Treated by Thrombectomy and Vertebral Artery Stenting: A Case Report

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Objective: There are few reports on endovascular treatment of tandem lesions in the posterior circulation and no consensus on treatment strategies has been reached. We report a case of tandem lesions of basilar artery occlusion and vertebral artery stenosis treated by thrombectomy and vertebral artery stenting.

Case Presentation: We present the case of a 73-year-old man who developed consciousness disorder and tetraplegia. Head and neck CTA revealed tandem left vertebral artery stenosis and basilar artery occlusion. The patient was treated using a reverse technique, which involves performing thrombectomy first and then vertebral artery stenting, along with Carotid Guardwire PS. Postoperative impairment of consciousness and improvement of tetraplegia were achieved.

Conclusion: The reverse technique combined with Carotid Guardwire PS may be a useful treatment strategy for tandem lesions in the posterior circulation.

Keywords basilar artery occlusion, vertebral artery stenosis, tandem lesions, thrombectomy, vertebral artery stenting

Introduction

Recently, randomized controlled trials of thrombectomy for the posterior circulation system, such as the Basilar Artery Occlusion Endovascular Intervention versus Standard Medical Treatment (BEST) study,[1)] were reported, but its efficacy has not been established. In particular, few reports on tandem lesions have been published and a consensus regarding therapeutic strategies has not been reached.[2–6)] In the present case, we performed thrombectomy and vertebral artery stenting for tandem lesions consisting of vertebral artery stenosis and basilar artery occlusion. A therapeutic strategy to combine the reverse technique with a distal embolic-protection device was useful. The protocol of this study was approved by the ethics review board of our institution (approved No. 348).

Case Presentation

Patient: A 73-year-old man.

Complaints: Dysarthria and vertigo.

Medical history: Hypertension and hyperuricemia (during drug therapy).

Lifestyle: The modified Rankin Scale (mRS) grade before onset was 0. He had smoked 40 cigarettes per day for 30 years. He drank 360 to 540 mL per day of Japanese sake.

Present illness: He was brought to our hospital with vertigo, dizziness on walking, and dysarthria developed in the morning.

Physical examination: Immediately after arrival, the Japan Coma Scale (JCS) score was 0 and the National Institutes of Health Stroke Scale (NIHSS) score was 0. There were no abnormal neurological findings. Before head CT, horizontal gaze palsy developed. After the CT, the JCS score was 3, and bilateral horizontal gaze palsy and tetraplegia were observed. The NIHSS score was 38, indicating symptom deterioration.

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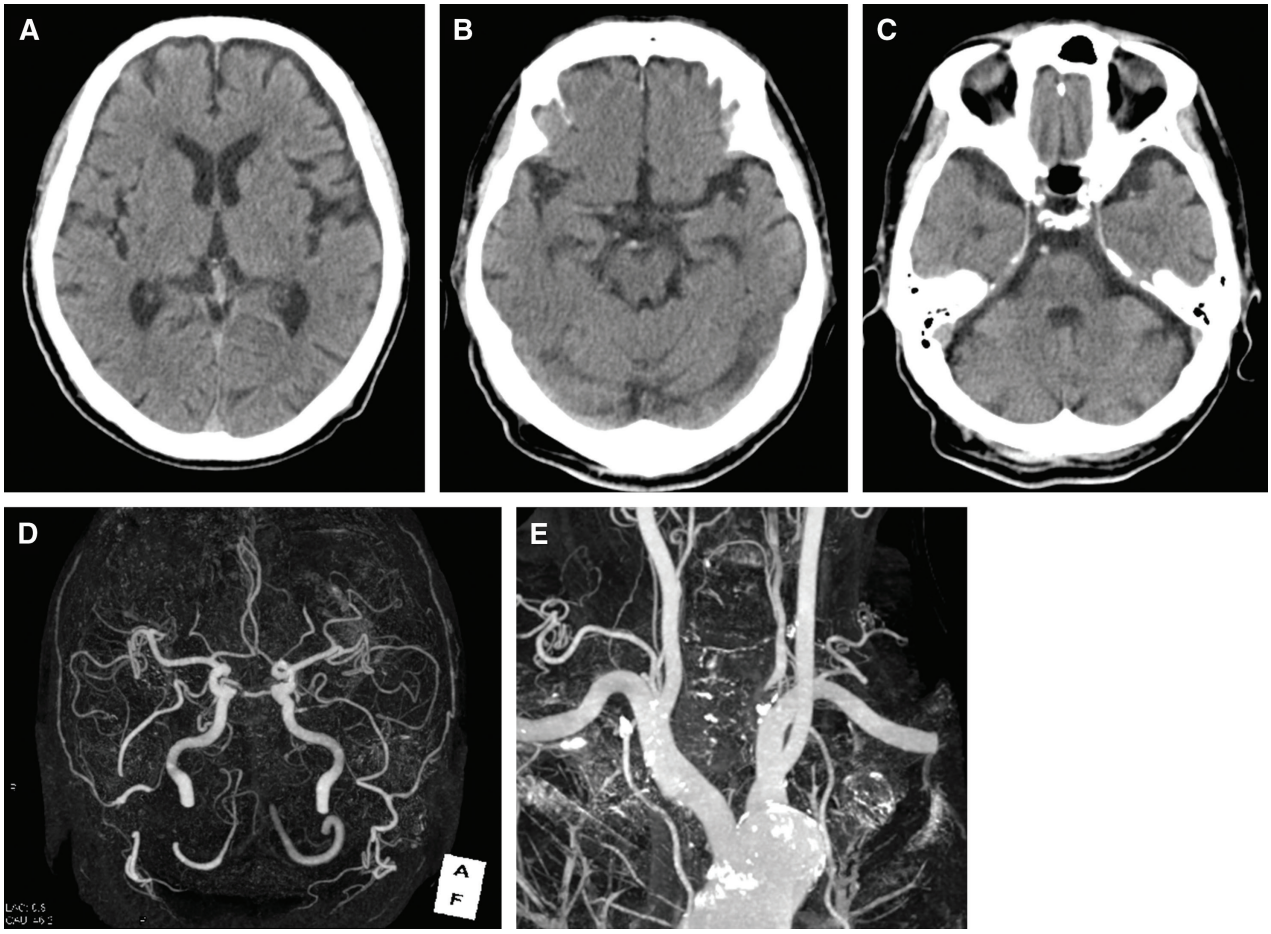

Fig. 1 (**A**–**C**) Head CT. The pc-ASPECTS was 10. A hyper-dense artery sign on the basilar artery was detected. (**D** and **E**) CTA of the head and neck. Stenosis at the origin of the left vertebral artery and occlusion of the basilar artery were observed. The right vertebral artery was ending in the posterior inferior cerebellar artery. pc-ASPECTS: posterior circulation acute stroke prognosis early CT score

Laboratory data: Electrocardiogram showed atrial fibrillation. On head CT, the posterior circulation acute stroke prognosis early CT score (pc-ASPECTS) was 10. A hyper-dense artery sign on the basilar artery was detected (**Fig. 1A**–**1C**). CTA of the head and neck revealed a tandem lesion consisting of stenosis at the origin of the left vertebral artery and occlusion of the basilar artery. The right vertebral artery was ending in the posterior inferior cerebellar artery (PICA) (**Fig. 1D** and **1E**).

Treatment course: Onset in the CT room was suggested. Alteplase at 0.6 mg/kg was administered 28 minutes after the onset and he underwent endovascular therapy. The right femoral artery was punctured, and a RoadMaster 8F (Goodman, Aichi, Japan) was brought into the left subclavian artery. Left subclavian angiography demonstrated severe stenosis of the origin of the left vertebral artery. The percent stenosis was calculated as 78% by the North American Symptomatic Carotid Endarterectomy Trial method according to the Vertebral Artery Ischaemia Stenting Trial (**Fig. 2A**).[7] Occlusion at the top of the basilar artery was also demonstrated (**Fig. 2B**). Since the right vertebral artery was not available as an access route, an approach through the left vertebral artery was selected. We considered it impossible to pass an 8-Fr guiding catheter through the site of stenosis. After crossing the lesion with Synchro[2] guidewires (Stryker, Kalamazoo, MI, USA), percutaneous transluminal angioplasty (PTA) for left vertebral artery stenosis was performed using Rx-Genity 3.5 mm/20 mm (Kaneka Medix, Osaka, Japan) at 8 atm for 30 seconds. Subsequently, the guiding catheter was sent to the distal to the stenosis (**Fig. 2C** and **2D**). REACT-68 catheter (Medtronic, Minneapolis, MN, USA) was brought to the site of basilar artery occlusion with Trevo Pro 18 (Stryker) and Synchro[2] Guidewires, and thrombectomy with a direct aspiration first pass technique was conducted (**Fig. 3A**). Left vertebral angiography showed thrombolysis in cerebral infarction (TICI) grade 3 recanalization (**Fig. 3B**). Red thrombi were retrieved in

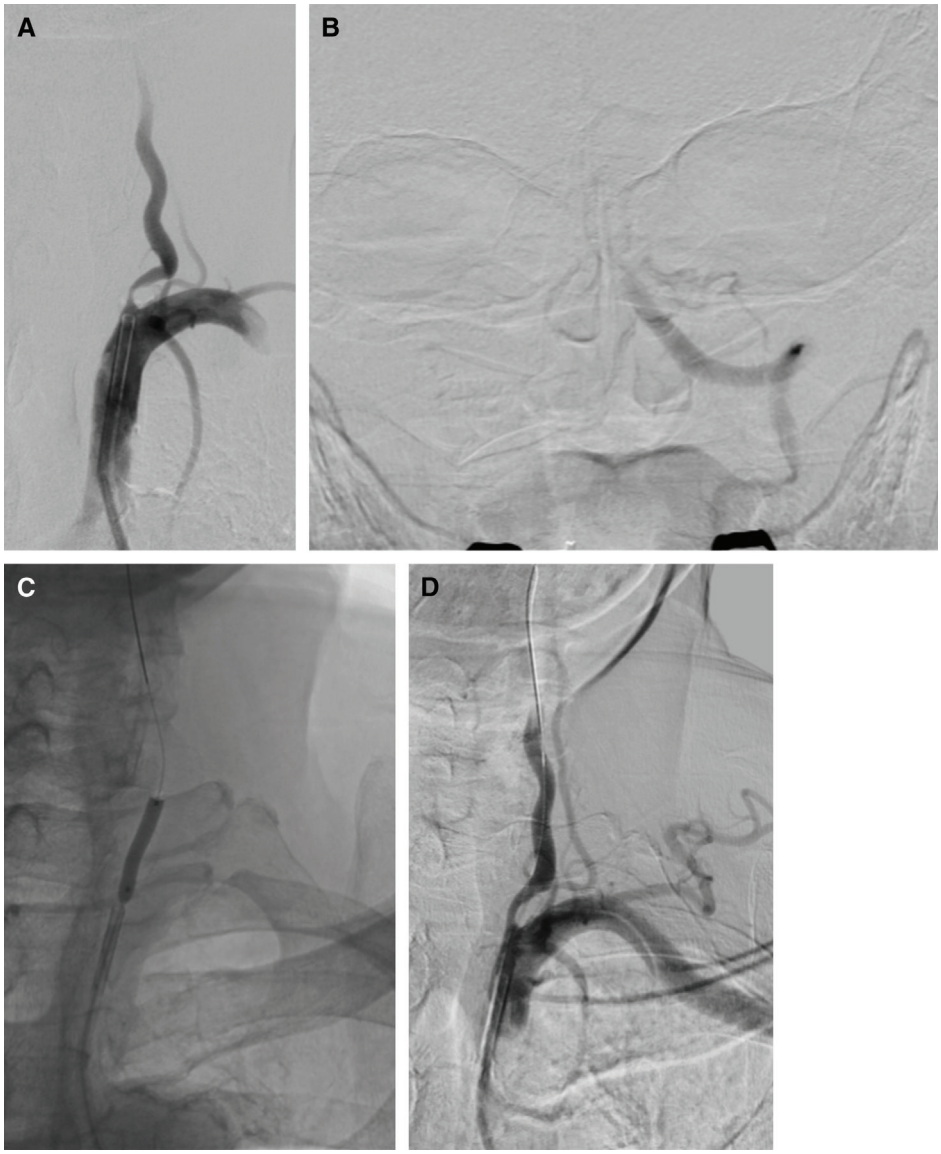

Fig. 2 (**A**) Left subclavian angiography. At the origin of the left vertebral artery, 78% stenosis in the NASCET method was noted. (**B**) Occlusion of the basilar artery was observed. (**C** and **D**) PTA for left vertebral artery stenosis was performed using an Rx-Genity 3.5 mm/20 mm at 8 atm for 30 seconds. NASCET: North American symptomatic carotid endarterectomy trial; PTA: percutaneous transluminal angioplasty

the aspiration catheter. The puncture to recanalization time was 45 minutes. The guiding catheter was guided into the left subclavian artery for angiography. Restenosis at the origin of the left vertebral artery was observed and it gradually occluded (**Fig. 3C** and **3D**). The percent stenosis was higher than before PTA, suggesting arterial dissection due to the first PTA. Accurate revascularization of the left vertebral artery was considered to be necessary. We decided to perform stenting at the origin of the left vertebral artery. Considering the possibility of thrombus at the occluded site, we decided to place Carotid Guardwire PS (Medtronic) to avoid distal embolism. Aspirin at 200 mg and clopidogrel at 300 mg were administered through a nasogastric tube, and the Carotid Guardwire PS was passed through the stenosis (**Fig. 4A**). A drug-eluting stent for the coronary artery, XIENCE Sierra 4.0 mm/28 mm (Abott Medical, Chicago, IL, USA), was deployed to the origin of the left vertebral artery (**Fig. 4B**–**4D**). Subsequently, a lot of red thrombi were aspirated using the Export Advance Aspiration Catheter (Medtronic) guided along the Carotid Guardwire PS (**Fig. 4E**). Stenosis at the origin of the vertebral artery was well dilated without distal embolism in left subclavian angiography. The procedure was completed.

Course after admission: Although postoperative head CT revealed hemorrhagic infarction at the pons (**Fig. 5A**), the NIHSS score improved to 11. On the 2nd postoperative day, diffusion-weighted MRI demonstrated hemorrhagic

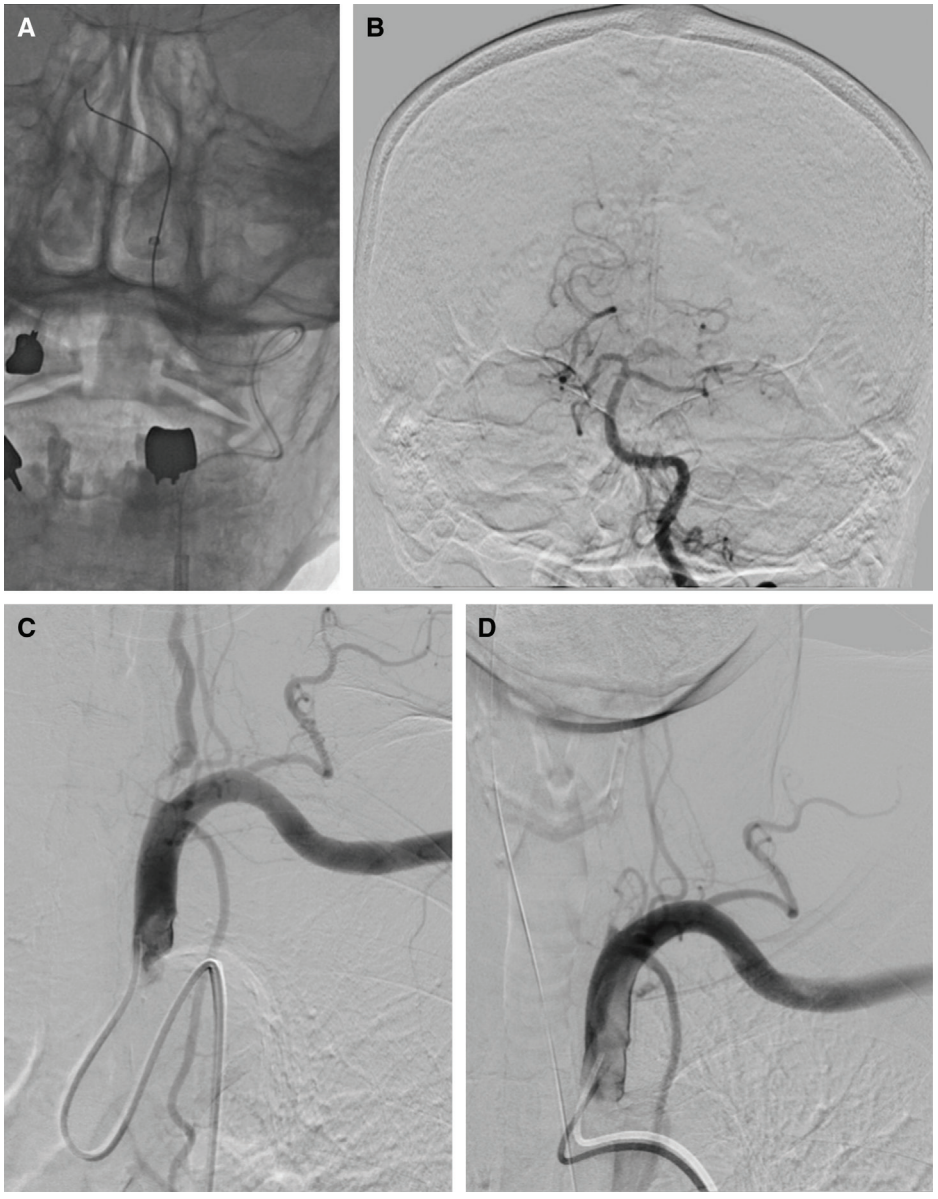

Fig. 3 (**A**) Thrombi were retrieved by ADAPT. (**B**) Left vertebral angiography confirmed TICI grade 3 recanalization. (**C**) Additional left subclavian angiography showed restenosis at the origin of the left vertebral artery. (**D**) The left vertebral artery occluded. ADAPT: a direct aspiration first pass technique; TICI: thrombolysis in cerebral infarction

infarction at the pons and acute cerebral infarction involving the bilateral cerebellar hemispheres (**Fig. 5B**). On carotid ultrasonography, a stent placed at the origin of the left vertebral artery extended into the subclavian artery (approximately 3.0 mm) (**Fig. 5C**). As hemorrhagic infarction was present, only dual antiplatelet therapy (DAPT) with aspirin at 100 mg/day and clopidogrel at 75 mg/day was initially administered. Anticoagulant therapy for atrial fibrillation, which was observed at the time of admission, was not conducted in the acute phase. Regarding the histology of thrombi that were retrieved, the erythrocyte component-to-fibrin to platelet component ratio was 9:1 in both thrombi retrieved from the basilar artery and those retrieved while stenting. Erythrocytes, platelets, fibrin, and granulocytes comprised a layered structure. There were no organized changes, such as smooth muscle cell, connective tissue, and capillary vessel ingrowth, suggesting fresh thrombi (**Fig. 6**). In addition to DAPT, 30 mg/day of edoxaban for atrial fibrillation was started 3 weeks after admission. We continued edoxaban at 30 mg/day and clopidogrel at 75 mg/day from four weeks after admission. The patient was transferred to a recovery-phase rehabilitation hospital with an NIHSS score of 11 and mRS grade of 4.

Discussion

In the present case, thrombectomy and vertebral artery stenting for tandem lesions in the posterior circulation

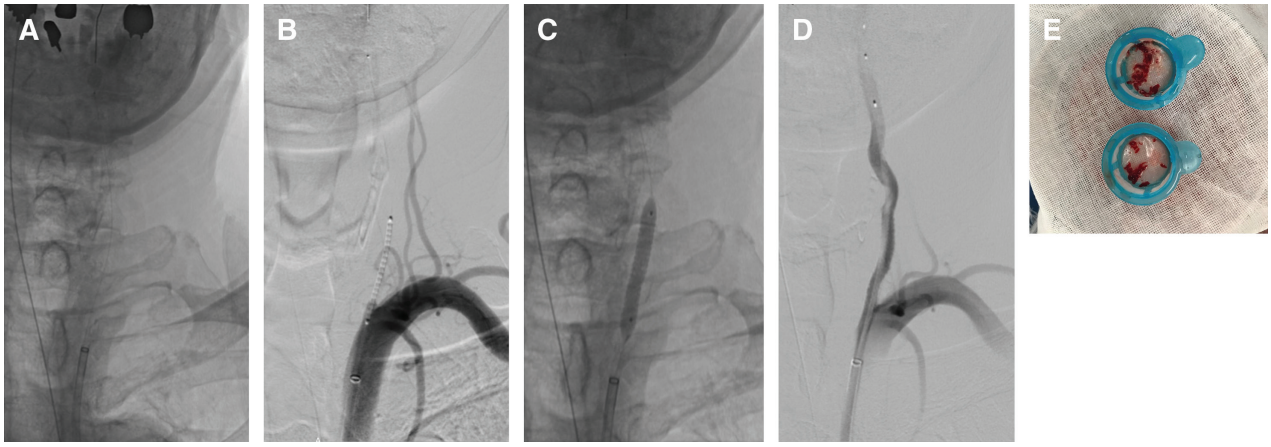

Fig. 4 (**A**) The Carotid Guardwire PS was passed through the site of stenosis. (**B**–**D**) A drug-eluting stent for the coronary artery, XIENCE Sierra 4.0 mm/28 mm, was deployed such that it slightly protruded into the left subclavian artery. (**E**) After deployment, many thrombi were aspirated.

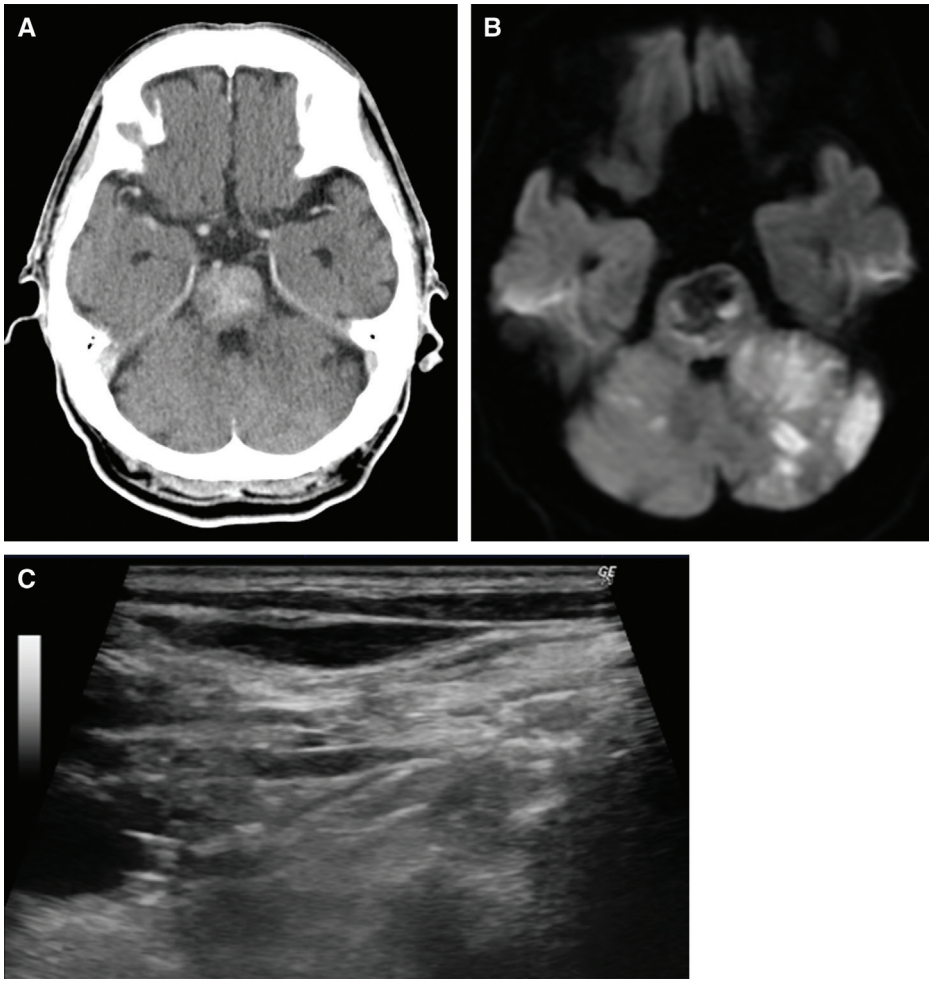

Fig. 5 (**A**) Postoperative head CT revealed hemorrhagic infarction involving the brainstem. (**B**) Diffusion-weighted MR image on the 2nd postoperative day. Hemorrhagic infarction of the brainstem and infarction in the bilateral cerebellar hemispheres were observed. (**C**) Carotid artery ultrasonography. A stent was placed in the vertebral artery. It protruded into the subclavian artery by 3.0 mm.

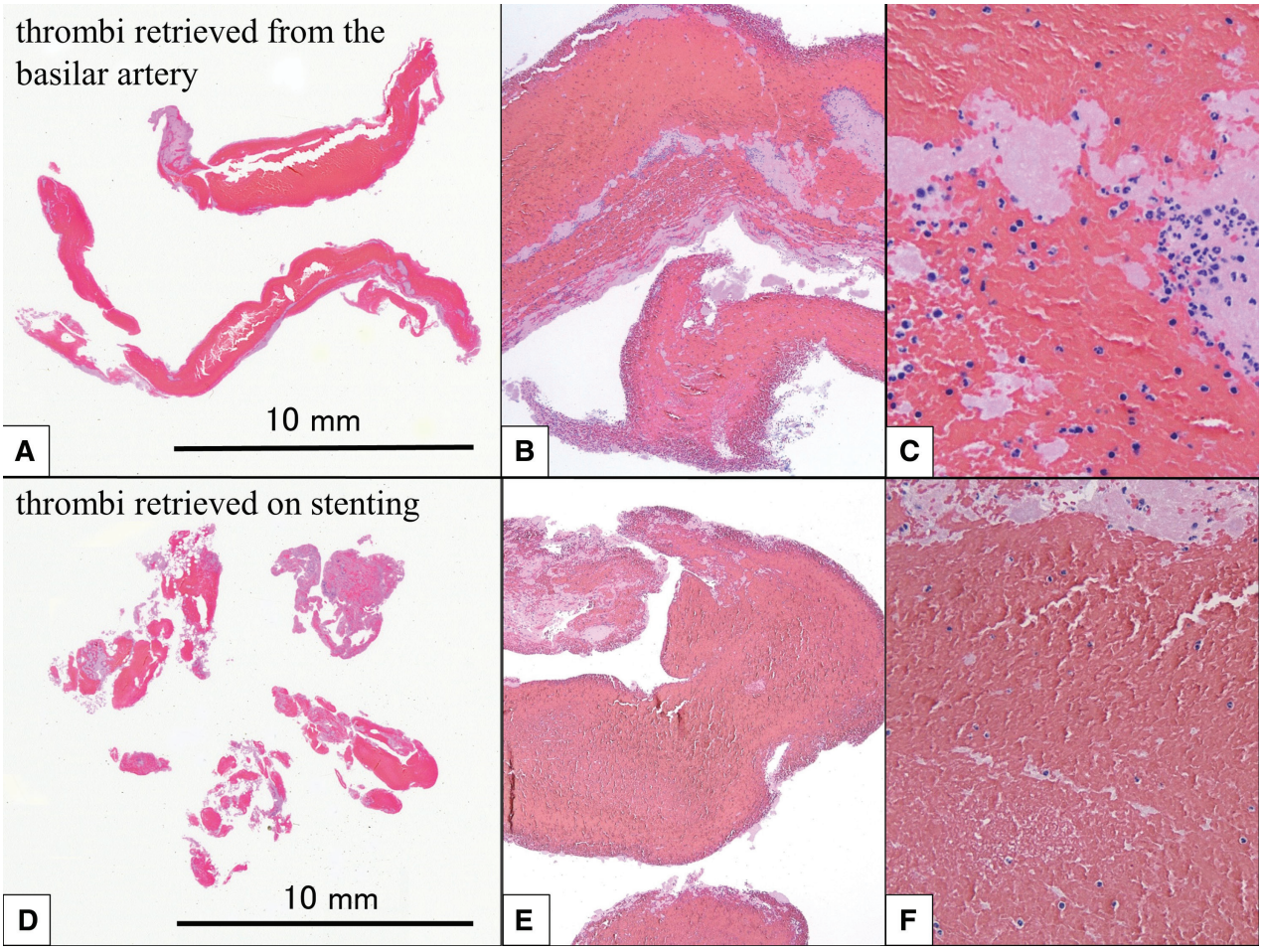

Fig. 6 Histological spectrum of thrombi retrieved by the treatment. Hematoxylin and eosin stain. Thrombi retrieved from the basilar artery are above. Thrombi retrieved after stenting are below. (**A**) Overview of thrombi retrieved from the basilar artery. (**B**) Detail of thrombi retrieved from the basilar artery. Objective lens magnification ×4. (**C**) Detail of thrombi retrieved from the basilar artery. Objective lens magnification ×20. (**D**) Overview of thrombi retrieved on stenting. (**E**) Detail of thrombi retrieved on stenting. Objective lens magnification ×4. (**F**) Detail of thrombi retrieved on stenting. Objective lens magnification ×20. In both the thrombi retrieved from the basilar artery and those retrieved on stenting, the erythrocyte component-to-fibrin to platelet component ratio was 9:1. Erythrocytes, platelets, fibrin, and granulocytes comprised a layered structure. There were no organized changes, such as smooth muscle cell, connective tissue, and capillary vessel ingrowth, suggesting fresh thrombi.

system were performed. A combination of the reverse technique and a distal embolic-protection device was useful.

Approaches for endovascular treatment for vertebrobasilar artery tandem lesions include clean- or dirty-road path approaches.[4–6] The clean-road path approach is a method to perform thrombectomy alone through the vertebral artery contralateral to a cervical lesion. Its procedure is similar to that of standard thrombectomy. On the other hand, the dirty-road path approach is an approach through the stenotic side and must be selected when the contralateral vertebral artery is not available as an approach route, such as in a case in which the contralateral vertebral artery is ending in the PICA like the present case. For the dirty-road path approach, two methods have been reported: antegrade and reverse techniques (retrograde technique).[4–6] The antegrade technique is defined as a method to perform thrombectomy after PTA and stenting for cervical lesions.[4,5] On the other hand, the reverse technique is defined as a method to initially perform PTA for cervical lesions in all patients[4,5] or only in those with occlusion or severe stenosis,[6] followed by thrombectomy and stenting.

A consensus regarding the superiority or inferiority of the antegrade and reverse techniques has not been reached.[4,5] The reverse technique has an advantage of initially relieving intracranial occlusion that causes symptoms. Furthermore, a study reported that, for stenting at the origin of the vertebral artery, the stent must be extended 2–3 mm to the subclavian artery to cover plaque lies from the subclavian artery to the vertebral artery origin.[8] On the other hand, excessive protrusion makes it difficult to guide

a device into the stent.[5] In the reverse technique, intracranial recanalization is achieved in advance; therefore, it may be permissible to take sufficient time for stent positioning. As the limitation of the reverse technique, distal embolism may occur during stent deployment. To avoid it, we used a distal embolic-protection device. A study using the reverse technique and a filter-type distal embolic-protection device reported that the time to recanalization, rate of TICI 2B/3 patients, and mRS score after 3 months were similar to those in patients with basilar artery occlusion alone, whereas the incidence of distal embolism was significantly lower.[6] In the present case, a balloon-type distal embolic-protection device, Carotid Guardwire PS, was used. As many thrombi were retrieved through aspiration after stenting, the use of the distal embolic-protection device may have been necessary. A previous study reported that the incidence of complications within 30 days after carotid artery stenting for unstable plaques using a balloon-type distal embolic-protection device was lower than that using a filter-type (Angioguard RX; Cardinal Health, Dublin, OH, USA).[9] On the other hand, another study comparing filter-type devices, such as the FilterWire EZ (Boston Scientific, Natick, MA, USA) and Spider FX (Medtronic), which are mainstream currently, with the Carotid Guardwire PS showed no difference in the incidence of perioperative complications, including ipsilateral stroke.[10] To our knowledge, no study has reported the use of a balloon-type distal embolic-protection device for tandem lesions in the posterior circulation system. The type of distal embolic-protection device (filter or balloon type) should be comprehensively determined from the viewpoint of the plaque volume or tolerance to the balloon occlusion. In this case, severe stenosis at the origin of the vertebral artery suggests a large volume of plaque. Thus, we selected balloon type to avoid no flow or slow flow phenomena, which may occur in filter type. When basilar artery blood flow cannot be provided from the contralateral vertebral artery, tolerance to the occlusion with balloon-type devices should be considered. In the present case, there was a collateral pathway via a posterior communicating artery, facilitating the use of a balloon-type device. However, in a case without enough collateral pathway, using a filter-type device should also be considered.

We used a drug-eluting stent for the coronary artery, XIENCE Sierra 4.0 mm/28 mm in this case. The type of stent for posterior circulation tandem lesions varied among previous studies: balloon expandable,[4] self-expandable,[5] and both[2,6] stents. In the Vertebral artery Ischaemia Stenting Trial[7] and Vertebral Artery Stenting Trial[11] involving patients with symptomatic intracranial vertebral artery stenosis, balloon-expandable stents were mainly used. The vertebral artery origin has a high risk of restenosis due to the well-developed muscularis and has difficulty positioning stents as described earlier. Considering these points, a previous study mentioned that coronary stents, which have a strong radial force and slight shortening, are appropriate for vertebral artery origin.[8] The restenosis rate after stenting at the origin of the vertebral artery was 36%,[12] whereas that using a drug-eluting stent was 12%.[13] Therefore, at the origin of the vertebral artery, balloon-expandable drug-eluting stents may be appropriate.

In the present case, although the symptoms improved, large cerebral infarction and hemorrhagic infarction occurred. Concerning the former, three possibilities were suggested: 1) left vertebral artery stenosis may have led to arteriogenic cerebral embolism; 2) distal embolism may have occurred during the first PTA; and 3) cerebral infarction may have occurred when the left vertebral artery origin occluded. The latter may have been related to DAPT for coronary-stent deployment after intravenous thrombolysis with recombinant tissue plasminogen activator. A previous study reported that aspirin therapy after alteplase administration increased the incidence of intracranial hemorrhage, with no improvement in the outcome.[14] Thus, antithrombotic drug administration may have promoted hemorrhagic infarction.

Pathological findings of thrombi were obtained. We compared thrombi retrieved by basilar artery thrombectomy with those aspirated after stenting at the origin of the vertebral artery. In both of them, the erythrocyte component-to-fibrin to platelet component ratio was 9:1. Erythrocytes, platelets, fibrin, and granulocytes comprised a layered structure. There were no organized changes, such as smooth muscle cell, connective tissue, and capillary vessel ingrowth, suggesting fresh thrombi.[15] A previous study reported no significant difference in the rate of thrombus erythrocytes between patients with cardiogenic embolism and those with large artery atherosclerosis.[16] However, another study found that the rate of fibrin/platelet components was significantly higher in patients with cardiogenic embolism, whereas the rate of erythrocyte components was significantly higher in those with large artery atherosclerosis.[17] In the present patient, there were no cholesterol crystals and a definitive diagnosis of the large artery atherosclerosis was not reached. However, a review of pathological findings of thrombi may be useful

for patients in whom several etiologies are suggested, as demonstrated in the present case.

Conclusion

We reported a patient in whom thrombectomy and vertebral artery stenting for tandem posterior circulation lesions were performed. A therapeutic strategy in which the reverse technique is combined with a Carotid Guardwire PS may be useful to avoid distal embolism.

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Disclosure Statement

The authors declare no conflicts of interest.

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