Basilar Artery Trunk Aneurysm: Symptomatic Basilar Artery Trunk Dissecting Aneurysm with Critical Vasospasm Treated by Blind Deconstructive Coiling, Angioplasty, Embolectomy, and Flow Diversion

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Abstract

Dissecting intracranial aneurysms in the posterior circulation are a rare cause of subarachnoid hemorrhage (SAH) or brain ischemia. They are associated with a high risk of mortality and early rebleeding, making early treatment imperative. Aneurysms located on the basilar trunk are particularly infrequent. A 54-year-old man with a history of hypertension and thymoma surgery that had resulted in left subclavian artery and left vertebral artery (VA) occlusion experienced an episode of sudden onset severe headaches followed by loss of consciousness. The patient was brought to the emergency room with a Glasgow Coma Score (GCS) of 6. He was urgently intubated. A CT of the head confirmed subarachnoid and intraventricular hemorrhage, causing hydrocephalus. CTA showed a medium-sized proximal basilar artery aneurysm associated with critical vasospasm of both distal vertebral arteries and the basilar trunk. Urgent ventriculostomy was performed in the operating room, and the patient was immediately transferred to the neuroendovascular suite. An angiogram of the right vertebral artery confirmed the presence of a medium-sized dissecting aneurysm of the proximal third of the basilar trunk associated with severe bilateral vasospasm of the distal VAs and basilar trunk. There was retrograde supply of the distal left VA from the right VA. The left subclavian artery and proximal left VA were occluded. Angiography of the left common carotid artery (CCA) showed the left internal carotid artery (ICA) supplying the upper basilar trunk via a midsized posterior communicating artery (PcomA), with the right ICA feeding a smaller PcomA. Under general anesthesia, we proceeded to place a guiding catheter in the right vertebral artery and confirmed the lack of intracranial angiographic opacification. The ventricular fluid was drained, and vasoactive agents were selectively infused with no angiographic improvement. Then, under road map and blind intracranial navigation, the aneurysm and lower basilar trunk were coiled, and angioplasty of the right VA was performed. After regaining intracranial angiographic flow, we

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proceeded to perform a right-hand posterior inferior cerebellar artery (PICA)-VA embolectomy and to implant a vertebro-vertebral flow diverter. Underexpansion of the flow diverter required a balloon-expandable stent to be implanted with excellent results. The final angiogram confirmed that the aneurysm had been excluded, there was symmetric bilateral PICA territory supply, and the basilar trunk was being supplied via the left ICA-PcomA pathway. The management of a symptomatic dissecting basilar aneurysm, performing deconstructive therapy on it under adverse angiographic conditions, and ultimately implanting a flow diverter to preserve the vertebro-vertebral junction and secure aneurysm occlusion are the main topics of this chapter.

Keywords
Basilar artery · Coiling · Deconstructive technique · Dissecting aneurysm · Flow diverter stent

Patient

A 46-year-old man who lost consciousness following a sudden onset of severe headaches was admitted in critical condition with Glasgow Coma Score (GCS) of 6.

Diagnostic Imaging

Preoperative cranial CT revealed a subarachnoid hemorrhage (SAH) focused on the pre-mesencephalic cisterns and the third and fourth ventricles, as well as hydrocephalus. CT angiography (CTA) depicted a proximal midsized irregularly shaped basilar artery (BA) aneurysm and severe vertebrobasilar vasospasm. Diagnostic cerebral angiogram of the left internal carotid artery (ICA), lateral view, showed that the distal third of the BA was supplied through the left posterior communicating artery (PcomA). An angiogram of the left subclavian artery confirmed its proximal chronic occlusion, while angiography of the right vertebral artery (VA) confirmed the occlusion of the distal VA (Fig. 1).

Treatment Strategy

The primary treatment goal was to exclude the BA dissecting aneurysm and alleviate the critical vertebrobasilar vasospasm. First, we assessed both ICAs and their contribution to the posterior circulation. The left ICA had a PcomA that was supplying the upper basilar trunk, compensating for the severe vertebrobasilar vasospasm, and the right ICA contributed to the supply of the right PcomA.

This pattern of primary collateral supply was of utmost importance in defining the therapeutic strategy for this aneurysm. Reconstructive endovascular techniques are usually favored; however, the presence of critical vasospasm, the segmental and circumferential extension of the dissecting aneurysm, and the presence of adequate ICA-to-BA collateral supply prompted us to choose a deconstructive option. The presence of a single vertebral artery supplying both VAs and posterior inferior cerebellar arteries (PICAs) also had to be taken into account and meant that the vertebro-vertebral junction needed to be preserved.

The original plan was to inject vasoactive agents to alleviate the vasospasm and then proceed with coiling the aneurysm and lower basilar trunk. This plan was modified several times during the procedure, as explained below, and eventually involved blind occlusion of the aneurysm and lower basilar trunk, balloon angioplasty, stentriever-assisted embolectomy, implanting a flow diverter across the vertebro-vertebral junction via the right PICA-VA, angioplasty of the implanted flow diverter with an additional balloon-expandable stent, and finally concluding with vasoactive agents being infused into the basilar trunk.

Treatment

Procedure, 28.09.2019: diagnostic cranial angiography and deconstructive coil occlusion of the BA aneurysm, intracranial angioplasty, and reconstruction of the vertebro-vertebral junction utilizing stent techniques

Anesthesia: general anesthesia, 2,500 IU unfractionated heparin IV (80 IU/kg), bolus

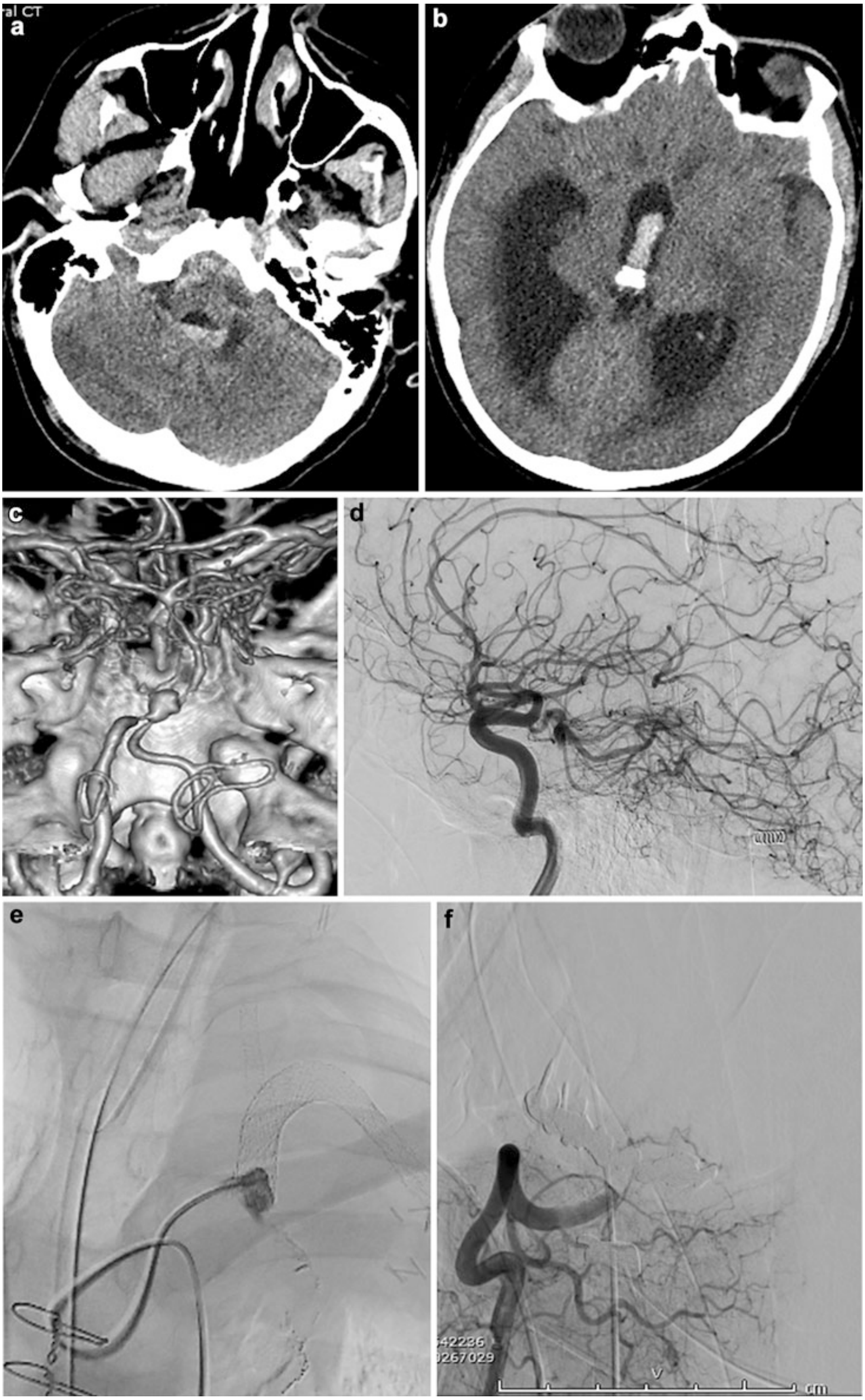

Fig. 1 Diagnostic imaging in a patient with a severe SAH due to a dissecting BA aneurysm. Non-contrast cranial CT at admission (**a**, **b**) revealed a basal subarachnoid hemorrhage focused on the pre-mesencephalic cisterns and extending into the third and fourth ventricles, causing acute hydrocephalus (**b**). CT angiography (CTA) showed a

dose; target activated clotting time (ACT) 250–320 s.

Premedication: 3× 90 mg ticagrelor via a nasogastric tube administered 60 mins before the flow diverter was to be implanted. Platelet reactivity to ticagrelor, confirmed by VerifyNow (Accumetrics), was checked 60 mins after the antiplatelet drug was administered

Access: right femoral artery, 6F introducer sheath (Terumo); *diagnostic catheter:* JB2 4F (Terumo); *guidewire:* Radifocus M, 220, 300 cm (Terumo); *guiding catheter:* 6F Envoy, D 0.071 (Cordis); *microcatheters:* Excelsior SL-10 (Stryker) for coil insertion, Headway 17 (MicroVention) for stentriever embolectomy and flow diverter stent implantation; *microguidewires:* Synchro2 0.014″ (Stryker), pORTAL 14 (phenox); *stentriever:* pRESET LITE 4× 20 mm (phenox); *balloon:* Copernic 5× 15 mm (Balt Extrusion).

Implants: nine detachable coils – 3× 5/12, 6× 4/8 (MicroVention); Silk Vista Baby flow diverter stent 2.25/15 (Balt Extrusion); Coroflex ISAR balloon-expandable coronary stent 2.5/8 (B. Braun)

Course of treatment: a diagnostic catheter was replaced by an Envoy guide catheter, which was placed in the distal right V2 segment. Coaxially, a Copernic balloon and an Excelsior SL-10 microcatheter were navigated under road map guidance through the right V3 segment. Then, both systems were “blindly” navigated and parked at V4. Blind angiographic navigation was made possible by the expected arterial anatomy and information acquired at both CTA reconstruction and 3D rotational angiogram reconstruction. Leaving the balloon as a proximal backup, the microcatheter was then advanced with the aid of a Synchro microguidewire and placed at the BA aneurysm body. A microangiography confirmed the microcatheter tip placement at the aneurysm body and showed the aneurysm anatomy. Contrast injection into the aneurysm failed to clear, confirming segmental flow arrest due to proximal vasospasm and mechanical catheter obstruction. Rapid placement of three 5/12 complex and six soft MicroVention coils allowed complete occlusion of the aneurysm and affected BA. Repeated balloon inflations allowed partial restoration of the vertebral-vertebral flow with residual vasospasm. A large right VA-PICA clot was occluding the PICA, and a small clot was seen at the vertebro-vertebral junction. At this stage, the ticagrelor loading dose was being administered via a nasogastric tube. The balloon and SL10 microcatheter were removed under gentle aspiration through the guiding catheter. The Headway 17 microcatheter was then navigated through the lateral medullary segment of the occluded right PICA. The stentriever was deployed at the PICA-VA, and the Headway microcatheter was removed to enable much better proximal aspiration. Stentriever-assisted embolectomy allowed complete recanalization of the PICA and removal of the clot tail located at the distal right VA after a single pass (Fig. 2).

The Headway microcatheter was then placed at the distal right VA to infuse nimodipine. VerifyNow testing confirmed a PRU of 122. A dose of 3 mg of diluted eptifibatide (Integrilin, GlaxoSmithKline) was injected at the vertebro-vertebral junction in an attempt to clear the filling defect noted there, without positive results. Then, the Headway microcatheter was navigated across the acute vertebro-vertebral junction and placed at the distal left VA. A Silk Vista Baby was then deployed at the vertebro-vertebral junction to reconstruct the compromised arterial junction and allow the left PICA supply. The flow diverter was intended to serve as a useful tight-meshed

Fig. 1 (continued) medium-sized irregularly shaped proximal basilar artery (BA) aneurysm circumferentially affecting the entire proximal BA segment, and presenting with multiple blebs associated with severe vertebrobasilar vasospasm mainly affecting the distal vertebral arteries and the mid-basilar trunk (**c**). Diagnostic cerebral angiography of the left internal carotid artery (ICA) (lateral view (**d**)) showed that the distal third of the BA was supplied through the left posterior communicating artery (PcomA). Selective angiogram of the left subclavian artery (posteroanterior view (**e**)) confirmed its proximal chronic occlusion. Angiography of the right vertebral artery (VA, posteroanterior view (**f**)) confirmed the occlusion of the distal VA

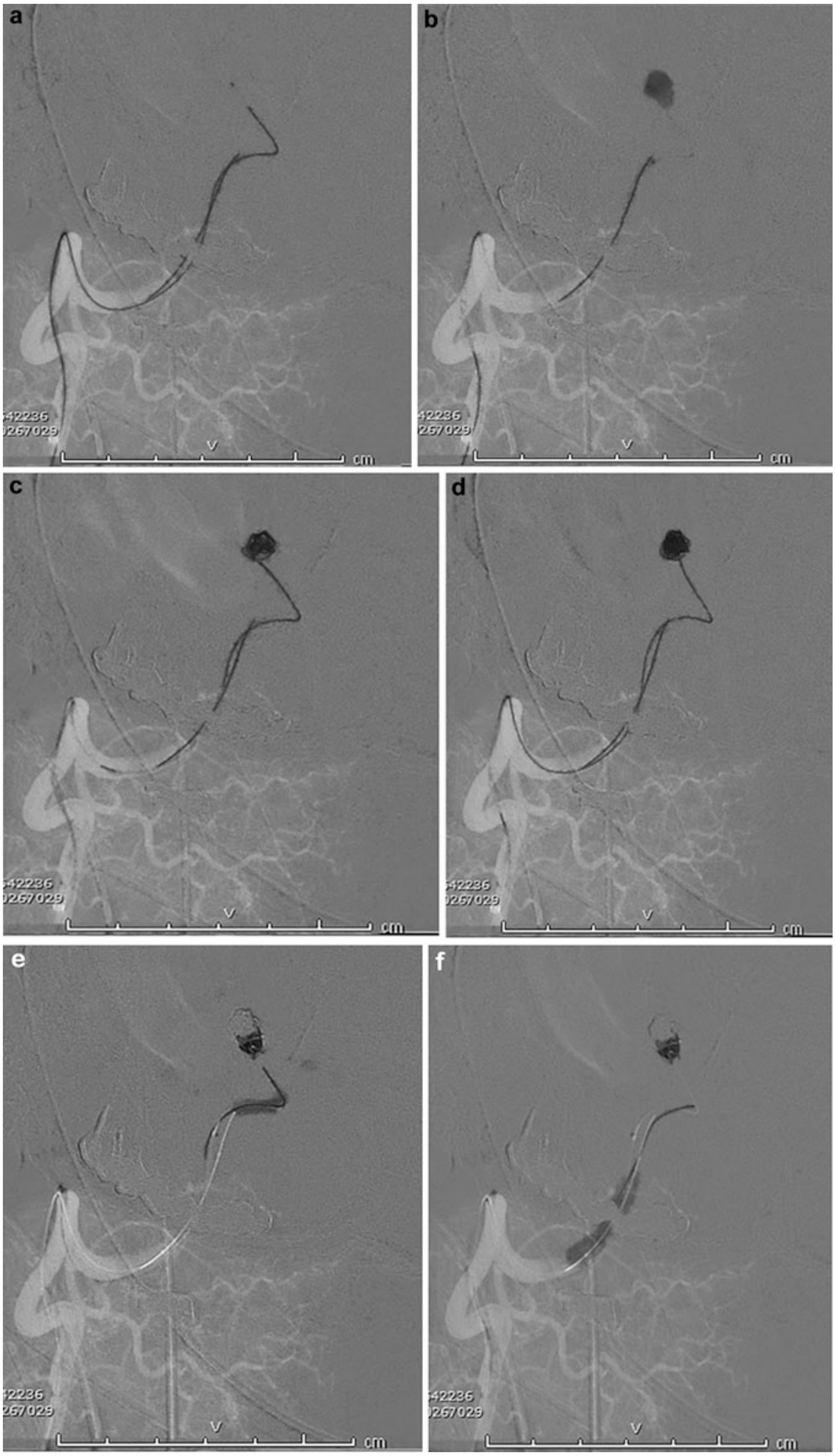

Fig. 2 (continued)

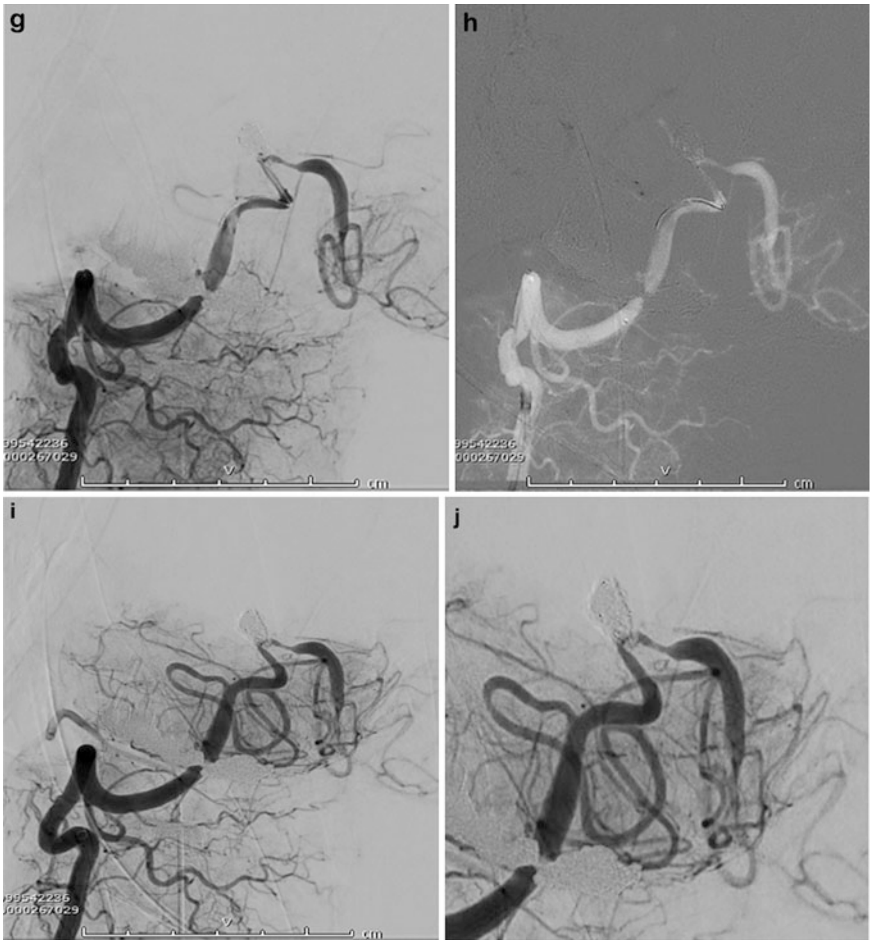

Fig. 2 Endovascular treatment of a presumably ruptured aneurysm. A Copernic balloon and SL-10 microcatheter were navigated under road map guidance through the right V3 segment (**a**). Then, both systems were "blindly" navigated and parked at V4. Blind angiographic navigation was made possible by the expected arterial anatomy and information acquired at both CTA reconstruction and 3D rotational angiogram reconstruction. Leaving the balloon as a proximal backup, the microcatheter was then advanced with the aid of a Synchro microguidewire and placed at the BA aneurysm body. Microangiography confirmed the microcatheter tip placed at the aneurysm body and showed aneurysm anatomy (**b**). Contrast inside the aneurysm failed to clear, confirming segmental flow arrest due to proximal vasospasm and mechanical catheter obstruction. Rapid placement of 3 × 5/12 cm complex and 6 × 4/8 soft coils allowed complete occlusion of the aneurysm and affected BA (**c**, **d**). Repeated balloon inflations allowed partial restoration of the vertebral-vertebral flow with residual vasospasm (**e**, **f**). A sizeable right VA-PICA clot occluded the right PICA and there was a small clot at the vertebra-vertebral junction (**g**). Under road map guidance, the stentriever was deployed at the PICA-VA junction (**h**). Angiogram obtained immediately after the stentriever-assisted embolectomy demonstrated complete recanalization of the PICA and removal of the clot tail from the distal right VA in a single pass. Magnified angiographic image showed the compromised vertebra-vertebral junction (**j**)

scaffold to cover the luminal clot, clear the arterial lumen, and also reinforce aneurysm exclusion by rerouting the flow. Anticipated underexpansion of the flow diverter at the critical lumen diameter point was corrected by placing a 2.5 × 8 mm balloon-expandable stent inside the flow diverter. This second stent implanted into the right arm of the V-shaped construct with its balloon extending beyond the stent expanded the flow diverter to the optimal diameter, allowing for synchronous bivertebral-PICA arterial supply. Angiograms of the left ICA confirmed primary supply to the upper part of the basilar trunk through the PcomA (Fig. 3).

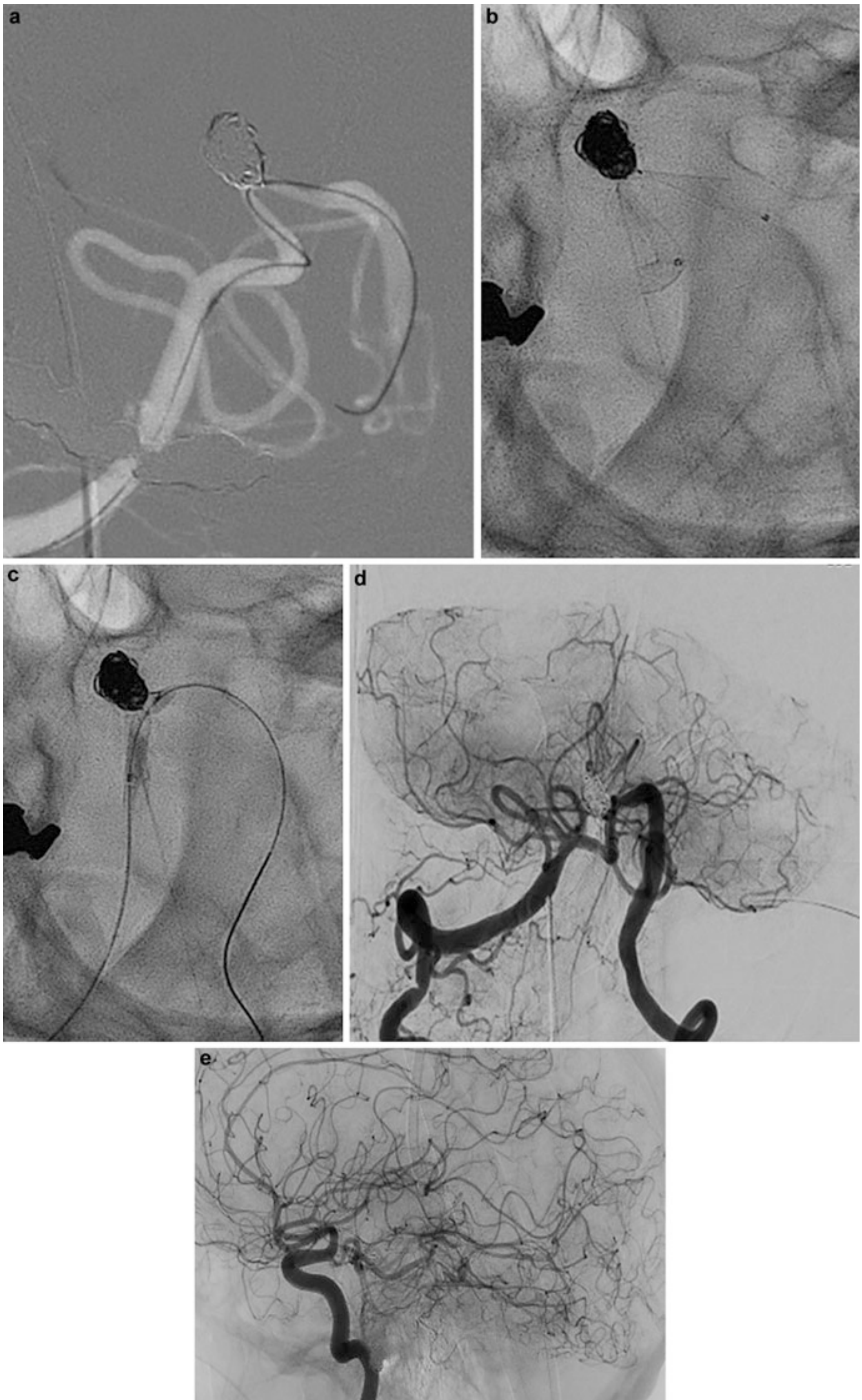

Fig. 3 A microsystem had been navigated across the acute vertebra-vertebral junction and placed at the distal left VA (road map image (**a**)). A poorly expanded Silk Vista Baby was deployed at the vertebro-vertebral junction (radioscopic image (**b**)). Expansion of the flow diverter using balloon-expandable coronary stent (**c**). Angiogram of the

Duration: 1st–16th DSA run: 144 min; fluoroscopy time: 37 min.

Complications: severe vertebrobasilar vasospasm, thrombosis of vertebral artery and PICA

Postmedication: 1× 100 mg ASA PO daily, 2× 90 mg ticagrelor PO for 4 months; ticagrelor was then discontinued and ASA was prescribed for 1 year.

Follow-Up Examinations

CTA at a 1-month follow-up confirmed complete exclusion of the treated aneurysm and preservation of the VV junction.

Clinical Outcome

Immediately after the endovascular procedure, the patient was transferred to the neurosurgical intensive care unit. The introducer sheath was removed 1 h later after confirming activated clotting time (ACT) normalization. Management of ventricular drain was complemented with induced hypertension and antiplatelet medications. The patient remained intubated and opened his eyes first to painful stimuli and then spontaneously during the second postoperative day, with a weak bilateral flexor response. The patient presented as GCS 8 after 72 h and was treated for nosocomial pneumonia. Ventriculostomy was removed on day 18. He was fully conscious when transferred to a rehabilitation facility after 27 days. One month after the intervention, the patient moved all four limbs but was generally weak and required assistance for basic tasks (mRS 3). On postoperative day 48, the patient was readmitted to the ICU and died following nosocomial pneumonia and sepsis.

Discussion

Dissecting intracranial aneurysms account for 3–5% of all SAH (Sikkema et al. 2014). Most dissecting aneurysms are located in the posterior circulation, likely reflecting its unique histological structure. The intradural VA lacks an external elastic lamina, has a thinner adventitia, and has fewer elastic fibers in the media, which may promote subadventitial dissection (Yamada et al. 2003). Whereas the intracranial VA is involved in >80% of posterior circulation arterial dissections, dissecting aneurysms of the BA are more rare, accounting for about 10.5% of posterior circulation vessel dissections (Ruecker et al. 2010). The plane of dissection plays a crucial role in the occurrence of SAH (Sasaki et al. 1991).

Unruptured vertebrobasilar dissecting aneurysms (VBDAs) have a benign clinical course when not associated with stroke or mass effect; however, they are prone to rupture and stroke when symptomatic. *Ruptured* VBDAs have a poor natural history, with high rates of rebleeding, stroke, and death when left untreated.

Endovascular therapies have emerged as the treatment strategy of choice due to the perception that they have lower rates of treatment-related morbidity as well as high efficacy. Several endovascular approaches to treat VBDAs exist. Parent artery occlusion or trapping the aneurysm have traditionally been considered the initial treatment of choice. With the advent of stents and flow diverters, however, parent artery preservation has emerged as an effective treatment technique.

A recent systematic review and meta-analysis to study clinical and angiographic outcomes of patients undergoing endovascular treatment of VBDAs was conducted by Sonmez et al. (2015). Seventeen studies encompassing 478 patients were included in this

Fig. 3 (continued) right VA confirmed exclusion of the coil-occluded aneurysm, reconstruction of the vertebrovertebral junction, and synchronous bivertebral-PICA arterial supply (**d**). Angiogram of the left ICA demonstrated the primary supply to the distal part of the basilar trunk through the PcomA analysis, including 16 studies with at least 6 months of clinical and angiographic follow-up. Endovascular treatment was associated with high rates of long-term occlusion (87.0%; 95% CI, 74.0–94.0%) as well as low recurrence (7.0%; 95% CI, 5.0–10.0%) and retreatment rates (3.0%, 95% CI, 2.0– 6.0%). The authors concluded that endovascular treatment of VBDAs is associated with high rates of complete occlusion and good long-term neurologic outcomes. Deconstructive techniques are associated with higher occlusion rates. There was no statistical difference in neurological outcomes between groups, possibly due to low power.

The case presented here shows the sequential technical management of a complex neurovascular condition: blind navigation for coiling a dissecting aneurysm and affected arterial segment (deconstructive technique), angioplasty for vasospasm, thrombectomy of PICA-VA, and arterial reconstruction of the vertebro-vertebral junction employing several types of stents.

Therapeutic Alternatives

Coil Occlusion
Flow Diversion
Telescopic Stenting

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