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Case Report

Percutaneous Transluminal Angioplasty and Stenting Using an Aspiration Catheter

Nobuaki Yamamoto,[1,2] Yuki Yamamoto,[1] Izumi Yamaguchi,[3] Shu Sogabe,[3] Takeshi Miyamoto,[3] Kenji Shimada,[3] Yasuhisa Kanematsu,[3] Ryoma Morigaki,[2,3] Yuishin Izumi,[1] and Yasushi Takagi[2,3]

Objective: During percutaneous transluminal angioplasty (PTA) for the vertebral artery, occlusion of the subclavian artery using a balloon guiding catheter may be useful to prevent embolism of clots and/or debris distal to an atherosclerotic lesion. However, when placing a balloon guiding catheter at the intended vessels is difficult, it may be useful to use an aspiration catheter (AC) for mechanical thrombectomy as an intermediate catheter to suction way clots and/or debris. We report two cases in which PTA was performed for an atherosclerotic lesion at the intracranial vertebral artery using an AC, which ended without complications.

Case Presentations: Case 1: A 74-year-old man presented with dysarthria and was admitted to our hospital. MRI revealed severe left vertebral artery stenosis and diffuse cerebral infarct areas at the territory of the posterior circulation. The patient had an abdominal aortic aneurysm and abnormally shaped left tortuous subclavian artery. Therefore, we performed PTA and stenting via the left brachial artery. We guided a 6-Fr long sheath to the left subclavian artery, and a 6-Fr AC for thrombectomy was guided through the long sheath to the V4 portion of the left vertebral artery. Thereafter, PTA was carried out under manual aspiration from the AC. As restenosis at the atherosclerotic lesion occurred after PTA, we performed stenting using a coronary stent system for this lesion under manual aspiration from the AC. No new infarct areas were observed on post-procedural MRI. Case 2: A 74-year-old woman presented with dysarthria and was admitted to our hospital. MRI demonstrated basilar artery occlusion and diffuse cerebral infarct areas at the territory of the posterior circulation. As her symptom worsened after admission, we performed urgent mechanical thrombectomy. We first performed thrombectomy using a stent retriever and then performed PTA and stenting (PTAS) for residual basilar artery stenosis via the AC under manual aspiration.

Conclusion: When it is difficult to place a guiding catheter at the intended vessels during PTA, an AC may be useful to prevent distal embolization.

Keywords percutaneous transluminal angioplasty, aspiration catheter

[1]*Department of Neurology, Tokushima University Hospital, Tokushima, Tokushima, Japan*
[2]*Department of Advanced Brain Research, Tokushima University, Graduate School of Biomedical Sciences, Tokushima, Tokushima, Japan*
[3]*Department of Neurosurgery, Tokushima University Hospital, Tokushima, Tokushima, Japan*

Received: March 3, 2021; Accepted: July 29, 2021
Corresponding author: Nobuaki Yamamoto. Department of Clinical neuroscience, Tokushima University Hospital, 2-50-1, Kuramotocho, Tokushima, Tokushima 770-8503, Japan
Email: nobyamamoto521129@yahoo.co.jp

Introduction

For percutaneous transluminal angioplasty (PTA) and intracranial stenting of intracranial blood vessels, prevention of distal embolism is important. This is the same for cases in which an atherosclerotic thrombotic lesion is found during acute phase revascularization, necessitating PTA and stenting. In cases of contralateral vertebral artery occlusion, expansion of cerebral infarct lesions due to impaired blood flow of the posterior circulation for a prolonged time induced by dissection or the accordion phenomenon of the vertebral artery on the affected side is of concern.

We considered it possible to avoid the above events, and stabilize the PTA balloon and stent delivery system by the

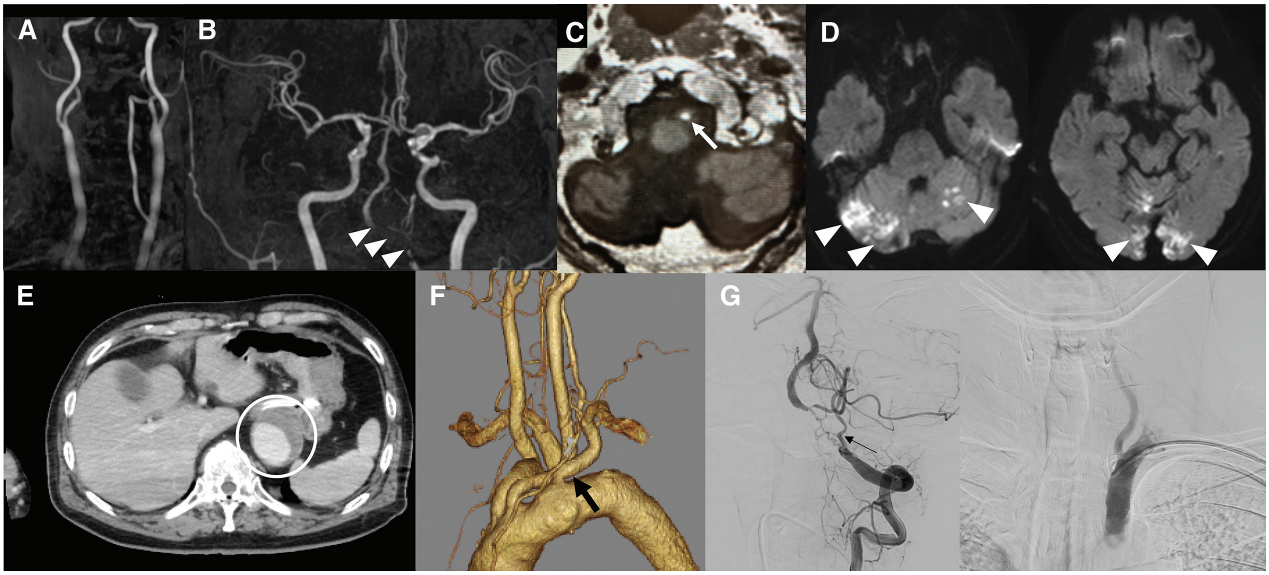

Fig. 1 (**A**) MRA of the neck. The right vertebral artery was not visualized. (**B**) Intracranial MRA. Severe stenosis (white arrowheads) of the left vertebral artery was observed. (**C**) T1-weighted imaging. A high-intensity lesion was noted in the vertebral artery, suggesting the presence of thrombus (white arrow). (**D**) Diffusion-weighted image. Diffuse infarct areas were observed in the posterior circulation system (white arrowheads). (**E**) Abdominal contrast-enhanced CT. An abdominal aortic aneurysm, which had become thrombus, was present (white circle). (**F**) CTA of the aortic arch over the neck. Tortuosity of the left subclavian artery was noted (black arrow). (**G**) Digital subtraction angiography. Marked stenosis of the left vertebral artery was noted, the lateral spinal artery was present as collateral circulation (black arrow), and the vertebrobasilar artery distal to the stenotic region was visualized through the posterior inferior cerebellar artery.

concomitant use of an aspiration catheter (AC). We report patients with arteriosclerotic stenosis and occlusion in whom distal embolism was prevented by aspiration through an AC during the procedure.

Case Presentations

Case 1

A 74-year-old man. The patient visited a physician for a chief complaint of dysarthria and was examined by head MRI. As visualization of the left vertebral artery was poor and diffuse infarct areas were observed in the territory of the posterior circulation, the patient was referred to our hospital. The National Institutes of Health Stroke Scale (NIHSS) score at arrival was 1. Similar infarction was noted several months before and severe stenosis of the left vertebral artery was also noted at that time, for which antiplatelet drugs were administered (acetylsalicylic acid 100 mg, clopidogrel 75 mg). Head MRI is shown in **Fig. 1A**–**1D**. The right vertebral artery was occluded, but the left vertebral artery was slightly visualized and signal of the distal lesion was observed, suggesting that antegrade blood flow was retained (**Fig. 1B**, white arrowheads). A high-intensity lesion was present in the vertebral artery on T1-weighted imaging, suggesting the presence of thrombus (**Fig. 1C**, white arrow). On diffusion-weighted imaging, diffuse infarct areas were observed in the territory of the posterior circulation (**Fig. 1D**, white arrowheads). On thoracicoabdominal contrast-enhanced CT, an abdominal aortic aneurysm, which became thrombus, was noted, as shown in **Fig. 1E** (white circle), and the left subclavian artery was tortuous from the aortic bifurcation (**Fig. 1F**, black arrow). On imaging through the left brachial artery, the left vertebral artery was markedly stenosed and used the lateral spinal artery (**Fig. 1G**, black arrow) as collateral circulation, which then anastomosed with the left posterior inferior cerebellar artery and the basilar artery was antegradely visualized. Moreover, the contralateral vertebral artery was occluded from the origin. As diffuse infarcts suggesting arteriogenic infarct lesions were present and the presence of thrombus in the vertebral artery was suspected, prevention of distal embolism was considered necessary. The procedure was applied through the brachial artery approach because it was complicated by the abdominal aortic aneurysm and marked tortuosity of the left subclavian artery. We considered it necessary to apply sufficient aspiration from the proximal region of the lesion to prevent distal embolism. The contralateral vertebral artery was occluded and the diameter of the affected-side vertebral artery was 3.2 mm, through which a 6-Fr catheter was considered able to be guided, but vascular dissection caused by guiding a low-flexible catheter with a large diameter and

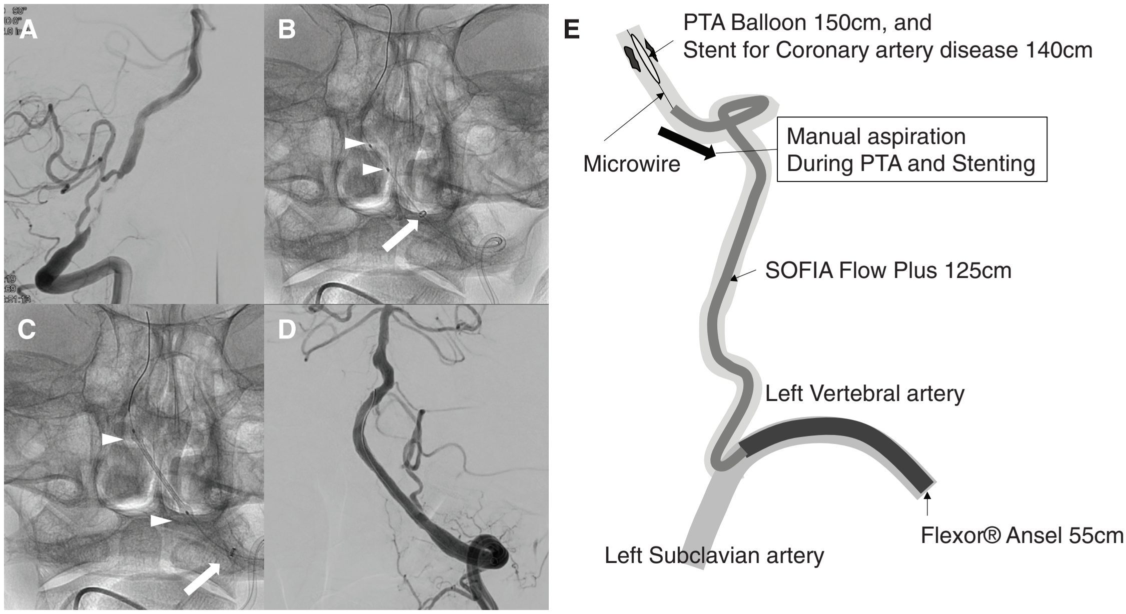

Fig. 2 (**A**) Lateral view of the left vertebral artery. Marked stenosis was present in the V4 segment, collateral circulation bifurcated from the proximal stenosis, the posterior inferior cerebellar artery was visualized, and the distal region was visualized via this artery. (**B**) PTA with the Unryu (white arrowheads) via SOFIA Flow Plus (white arrow). (**C**) Stenting with the coronary artery stent system (white arrowheads) via SOFIA Flow Plus (white arrow). (**D**) Postoperative digital subtraction angiography. (**E**) Illustration of the procedure. PTA: percutaneous transluminal angioplasty

intraoperative impairment of blood flow of the posterior circulation caused by the accordion phenomenon were of concern. To prevent these events, we decided to perform treatment while preventing distal embolism using a high-flexible AC with a large diameter capable of PTA and stenting. Under general anesthesia, a 6-Fr Flexor Ansel Guiding sheath ANL1 (Cook Medical, Bloomington, IN, USA) was placed in the left brachial artery and guided to the vicinity of the vertebral artery, and a 6-Fr SOFIA Flow Plus 125 cm (MicroVention Terumo, Tustin, CA, USA) was guided to the V4 segment of the left vertebral artery using a Marksman microcatheter (Medtronic, Minneapolis, MN, USA) and ASAHI CHIKAI Black 0.014 microwire (Asahi Intecc, Aichi, Japan) (**Fig. 2B** and **2C**, white arrow). After crossing the lesion using a CHIKAI Black microwire and removing the Marksman by connecting the CHIKAI Extension NV (Asahi Intecc) to the microwire, a Unryu XP 2.0 mm × 10 mm (Kaneka Medix, Osaka, Japan) was guided to and expanded in the lesion (**Fig. 2B**, white arrowheads). As recoil was noted thereafter, stenting was performed using a coronary stent (Resolute Onyx; Medtronic) (**Fig. 2D**). All procedures including lesion crossing were performed while manually aspirating through SOFIA Flow Plus (**Fig. 2E**). White thrombus was collected from the aspirated blood. No postoperative aggravation of neurological manifestations or expansion of the infarct lesions occurred throughout the course (**Fig. 3**), and the patient was transferred to a clinic for rehabilitation.

Case 2

A 74-year-old woman. The patient visited the emergency service because dysarthria was noted. As diffuse infarcts in the posterior circulation system and loss of basilar artery intensity were observed on head MRI, the patient was admitted for treatment. The NIHSS score was 3 at arrival and internal medical treatment was selected, but the patient was resistant and disturbance of consciousness developed on the day following admission. Thus, emergency revascularization was performed. A 9-Fr sheath was placed in the right femoral artery and a 9-Fr OPTIMO (Tokai Medical Products, Aichi, Japan) was guided to the left vertebral artery. When an image was acquired from this region, basilar artery occlusion, a severe stenotic lesion of the proximal occluded region, and thrombus in the distal region were observed. A Trevo Trak 21 microcatheter (Stryker, Kalamazoo, MI, USA) was guided to the tip of the basilar artery beyond the lesion using an ASAHI CHIKAI Black microwire 0.014 (Asahi Intecc, Aichi, Japan), a Trevo NXT ProVue Retriever 4 mm × 41 mm (Stryker) was deployed, and the Trevo Trak 21 microcatheter was removed. A SOFIA Flow Plus 125 cm was guided to the proximal lesion

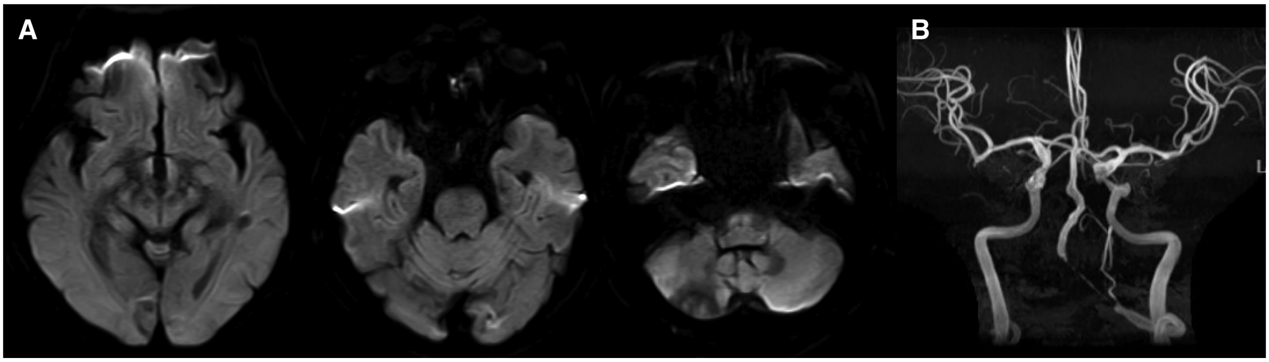

Fig. 3 Postoperative diffusion-weighted image (**A**) and MRA (**B**).

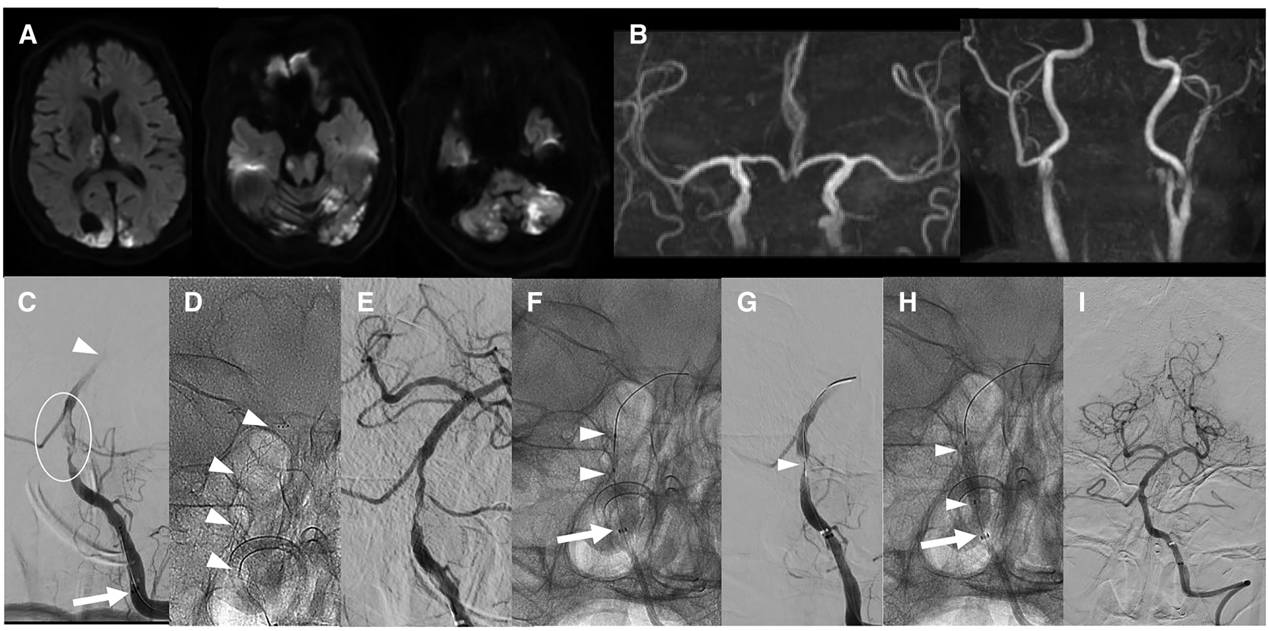

Fig. 4 (**A**) Diffusion-weighted image. Diffuse infarct areas were observed in the posterior circulation system. (**B**) Intra- and extracranial MRA. The bilateral vertebral arteries and basilar arteries were not visualized. (**C**) Left vertebral artery DSA. Basilar artery occlusion (white arrowhead) and thrombus (white circle) were noted. An arrow shows distal tip of aspiration catheter. (**D**) Live imaging. The SR was deployed in the thrombus region (white arrowheads). (**E**) DSA. Recanalization was acquired after thrombectomy using SR. (**F**) Live imaging. Percutaneous luminal angioplasty was executed using the Unryu (white arrowheads) through the AC (white arrow). (**G**) DSA. Re-stenosis was noted after PTA (white arrowhead). (**H**) Live imaging. Stenting was performed using the coronary artery stent system (white arrowheads) via the AC (white arrow). (**I**) DSA. Complete recanalization was noted after treatment. AC: aspiration catheter; PTA: percutaneous transluminal angioplasty; SR: stent retriever

using the stent retriever (SR) as an anchor and the SR was retrieved into the AC. The basilar artery was recanalized, but the stenotic lesion remained and recoil occurred over time, resulting in stagnant flow, for which the stenotic region was expanded using a Unryu XP 2.0 mm × 10 mm. However, re-stenosis occurred again and placement of Resolute Onyx was decided. Lesion crossing, PTA, and stenting after thrombectomy were performed while aspirating blood through the AC. Favorable expansion was acquired and occlusion of a distal portion was not noted; therefore, the procedure was completed (**Fig. 4**). No expansion of the infarct lesions was noted on MRI on the day following treatment and the patient was transferred to a hospital for rehabilitation.

Discussion

In patients with intracranial vascular stenosis lesions, the risk of developing cerebral infarction within 1 year is 14–23%, being relatively high.[1] The efficacy of stenting for intracranial stenosis lesions was investigated in the SAMMPRIS trial[2] and many perioperative complications occurred. Subsequently, the WEAVE trial[3] was performed employing strict indication criteria and

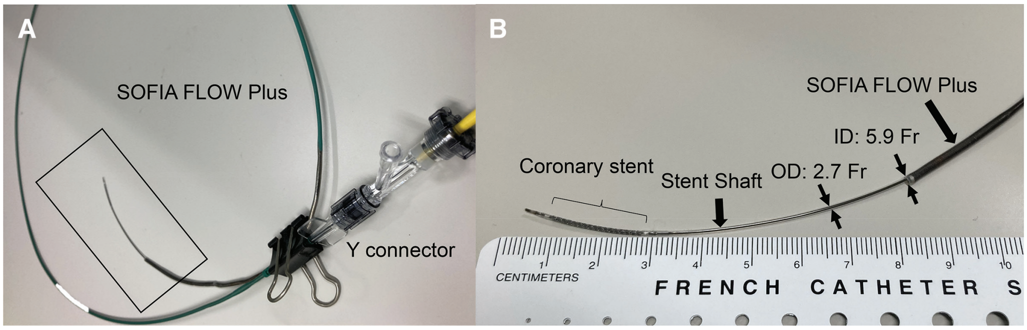

Fig. 5 (**A**) Photograph of the coronary stent system inserted by connecting the Y connector to SOFIA Flow Plus. (**B**) Magnified photograph of the black square part of (**A**). The device was advanced by approximately 5 cm from the tip of SOFIA Flow Plus to the proximal stent of the coronary stent system.

perioperative complications occurred in 2.6%, in which the results of 1-year follow-up were presented in the subsequent WOVEN trial,[4] in which the incidence of stroke was 5.9% and that of severe stroke was 0.8%. These studies suggested that intracranial stenting may become a treatment option for intracranial stenosis by making the indication stricter and having skilled operators perform the procedure. Regarding the type of perioperative complications, distal embolism and perforating branch infarction are serious, and their prevention is important. In the present patients, multiple embolic cerebral infarctions developed, for which thrombus adhesion to the distal stenosis region was of concern, suggesting the importance of prevention of distal embolism. In extracranial carotid artery stenting, the procedure is performed using devices to prevent distal embolism as a standard procedure, but in intracranial PTA and stenting, it may be performed with proximal flow control using a balloon guiding catheter because guiding a device to prevent distal embolism to a site distal to the lesion is difficult. When the aortic approach is difficult, a method in which a balloon guiding catheter is inserted through the brachial artery using a long sheath dilator and guided to the target blood vessel is employed. In case of the vertebral artery, the steal phenomenon may be intentionally prepared by placing a balloon guiding catheter to occlude the subclavian artery or a random artery to prevent distal embolism. However, the contralateral vertebral artery may be occluded in patients with severe arteriosclerosis, and the accordion phenomenon induced by guiding a stiff guiding catheter and expansion of infarct lesions due to impairment of blood flow of the posterior circulation system accompanying vascular dissection during the procedure are of concern. We considered it possible to simplify and stabilize guidance of the PTA balloon and stent delivery system, and prevent distal embolism using an AC as an intermediate catheter while avoiding straightening of the blood vessel and aspirating blood during the procedure.

For treatment, the length of each device matters, and it is important to use a guiding catheter and AC with the shortest length, and a PTA balloon with a long shaft. As shown in **Fig. 5**, the coronary stent precedes the proximal region of the stent mount by approximately 5 cm even when the Y connector is connected to the SOFIA Flow Plus. In addition, the difference in the lumen between the stent shaft diameter and SOFIA Flow Plus is 3-Fr or larger, being capable of aspiration.

The limitations of this procedure are that when the AC cannot be guided sufficiently close to the lesion, the procedure itself becomes difficult. Guiding of the AC after guiding an SR and then using it as an anchor is possible in revascularization, but this method cannot be used for PTA and stenting. Moreover, the AC may be insufficiently long if its length and that of the guiding catheter are not considered. In addition, the AC for thrombectomy is highly flexible because it is prepared on the assumption of delivery into the cranium, for which attention should be paid to slipping of the guiding catheter while guiding the stent delivery system. Furthermore, contrast imaging through the AC using an injector cannot be performed and it is desirable to use a normal catheter for angiography for preoperative evaluation such as 3D imaging. When imaging is inevitably performed, it is necessary to confirm that the catheter is not occluded and it should be slowly applied manually in principle. Regarding the stent, a coronary stent was used in the present cases, but these were elective surgery and it is desirable to use an intracranial stent system, such as the Wingspan Stent System (Stryker), but the shaft length of the Wingspan is 135 cm, being shorter than that of a coronary stent; thus, its use was avoided because it may be insufficiently long. As drug-eluting stents have recently become the mainstream of coronary stent systems, bare metal stents have become difficult to obtain; however, their efficacy and safety have been reported,[5,6] and they were used in the present patients. The AC was used for revascularization of the occluded blood vessel, which was necessary, and the coronary stent was used after acquiring permission and approval for the use of an unapproved device from the safety control department of our hospital.

Conclusion

For acute revascularization in cases with difficulty in preventing distal embolism by proximal flow control of intracranial arteriosclerosis lesions and intracranial atherosclerotic disease (ICAD), it is possible to prevent distal embolism, and stabilize the PTA balloon and stent system by the concomitant use of an AC.

Disclosure Statement

The authors declare no conflicts of interest.

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