CASE REPORT

Endovascular repair of a double-lumen dissecting aneurysm

Andrew Kelly Johnson, Carter S Gerard, Demetrius Klee Lopes

Department of Neurological Surgery, Rush University Medical Center, Chicago, Illinois, USA

Correspondence to
Dr Demetrius Klee Lopes,
brainaneurysm@mac.com

SUMMARY

Treating dissections and dissecting aneurysms requires maintenance of flow through the true lumen and exclusion of the false lumen from the circulation. A dissecting aneurysm of the vertebral artery presented with both a true and false lumen within the aneurysmal sac. Stenting of the true lumen followed by coil embolization of both lumens was performed. Management options and decision-making are discussed for this unique situation.

Several studies have shown that the intracranial vertebral artery is the most common site for dissecting aneurysm formation.^{1 2 8 9} Sasaki *et al* reported an autopsy series of 110 patients with subarachnoid hemorrhage, 4.5% of whom had a dissecting vertebral artery aneurysm.¹ Yamaura *et al* examined a series of 94 vertebral aneurysms and found 28% to be dissecting aneurysms.¹⁰

Patients with dissecting aneurysms who present with subarachnoid hemorrhage require urgent treatment owing to the high risk of rebleeding.^{10–12}

BACKGROUND

Intracranial arterial dissection can lead to ischemia from vessel occlusion or hemorrhage from formation and rupture of a dissecting aneurysm. The internal elastic lamina is considered the most important layer in resisting transmural stress, and damage to this layer is suspected as the primary cause of arterial dissection.^{1–3} When an intimal tear occurs, dissection extends into the subintimal space or the subadventitial plane. Patients who have subintimal dissection between the intima and media are prone to luminal occlusion and subsequent ischemia. Unlike extracranial arteries, intracranial arteries lack the external elastic lamina and have thinner tunica media, making them prone to subadventitial dissection and subsequent aneurysmal dilation.^{4–7}

Figure 1 Three-dimensional rotational digital subtraction angiography (orange) embedded in sagittal multiplanar reconstruction depicts a pear-shaped aneurysm of the right vertebral artery incorporating the origin of the posterior inferior cerebellar artery.

Figure 2 (A–C) Sequential lateral digital subtraction angiography (DSA) images showing flow proceeding from the proximal right vertebral artery to the false aneurysmal lumen, then to the true lumen and the posterior inferior cerebellar artery. (D) iFlow reconstruction of lateral DSA. (E–H) Anterior-posterior DSA and iFlow.

To cite: Johnson AK, Gerard CS, Lopes DK. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2013-010701

The management for those who are asymptomatic and present with intact dissecting aneurysms remains a topic for debate.^{13–16} Successful outcomes have been described for both open and endovascular techniques.^{10 12 14–18}

Historically, a suboccipital craniotomy with ligation of the artery proximal to the aneurysm, or aneurysmal entrapment, was possible for those patients who tolerated a balloon occlusion. Aneurysms which involved the dominant vertebral artery were wrapped in an attempt to limit further dilation and subsequent hemorrhage.^{1 10 12} As many as 25% of patients undergoing surgery developed lateral medullary syndrome along with other ischemic complications.¹⁰ Later series described aneurysm clipping and vascular reconstruction to preserve the posterior inferior cerebellar artery (PICA) distribution.^{9 19} Detachable coils were first used for arterial occlusion and internal trapping. Patients with aneurysms involving the PICA underwent internal occlusion in addition to open vascular reconstruction.^{14 20} Stent-assisted coiling was later described as a therapeutic option for patients who were unable to tolerate balloon occlusion.^{17 21} The latest addition to the endovascular treatment of dissecting

aneurysms is the flow-diverting stent which has shown some early success.¹⁸ Stenting and flow diversion in ruptured aneurysms carry an inherent risk of thromboembolic or hemorrhagic complications due to antiplatelet requirements. These strategies may be excellent options for unruptured cases, particularly when the PICA is compromised.

We present a patient who, on surveillance imaging for neck cancer, was found to have a dissecting vertebral aneurysm. We illustrate features of a double-lumen aneurysm incorporating the PICA origin and the diagnostic and treatment options used for endovascular repair.

CASE PRESENTATION

A 49-year-old man with a past medical history of atrial fibrillation originally presented with squamous cell carcinoma of the neck and was treated with modified neck dissection and concurrent radiation with chemotherapy. During the 1-year follow-up with his otolaryngologist the patient complained of a 3-month history of tingling of the right shoulder intermittently extending to the right first to third fingers. An MRI was obtained because

Figure 3 Microcatheter injections from the distal (A) and proximal (B) right vertebral artery showing the true and false lumens of the dissecting aneurysm, respectively. The posterior inferior cerebellar artery (PICA) fills directly from the distal vertebral artery. (C) The microcatheter has passed through the true lumen from the distal vertebral artery into the PICA. (D) Schematic diagram showing the aneurysm (black) and the normal vessel (orange). Blue arrows indicate flow entering and exiting the false lumen. The white rim around the false lumen (black arrows) represents the dissected intimal flap. RVA_{dist}, distal right vertebral artery; RVA_{prox}, proximal right vertebral artery.

of concern for tumor recurrence and a right vertebral artery aneurysm was found. The patient was referred to endovascular neurosurgery for a diagnostic angiogram.

INVESTIGATIONS

Initial biplane digital subtraction angiography with three-dimensional rotational angiography (figure 1) and iFlow processing (Siemens, Erlangen, Germany) revealed two distinct compartments within the pear-shaped aneurysm dome separated by a flap of the vessel wall (figure 2).

TREATMENT

Options including observation, endovascular repair and surgical ligation were discussed with the patient who agreed to proceed with endovascular treatment including possible stenting. Loading doses of aspirin 325 mg and clopidogrel 600 mg were

administered to the patient, who returned to the angiography suite the following day for treatment.

After placement of a standard guide catheter in the right cervical vertebral artery, a Prowler Select Plus microcatheter (Codman, Raynham, Massachusetts, USA) was navigated to the aneurysm. Access to the true lumen adjacent to the lesion was unsuccessful as the wire only found the false lumen of the aneurysm; the wire could not be advanced to the distal right vertebral artery beyond the origin of the PICA. The left cervical vertebral artery was then catheterized and a second Prowler Select Plus microcatheter was navigated to the distal right vertebral artery. Microcatheter injections from both ends of the vertebral artery showed that the right PICA filled best from the distal right vertebral artery via the left vertebral artery (figure 3). These microcatheter injections indicated that the true lumen of the dissection was patent between the distal right vertebral artery and the PICA. The decision was made to embolize the false lumen with coils and sacrifice the proximal right vertebral artery. Because aggressive coil packing could have compromised the path from the distal right vertebral artery to the PICA, an Enterprise stent (Codman) was deployed from the PICA to the distal vertebral artery to protect the true lumen prior to coil embolization. Coils were deployed into the false lumen within the aneurysm and the adjacent proximal right vertebral artery. Coils were then placed distally via the left vertebral artery through the stent struts into the true lumen of the aneurysm for completion of repair. The patient awoke and was discharged the following day without complication.

OUTCOME AND FOLLOW-UP

Six-month follow-up angiography showed complete occlusion of the right vertebral artery without aneurysm filling. The left vertebral artery angiogram showed reconstruction of the right PICA via the stent and coil technique. There was small stable filling of the true lumen of the aneurysm around the Enterprise stent and good reconstruction of the PICA through retrograde vertebral artery flow (figure 4). At 6-month follow-up the patient was in good health and without complaints.

DISCUSSION

Angiographic evaluation of the presented dissecting aneurysm had many typical features including a characteristic stricture proximal to the origin of the aneurysm where the false lumen originated.²² Entry-exit type dissecting aneurysms, such as this one, with flow from the true lumen into the aneurysmal pseudolumen and back into the distal true lumen are frequently observed.^{15 23} Unlike typical dissecting aneurysms, however, angiography in this case demonstrated two distinct lumens within a single aneurysmal dilation.

Access to the proximal true lumen prevented the original plan of stenting to restore the true lumen. Stenting through the false lumen into the true lumens of the distal and proximal vertebral artery would have pushed the partial thickness flap against the origin of the PICA and excluded it from the circulation. Fortunately, these flow characteristics were determined prior to treatment and, instead, a stent was placed from the PICA to the true lumen of the distal vertebral artery, protecting this major branch. Intervention through the contralateral healthy vertebral artery compromised both vertebral arteries, but the expected gain in right PICA protection was perceived to outweigh this risk.

There were multiple options for embolization after stenting. To completely remove the false lumen from the circulation, this section of the aneurysm was aggressively coiled. Coiling of the smaller true lumen of the aneurysm may not have been

Figure 4 (A) Post-treatment left vertebral artery injection showing small residual filling of the true lumen. (B) Follow-up rotational digital subtraction angiogram of the left vertebral artery showing patency of the right posterior inferior cerebellar artery and stable occlusion of the aneurysm.

necessary, but it was abnormally dilated and it clearly connected with the false aneurysmal lumen.

In a series of 119 vertebrobasilar dissecting aneurysms, Kim *et al* treated the aneurysms reconstructively with stenting or deconstructively with proximal occlusion or trapping.²⁴ Ten of 47 (21.3%) aneurysms involving the origin of the PICA recurred after endovascular treatment, and the authors found that involvement of the PICA origin was the only statistically significant independent risk factor affecting aneurysm recurrence in their series. Furthermore, in this series, four aneurysms involving the PICA ruptured after endovascular treatment.

In order to protect the origin of the PICA they did not occlude the aneurysm entirely, specifically at the PICA take-off. When employing stent-assisted coiling or internal trapping, the dissecting aneurysm was left partially open and, with proximal occlusion, it remained entirely open. This may account for their high recurrence rate and the inherent increased difficulty of vertebrobasilar dissecting aneurysms that incorporate this critical vessel. In the case report presented, information obtained on microcatheter injections allowed us to employ a combined reconstructive and deconstructive technique where the PICA was stented to the distal vertebral artery and the proximal vertebral artery was occluded.

Learning points

- ▶ Dissecting aneurysms do not have consistent vessel wall structure like saccular aneurysms, making both endovascular and open surgical repair more challenging.
- ▶ Microcatheter injections, test balloon occlusion and potentially intravascular imaging may all provide insight into the nature of the dissection flap. In this case of an unusual double-lumen dissecting aneurysm, the dissection flap was obvious.
- ▶ Understanding the boundaries of the true and false lumens in a vertebral artery dissecting aneurysm can suggest a treatment option that both occludes the aneurysm and protects the connection of the PICA to the true lumen of the dissected vertebral artery.

Contributors AKJ helped to conceive the study, drafted the original manuscript and approved the final manuscript. CSG drafted the original manuscript and approved the final version. DKL conducted the procedure and was responsible for the patient's care; he conceived the study and reviewed and approved the final manuscript.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Sasaki O, Ogawa H, Koike T, *et al*. A clinicopathological study of dissecting aneurysms of the intracranial vertebral artery. *J Neurosurg* 1991;75:874–82.
- 2 Berger MS, Wilson CB. Intracranial dissecting aneurysms of the posterior circulation. *J Neurosurg* 1984;61:882–94.
- 3 Yamada M, Miyasaka Y, Yagishita S, *et al*. Dissecting aneurysm of the intracranial vertebral artery associated with proximal focal degeneration of the elastica. *Surg Neurol* 2003;60:431–7.
- 4 Debette S, Leys D. Cervical-artery dissections: predisposing factors, diagnosis, and outcome. *Lancet Neurol* 2009;8:668–78.
- 5 Caplan LR. Dissections of brain-supplying arteries. *Nat Clin Prac Neurol* 2008;4:34–42.
- 6 Schievink WI. Spontaneous dissection of the carotid and vertebral arteries. *N Engl J Med* 2001;344:898–906.
- 7 Agostoni E, Aliprandi A, Longoni M. Dissection of the eptiaortic and intracranial arteries. *Neurol Sci* 2010;31:5123–5.
- 8 Yamaura A, Ono J, Hirai S. Clinical picture of intracranial non-traumatic dissecting aneurysm. *Neuropathology* 2000;20:85–90.
- 9 Sano H, Kato Y, Okuma I, *et al*. Classification and treatment of vertebral dissecting aneurysm. *Surg Neurol* 1997;48:598–605.
- 10 Yamaura A, Watanabe Y, Saeki N. Dissecting aneurysms of the intracranial vertebral artery. *J Neurosurg* 1990;72:183–8.
- 11 Mizutani T, Aruga T, Kirino T, *et al*. Recurrent subarachnoid hemorrhage from untreated ruptured vertebrobasilar dissecting aneurysms. *Neurosurgery* 1995;36:905–11.
- 12 Friedman AH, Drake CG. Subarachnoid hemorrhage from intracranial dissecting aneurysm. *J Neurosurg* 1984;60:325–34.
- 13 Mizutani T. Natural course of intracranial arterial dissections. *J Neurosurg* 2011;114:1037–44.
- 14 Iihara K, Sakai N, Murao K, *et al*. Dissecting aneurysms of the vertebral artery: a management strategy. *J Neurosurg* 2002;97:259–67.
- 15 Kai Y, Nishi T, Watanabe M, *et al*. Strategy for treating unruptured vertebral artery dissecting aneurysms. *Neurosurgery* 2011;69:1085–91.
- 16 Naito I, Iwai T, Sasaki T. Management of intracranial vertebral artery dissections initially presenting without subarachnoid hemorrhage. *Neurosurgery* 2002;51:930–7.
- 17 Lylyk P, Cohen JE, Ceratto R, *et al*. Combined endovascular treatment of dissecting vertebral artery aneurysms by using stents and coils. *J Neurosurg* 2001;94:427–32.
- 18 Narata AP, Yilmaz H, Schaller K, *et al*. Flow-diverting stent for ruptured intracranial dissecting aneurysm of vertebral artery. *Neurosurgery* 2012;70:982–9.
- 19 Durward Q. Treatment of vertebral artery dissecting aneurysm by aneurysm trapping and posterior inferior cerebellar artery reimplantation. Case report. *J Neurosurg* 1995;82:137–9.
- 20 Hamada JI, Kai Y, Morioka M, *et al*. Multimodal treatment of ruptured dissecting aneurysms of the vertebral artery during the acute stage. *J Neurosurg* 2003;99:960–6.
- 21 Albuquerque FC, Fiorella DJ, Han PP, *et al*. Endovascular management of intracranial vertebral artery dissecting aneurysms. *Neurosurg Focus* 2005;18:E3.
- 22 Mokri B, Houser OW, Sandok BA, *et al*. Spontaneous dissections of the vertebral arteries. *Neurology* 1988;38:880–5.
- 23 Mizutani T, Kojima H, Asamoto S, *et al*. Pathological mechanism and three-dimensional structure of cerebral dissecting aneurysms. *J Neurosurg* 2001;94:712–17.
- 24 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.

Copyright 2013 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow