CASE REPORT

Treatment of a dissecting vertebral artery aneurysm with angioplasty and the pipeline embolisation device

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SUMMARY

A 49-year-old woman was admitted with Hunt and Hess grade 1 subarachnoid haemorrhage. A cerebral aneurysm of the intracranial left vertebral artery (VA) distal to the left posterior inferior cerebellar artery (PICA) was found and treated using parent vessel occlusion with coils. The PICA was preserved. Angiography at three time points during her hospitalisation showed a normal right VA. Eight months later, angiography demonstrated a new 14 mm right VA dissecting aneurysm with 90% outflow stenosis and recurrence of the left VA aneurysm distal to the coils. A Marksman microcatheter would not traverse the stenosis despite the use of two intraluminal wires. Following Gateway balloon (1.5 mm×9 mm) angioplasty, the Marksman passed easily. The pipeline embolisation device (PED) was successfully deployed across the aneurysm and 11 coils placed through a trapped microcatheter. The patient was discharged home 2 days later. Eighteen-month follow-up has revealed complete resolution of both aneurysms.

BACKGROUND

The use of flow diverters has become a common treatment option for intracranial aneurysms, although questions persist about their safety in acute subarachnoid haemorrhage. In addition, few cases have described intracranial angioplasty prior to deployment of flow diverters. Finally, there is a paucity of studies reporting the development of new dissecting vertebral artery (VA) aneurysms after parent vessel occlusion (PVO) of the contralateral VA.¹

CASE PRESENTATION

A 49-year-old Caucasian woman with a history of migraine headaches and hypertension, and family history significant for a fatal ruptured intracranial aneurysm in her father, presented to the emergency department for severe headache.

Non-contrast head CT revealed subarachnoid haemorrhage concentrated in the prepontine region. Subsequent cerebral CT angiogram and six vessel diagnostic cerebral angiogram showed no aneurysm. Repeat angiogram was performed 8 days later, which demonstrated a dissecting aneurysm of the intracranial left VA, distal to the origin of the left posterior inferior cerebellar artery (PICA) and proximal to the left vertebrobasilar junction (figure 1). This aneurysm, with a fusiform shape, was likely a dissecting aneurysm, although MRI

was not utilised to confirm an intimal flap and/or intramural haematoma.

PVO of the left VA and aneurysm was performed with coils. Cerebral angiography was carried out immediately postprocedure and 5 days later. In both instances, normal appearance of the coil and posterior vasculature, including the right VA, was noted (figure 2). No antegrade flow was seen in the dissected segment and no residual contrast opacification of the aneurysm noted. The left PICA remained patent with antegrade flow seen within.

The patient was started on aspirin and clopidogrel and discharged home after a 3-week stay in hospital.

INVESTIGATIONS

At 6 months follow-up, the patient continued to experience generalised headaches as well as reporting a new visual disturbance in her left eye. An outside hospital non-contrast MR angiography (MRA) showed diminished flow in the right VA and occlusion of the left VA with partial exclusion of the prior left VA aneurysm. This led to a follow-up MRA with and without contrast (figures 3 and 4) and cerebral catheter angiogram (figure 5) at our institution at 8 months, which showed interval development of a 14 mm intradural right VA wide-necked dissecting aneurysm with a significant outflow tract stenosis. The aneurysm incorporated the origin of the right PICA. There was also new

Figure 1 Left vertebral artery aneurysm (white arrow) detected following acute subarachnoid hemorrhage.

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Figure 2 Angiogram 5 days post-parent vessel occlusion of left vertebral artery (VA) aneurysm. Notice the normal appearance of right VA.

aneurysmal enlargement of the residual left VA distal to the prior coil sacrifice and proximal to the basilar junction (figure 6).

TREATMENT

A decision was made to treat the new dissecting right VA aneurysm with the pipeline embolisation device (PED) (ev3-Covidien, Irvine, California, USA). A 7 Fr shuttle sheath (Cordis, USA)

Figure 3 Three-dimensional time-of-flight precontrast study 8 months post-left vertebral artery aneurysm parent vessel occlusion. Owing to slow flow from the stenotic outflow tract, the aneurysm (white arrow) showing low signal relative to the internal carotid arteries.

Figure 4 Corresponding postcontrast three-dimensional time-of-flight study. The aneurysm now appears bright as blood fills the lumen.

was placed in the right subclavian artery. A Marksman microcatheter (Covidien) with a Synchro-2 microwire was advanced in a 115 cm 058 Navien Catheter and used to select the right VA. An Echelon-10 microcatheter with microwire was also used to select the right VA alongside the pre-existing Navien and Marksman microcatheters.

Preprocedure angiography had demonstrated a substantial amount of retrograde filling of the basilar arteries from the internal carotid arteries via the posterior communicating arteries, indicating a high grade right vertebral aneurysm outflow stenosis. Multiple attempts were made to traverse the stenosis

Figure 5 Right dissecting vertebral artery (VA) aneurysm 8 months later. Black arrow: stenotic outflow tract of aneurysm. Black dash arrow: prior coil sacrificed left VA. The residual left VA stump can be seen. White arrow: severe narrowing of right posterior inferior cerebellar artery origin from mass effect of aneurysm wall.

Figure 6 Three-dimensional reconstruction of dissecting right vertebral artery (VA) aneurysm. White arrow: left VA aneurysm recurrence distal to coil mass.

with the Marksman microcatheter and Synchro-2 microwire, with no success. A decision was then made to angioplasty the outflow zone to allow the catheter to pass (figure 7). A SL-10 microcatheter was advanced into the right posterior cerebral artery and a 1.5 mm×9 mm Gateway angioplasty balloon (Boston Scientific, Massachusetts, USA) over a Transcend 300 exchange microwire was inflated at the level of the stenosis, following which the Marksman passed easily over the single exchange wire. The 4.5 mm×25 mm PED was then successfully deployed (figure 8). Repeat angioplasty with a 2.5 mm×9 mm Gateway angioplasty balloon was carried out across the outflow zone of the aneurysm and the distal VA to fully expand the PED.

Figure 7 Angioplasty of stenosis performed using a 1.5 mm×9 mm Gateway angioplasty balloon. White arrow represents the angioplasty balloon.

Figure 8 Pipeline deployed and expanded postangioplasty.

We chose to also perform coil embolisation due to the large size, irregular borders and dissecting nature of the aneurysm. This was carried out using a trapped Echelon-10 microcatheter already in the aneurysm lumen with 11 detachable coils (figure 9).

On completion of the procedure, excellent antegrade flow to fill the basilar artery was noted through the right VA. The patient tolerated the procedure well with no new neurological symptoms elicited and reported resolution of the left visual deficit. She was discharged home after 2 days.

OUTCOME AND FOLLOW-UP

Follow-up imaging 10 months after PED placement demonstrated complete resolution of the right vertebral dissecting aneurysm, as well as resolution of the recurrent aneurysmal

Figure 9 Pipeline deployed across the right vertebral artery aneurysm with coils placed in the aneurysm lumen. Notice that the aneurysm outflow tract is no longer stenotic following angioplasty.

Figure 10 Resolution of the right vertebral artery aneurysm at 10-month follow-up. The right posterior inferior cerebellar artery origin now has a normal appearance.

dilation of the left VA distal to the prior coil sacrifice (figure 10). Currently, although the patient continues to experience chronic headaches, no new neurological symptoms have arisen and follow-up studies have demonstrated stability of the PED and treated aneurysms. At 18-month follow-up, the patient has a modified Rankin Score of 1.

DISCUSSION

A dissecting aneurysm is defined as a dilation of the wall of an artery secondary to a tear in the intima and internal elastic lamina, leading to an intramural haematoma that extends into the subadventitial plane causing a sac-like outpouching. Intracranial dissecting aneurysms can have a ‘pearl-and-string’ sign on imaging,² although they typically appear as either fusiform dilations of the parent vessel or in unusual patterns such as lateral outpouching or focal stenosis.³

Conventionally, PVO has been demonstrated as a safe and effective treatment for dissecting vertebrobasilar aneurysms, with satisfactory long-term outcomes.⁴ Several recent studies have noted good clinical and angiographic outcomes for the treatment of complex dissecting intracranial aneurysms with flow diverters on long-term follow-up⁵ as well as higher aneurysm occlusion rates than with coiling, especially when parent vessel preservation is mandatory.^{6 7}

Presently, however, there are only a few case reports and a relatively small case series on the safety of PED use in acute subarachnoid haemorrhage. The need for dual antiplatelet therapy is a major concern in PED use in acutely ruptured cerebral aneurysms. A retrospective multicentre study of PED use in aneurysmal subarachnoid haemorrhage noted 15% procedure-related morbidity and mortality.⁸ In addition, Cruz *et al*⁹ demonstrated an 8.5% incidence of delayed haemorrhage 1–6 days after treatment of anterior circulation aneurysms with the PED. Owing to this risk, especially in patients who may need external ventricular drainage, and the procedural risk of rebleeding and death, we decided it would be safer to treat the aneurysm using PVO with coiling to achieve complete thrombosis.

The ipsilateral recurrence of coiled intracranial vertebrobasilar dissecting aneurysms has been described with rates as high as 13%.¹⁰ However, the incidence of a *de novo* dissecting aneurysm after prior coil sacrifice of contralateral VA is low, with only a few case reports describing this outcome.^{1 11} The pathophysiology of such aneurysm formation remains unclear. Increased contralateral blood flow to the right VA causing increased haemodynamic stress may have contributed to the formation of the second aneurysm in this patient with an inherent familial susceptibility. In addition, altered flow with retrograde filling of the basilar artery could also explain the refilling or recurrence of the distal left VA aneurysm.

A number of treatment techniques for the right VA aneurysm were considered. Although aneurysm coiling alone can be carried out to prevent aneurysm rupture, in this patient, sacrificing the right VA aneurysm with coils alone would have resulted in occlusion of the PICA and definite PICA stroke. Deploying the PED allowed us to visualise the PICA prior to coiling. Dissecting basilar and VA aneurysm re-growth and rebleed have been reported following stent assisted coiling.¹² Moreover, there is no definitive criterion to define the degree of coil packing sufficient to spare the aneurysm from rupture. In our experience, sacrificing both VAs may result in profound vertebrobasilar insufficiency and cortical infarcts in the posterior circulation, demonstrable weeks or months after the procedure, even in people who temporarily tolerate a balloon occlusion test. Nossek *et al*¹³ reported outcomes of a retrospective review assessing safety, technique and efficacy of concurrent subtotal coiling and PED use in 28 aneurysms. No clinical, intraoperative or postprocedural complications were noted. All patients demonstrated total aneurysmal occlusion on follow-up imaging without any delayed rupture. The authors hypothesised several advantages of this dual treatment approach. This included earlier complete occlusion, a smaller number of PEDs needed to be deployed to reduce the amount of intimal coverage in the parent vessel, and a summative effect of both coils and PED on intra-aneurysmal flow velocities and pressures. Earlier occlusion could also shorten the need for extended dual antiplatelet therapy. With the above factors in mind, in addition to the aneurysm size and patient’s family history, we decided to perform adjuvant coiling with the PED using the ‘jailing’ technique of a microcatheter in the aneurysmal sac for coil deployment.

There are very few studies that have assessed the efficacy of angioplasty prior to flow diverter deployment. Fischer *et al*¹⁴ carried out balloon dilation of the target vessel prior to PED deployment in eight patients with good outcomes, noting that high-grade and/or eccentric circumscribed stenoses should have a non-compliant balloon angioplasty of the stenotic segment prior to PED deployment. The role of preprocedure angioplasty is better established in the setting of intracranial stent placement. In their study evaluating outcomes of endovascular treatment for vertebrobasilar atherosclerosis, Alexander *et al*¹⁵ showed good outcomes in 114 patients undergoing concomitant angioplasty followed by stent deployment. The study population included patients undergoing treatment for both elective intervention and acute treatment for stroke. Qureshi *et al*¹⁶ carried out a small prospective randomised trial comparing the efficacy of primary angioplasty of intracranial stenosis to angioplasty followed by stent placement. Out of 18 patients, 8 were treated with pre-stenting angioplasty, including 2 patients with angiographic evidence of stenosis in the VA. A high technical success rate and very low stroke and death rate were seen across both groups.

Learning points

- ▶ Randomised clinical trials of sufficient strength are needed to comprehensively assess the safety and efficacy of the pipeline embolisation device in acutely ruptured cerebral aneurysms. The need for dual antiplatelet therapy is a major concern.
- ▶ The risk of a 'de novo' dissecting aneurysm may be increased by coil sacrifice of a dissecting aneurysm of the contralateral vertebral artery (VA). Future studies may focus on the comparison of flow diverters and parent vessel occlusion in the treatment of subarachnoid haemorrhage caused by dissecting VA aneurysms.
- ▶ Intracranial angioplasty of a high-grade stenosis associated with a dissecting cerebral aneurysm can be performed to allow stent deployment with good outcomes, although further studies are needed in the context of flow diverter use.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Inui Y, Oiwa Y, Terada T, *et al.* De novo vertebral artery dissecting aneurysm after contralateral vertebral artery occlusion—two case reports. *Neurol Med Chir (Tokyo)* 2006;46:32–6.
- 2 Krishnakumar K, Menon G, Kesavadas C, *et al.* Dissecting intracranial aneurysms presenting as subarachnoid haemorrhage: report of two cases and review of literature. *Br J Neurosurg* 2008;22:801–4.
- 3 Hacein-Bey L, Provenzale JM. Current imaging assessment and treatment of intracranial aneurysms. *AJR Am J Roentgenol* 2011;196:32–44.
- 4 Kashiwazaki D, Ushikoshi S, Asano T, *et al.* Long-term clinical and radiological results of endovascular internal trapping in vertebral artery dissection. *Neuroradiology* 2013;55:201–6.
- 5 Fischer S, Perez MA, Kurre W, *et al.* Pipeline embolization device for the treatment of intra- and extracranial fusiform and dissecting aneurysms: initial experience and long-term follow-up. *Neurosurgery* 2014;75:364–74; discussion 74.
- 6 de Barros Faria M, Castro RN, Lundquist J, *et al.* The role of the pipeline embolization device for the treatment of dissecting intracranial aneurysms. *AJNR Am J Neuroradiol* 2011;32:2192–50.
- 7 Ducruet AF, Crowley RW, Albuquerque FC, *et al.* Reconstructive endovascular treatment of a ruptured vertebral artery dissecting aneurysm using the Pipeline embolization device. *J Neurointerv Surg* 2013;5:e20.
- 8 Cruz JP, O'Kelly C, Kelly M, *et al.* Pipeline embolization device in aneurysmal subarachnoid hemorrhage. *AJNR Am J Neuroradiol* 2013;34:271–6.
- 9 Cruz JP, Chow M, O'Kelly C, *et al.* Delayed ipsilateral parenchymal hemorrhage following flow diversion for the treatment of anterior circulation aneurysms. *AJNR Am J Neuroradiol* 2012;33:603–8.
- 10 Kim BM, Shin YS, Kim SH, *et al.* Incidence and risk factors of recurrence after endovascular treatment of intracranial vertebrobasilar dissecting aneurysms. *Stroke* 2011;42:2425–30.
- 11 Kubo Y, Miura K, Suzuki M, *et al.* Development of a dissecting aneurysm on the vertebral artery immediately after occlusion of the contralateral vertebral artery: a case report. *Neurosurg Rev* 1998;21:177–80.
- 12 Ahn JY, Han IB, Kim TG, *et al.* Endovascular treatment of intracranial vertebral artery dissections with stent placement or stent-assisted coiling. *AJNR Am J Neuroradiol* 2006;27:1514–20.
- 13 Nossek E, Chalif DJ, Chakraborty S, *et al.* Concurrent use of the pipeline embolization device and coils for intracranial aneurysms: technique, safety, and efficacy. *J Neurosurg* 2015;122:904–11.
- 14 Fischer S, Vajda Z, Aguilar Perez M, *et al.* Pipeline embolization device (PED) for neurovascular reconstruction: initial experience in the treatment of 101 intracranial aneurysms and dissections. *Neuroradiology* 2012;54:369–82.
- 15 Alexander MD, Rebhun JM, Hettis SW, *et al.* Lesion location, stability, and pretreatment management: factors affecting outcomes of endovascular treatment for vertebrobasilar atherosclerosis. *J Neurointerv Surg* 2015;0:1–6. doi:10.1136/neurintsurg-2014-011633
- 16 Qureshi AI, Chaudhry SA, Siddiq F, *et al.* A randomized trial comparing primary angioplasty versus stent placement for symptomatic intracranial stenosis. *J Vasc Interv Neurol* 2013;6:34–41.

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