New devices

Treatment of a pediatric recurrent fusiform middle cerebral artery (MCA) aneurysm with a flow diverter

Anthony M Burrows,¹ Gregory Zipfel,² Giuseppe Lanzino^{1,3}¹Department of Neurosurgery, Mayo Clinic, Rochester, Minnesota, USA²Department of Neurosurgery, Washington University, St Louis, Missouri, USA³Department of Radiology, Mayo Clinic, Rochester, Minnesota, USA

Correspondence to Dr Giuseppe Lanzino, lanzino.giuseppe@mayo.edu

Summary

Pediatric patients with aneurysm often have different localizations and morphologies from adults and recurrences are not uncommon after successful clip reconstruction/obliteration. Treatment of a recurrent pediatric aneurysm after clip ligation is a technical challenge. We present the case of an adolescent with a middle cerebral artery (MCA) fusiform aneurysm which recurred following clip reconstruction and bypass. The aneurysm was successfully treated with endovascular flow diversion.

BACKGROUND

Intracranial aneurysms are rare in adolescents and may have different morphologies and underlying etiopathogenesis from that in adults.^{1–5} Case series indicate that, in pediatric patients, middle cerebral artery (MCA) location and fusiform morphology are more common than in adults.^{2–3–6} Recurrence of pediatric aneurysms after clipping/reconstruction is not uncommon and its treatment is challenging.^{2–5} Recently, flow diverters including the Pipeline Embolisation Device (PED; Covidien, Plymouth, Minnesota, USA) have been introduced as a new endovascular treatment for complex and fusiform intracranial aneurysms.⁷ Preliminary clinical experiences have demonstrated a high incidence of complete obliteration.⁸ In this report we describe successful endovascular treatment of a recurrent fusiform MCA aneurysm in an adolescent using the PED and discuss potential implications of this emerging technology in the treatment of some pediatric aneurysms.

CASE PRESENTATION

A 15-year-old boy presented with a seizure and was found to have a large complex fusiform aneurysm emanating from the inferior M2 branch on the left (figure 1A). Three-dimensional and selective MCA catheterization showed that the aneurysm incorporated one of the branches of the posterior-inferior trunk of the MCA. Surgical treatment with clip reconstruction and superficial temporal artery (STA)-MCA bypass to the territory of the incorporated branch was performed. Both intraoperative and postoperative catheter angiography confirmed complete aneurysm exclusion (figure 1B) and a patent bypass (figure 1C).

A routine follow-up angiogram obtained 1 year later showed a recurrent asymptomatic aneurysm (figure 2A). Observation, surgical and endovascular options were contemplated. Invasive treatment was recommended due to recurrence, but revision surgery was considered arduous. Flow diversion with the PED was chosen as the option

with the highest degree of affording complete aneurysm obliteration with an acceptable risk among other endovascular treatment options.

The patient was pretreated for 5 days with aspirin 325 mg/daily and clopidogrel 75 mg/daily. Under general endotracheal anesthesia using a triaxial system and under full heparinization, the target vessel was catheterized past the aneurysm with a Marksman catheter (Covidien). Three telescopic flow diverters (dimensions 2.5×12 mm, 2.5 mm×12 mm and 2.5×14 mm) were required to obtain adequate coverage of the aneurysm neck. The intended treatment was a single PED placement, but deployment of the first two devices resulted in inadequate covering of the aneurysm neck due to foreshortening of the proximal portion of the PED while trying to avoid the MCA bifurcation. A third device afforded complete coverage of the neck without covering the MCA bifurcation (figure 2B,C). The procedure was otherwise uneventful and the patient was discharged home after 2 days on dual antiplatelet therapy. Follow-up catheter angiography obtained 4 months (figure 2D) and 10 months (figure 2E,F) after PED treatment showed complete exclusion of the aneurysm, reconstruction of the artery and mild stenosis within the device (figure 2C). Clopidogrel was discontinued at 10 months and the patient continued daily aspirin. He has had no recurrence of his seizures at 18-month follow-up and continues to do well.

DISCUSSION

We report the successful endovascular treatment with a flow diverter of a recurrent fusiform MCA aneurysm in an adolescent. Although use of the PED device has been reported in patients with MCA aneurysms,¹ to our knowledge the use of the device in this location has not been reported in pediatric patients. Flow diverters have recently been introduced in clinical practice for the treatment of complex wide-necked aneurysms involving the paraclinoid internal carotid artery not amenable to other conventional endovascular treatment.⁷ Flow diverters

Figure 1 Left anterior-posterior common carotid angiogram demonstrating a fusiform M2 aneurysm incorporating posterior-inferior branches (A). Postoperative anterior-posterior internal carotid artery angiogram showing clip exclusion of the M2 aneurysm (B) and patent bypass (C).

allow reconstruction of the segment of the vessel harboring an aneurysm without intra-aneurysmal manipulation. By ‘diverting’ flow away from the aneurysm, these devices induce intra-aneurysmal stasis that eventually leads to thrombosis and obliteration of the aneurysmal sac. In experimental studies, flow diverters become covered by an endothelial layer which eventually results in ‘closure’ of the ostium of the aneurysm while side branches remain patent.^{9–10} The downsides of this treatment strategy include the prolonged need for antiplatelet therapy, the risk of delayed hemorrhages while aneurysm thrombosis occurs¹¹ and the risk of ischemic complications when small side branches and perforating vessels are covered.¹²

Precise placement of the PED can be challenging because it is difficult to predict the degree of foreshortening of the device once fully deployed. In our case, three PEDs were required to cover the aneurysm neck adequately while avoiding coverage of the MCA bifurcation. The need for

multiple devices in a small vessel may partially explain the mild stenosis seen on the follow-up studies. Optimal placement of this device implies complete coverage of the neck and also at least 5 mm proximally and distally to the neck to assure ‘anchorage’ to the parent artery wall. Despite placement of three PEDs, no ischemic changes related to lenticulostriate artery or perforating artery occlusions were noted on follow-up imaging. This may be related to the fusiform nature of the aneurysm and the small number of perforating arteries normally found in the M2 segment.

Pediatric aneurysms often have a fusiform morphology and possibly a different etiopathology from that of adults.^{4–6} Given these differences, they have a higher potential to recur after successful clip reconstruction. Pediatric aneurysms have a predilection for the MCA and, given a fusiform morphology, have a tendency to assimilate branches of the parent vessel.^{2–3} As many pediatric aneurysms can be related to an intrinsic ‘weakness’ of the vascular segment involved,² placement of a flow

Figure 2 Left anterior-posterior internal carotid angiogram 1 year after surgery showing a recurrent M2 aneurysm (A). Unsubtracted (B) and subtracted (C) anterior-posterior view after placement of three telescoping devices, highlighted by white arrows. The profile of the Pipeline Embolization Devices can be seen in the unsubtracted view (B, arrows). Angiograms at 4 months (D) and 10 months (E, F) angiograms showing occlusion of the aneurysm and mild stenosis within the devices but adequate distal filling of the treated branch.

diverter may 'redirect' flow and also provide intrinsic structural support to the diseased vessel wall. Flow diverters may become the treatment of choice for these unusual aneurysms as more experience is acquired.

There are, of course, concerns related to the placement of flow diverters in pediatric patients as the long-term patency in this age group is unknown. Clinical experience in adults suggests that patency rates are very high in the internal carotid artery, although cases of delayed occlusion of flow diverters have been reported in the posterior circulation.¹³ We are aware of only one other case reported in the literature of a possibly dissecting giant fusiform aneurysm of the basilar artery successfully treated with the PED¹³ with an excellent clinical result maintained years after treatment (patient's personal communication, April 2011). In our patient, the first follow-up angiogram showed mild stenosis within the device which was clinically silent and remained stable at 1 year follow-up.

Learning points

- ▶ We report the successful treatment of a recurrent pediatric fusiform MCA aneurysm with the PED device.
- ▶ The patient had a good angiographic follow-up 1 year after treatment with PED and is clinically well at 18 months follow-up.
- ▶ This therapeutic strategy may be considered as an option when dealing with these complex and often refractory cases.

Contributors GZ and GL conceived of the study. All authors participated in data acquisition, interpretation, manuscript drafting, and editing.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **Pistocchi S**, Blanc R, Bartolini B, *et al*. Flow diverters at and beyond the level of the circle of Willis for the treatment of intracranial aneurysms. *Stroke* 2012;**43**:1032–8.
2. **Fulkerson DH**, Voorhies JM, Payner TD, *et al*. Middle cerebral artery aneurysms in children: case series and review. *J Neurosurg Pediatr* 2011;**8**:79–89.
3. **Proust F**, Toussaint P, Garnier J, *et al*. Pediatric cerebral aneurysms. *J Neurosurg* 2001;**94**:733–9.
4. **Ostergaard JR**. Aetiology of intracranial saccular aneurysms in childhood. *Br J Neurosurg* 1991;**5**:575–80.
5. **Meyer FB**, Sundt TM Jr, Fode NC, *et al*. Cerebral aneurysms in childhood and adolescence. *J Neurosurg* 1989;**70**:420–5.
6. **Koroknay-Pál P**, Lehto H, Niemelä M, *et al*. Long-term outcome of 114 children with cerebral aneurysms. *J Neurosurg: Pediatrics* 2012;**9**:636–45.
7. **D'Urso PI**, Lanzino G, Cloft HJ, *et al*. Flow diversion for intracranial aneurysms: a review. *Stroke* 2011;**42**:2363–8.
8. **Lylyk P**, Miranda C, Ceratto R, *et al*. Curative endovascular reconstruction of cerebral aneurysms with the pipeline embolization device: the Buenos Aires experience. *Neurosurgery (Clinical Trial)* 2009;**64**:632–42; discussion 42–3; quiz N6.
9. **Kallmes DF**, Ding YH, Dai D, *et al*. A second-generation, endoluminal, flow-disrupting device for treatment of saccular aneurysms. *AJNR Am J Neuroradiol* 2009;**30**:1153–8.
10. **Kallmes DF**, Ding YH, Dai D, *et al*. A new endoluminal, flow-disrupting device for treatment of saccular aneurysms. *Stroke* 2007;**38**:2346–52.
11. **Szikora I**, Berentei Z, Kulcsar Z, *et al*. Treatment of intracranial aneurysms by functional reconstruction of the parent artery: the Budapest experience with the pipeline embolization device. *AJNR Am J Neuroradiol* 2010;**31**:1139–47.
12. **van Rooij WJ**, Sluzewski M. Perforator infarction after placement of a pipeline flow-diverting stent for an unruptured A1 aneurysm. *AJNR Am J Neuroradiol* 2010;**31**:E43–4.
13. **Dashti SR**, Fiorella D, Toledo MM, *et al*. Proximal migration and compaction of an enterprise stent into a coiled basilar apex aneurysm: a posterior circulation phenomenon? *J Neurointerv Surg* 2010;**2**:356–8.

Copyright 2012 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.

Please cite this article as follows (you will need to access the article online to obtain the date of publication).

Burrows AM, Zipfel G, Lanzino G. Treatment of a pediatric recurrent fusiform middle cerebral artery (MCA) aneurysm with a flow diverter. *BMJ Case Reports* 2012;10.1136/bcr-2012-010478, Published XXX

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