CASE REPORT

Pipeline embolization device thrombosis induced peri-construct collateral channels

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SUMMARY

More than half a decade of experience and follow-up has now been accumulated with regard to flow diversion as a treatment for intracranial aneurysms; however, many uncertainties, such as the nature of aneurysmal remnants and the meaning of non-regressed, non-perfused aneurysmal masses, are still unknown. Here we discuss a 22-year-old man who presented with a grade 1 subarachnoid hemorrhage secondary to a dissecting right anterior cerebral artery aneurysm who was subsequently treated with a Pipeline Embolization Device construct. After ceasing dual antiplatelet therapy himself, he was found on MRI to have an area of increased aneurysmal remnant reperfusion. This was found to connect to multiple channels which reconstituted flow within the distal construct on angiography. The central area of construct thrombosis could not be visualized on MRI. The finding suggests that non-opacified aneurysmal remnants that have not regressed are biologically active and raises concerns regarding using MRI for long term follow-up.

BACKGROUND

More than half a decade of experience and follow-up has now been accumulated with regard to flow diversion as a treatment for intracranial aneurysms;^{1–3} however, many uncertainties, such as the nature of aneurysmal remnants and the meaning of non-regressed, non-perfused aneurysmal masses, are still largely unknown.

CASE PRESENTATION

Our patient, a 22-year-old man with no relevant clinical history, presented with a clinical grade 1

subarachnoid hemorrhage secondary to a 25 mm partially thrombosed dissecting right anterior cerebral artery aneurysm. After consultation with the neurosurgical service, he was treated with a three stent Pipeline Embolization Device (PED) construct. This was complicated by an ipsilateral right frontopolar infarct from which he essentially recovered fully after a month of follow-up, and the patient returned to a modified Rankin Scale score of 0. He had one follow-up angiogram at 2 months which showed construct patency without neointimal hyperplasia, and in light of his age, further angiographic imaging was deferred in favor of MRI. Serial MRI with gadolinium enhanced MR angiography demonstrated slow reduction in size of the non-perfused aneurysmal sac without complete resolution, and due to this and the small size of the reconstructed vessel, he was kept on dual antiplatelet blockade.

However, 5 months prior to his most recent MRI (which was performed 3 years and 3 months after flow diversion), the patient ceased dual antiplatelet medication himself asymptotically without consulting medical advice. He was found on MRI to have increased area of aneurysmal remnant re-perfusion ([figure 1](#)). Due to this, a catheter angiogram was performed on a Siemens Axiom Artis Biplane angiography unit (Siemens Healthcare, Erlangen, Germany), including dual volume cone beam CT angiography, which demonstrated a new mid-construct occlusion. Tortuous vascular channels were noted arising from the reperfused aneurysm remnant, which passed distally in close proximity to the outer surface of the construct, and reconstituted flow within the distal

Figure 1 Axial time of flight MR angiography of the intracranial circulation at the midbrain level demonstrates flow signal outside the stent construct which was not present previously (A). (B) Corresponding immediate post-pipeline embolization device MRI for comparison. (C) Time of flight signal within the stent construct at the midthalamic level suggests antegrade flow.

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Figure 2 (A) Lateral oblique projection right internal carotid artery cerebral angiography demonstrates the right A2 segment anterior cerebral artery Pipeline Embolization Device stent construct with mid-construct occlusion, the small reperfused aneurysmal remnant pocket projected inferior to the construct, and subtle opacification within the distal construct. A video of the entire run is available online (see online supplementary data 1). (B) Dual volume three-dimensional rotational angiography performed with 4 mL/s for 20 mL injection of Omnipaque 300 (GE Healthcare, Ontario, Canada) and reconstructed as a dual volume cone beam CT demonstrates a trans-construct connection between the lumen and the tortuous vessels outside the construct on axial reconstructions. (C) Reconstitution of flow within the construct via more distal trans-construct connections is seen on this sagittal reconstruction. A video of the MPR stack in the sagittal plane is available online (see online supplementary data 2).

construct on angiography by passing through the construct (figure 2). The central area of stent construct thrombosis could not be visualized on MRI.

Due to this unusual finding, the patient also had a MRI vessel wall study performed on a Siemens Skyra 3 Tesla MRI scanner (Siemens Healthcare) during the same day surgery admission, which demonstrated prominent vessel wall and remnant enhancement surrounding the construct (figure 3).

Given the patient was currently asymptomatic, and treatment of the reperfused aneurysmal pocket would entail either anterior cerebral artery sacrifice or possibly placing additional flow diverters within the stent construct, treatment was deferred. He continues under observation. Antiplatelet medications were not restarted due to lack of ischemic symptoms and concern for potential acceleration of aneurysmal regrowth.

DISCUSSION

Although the PED has now been used for over half a decade, many questions remain as to its occasional non-efficacy and unusual, albeit rare, complications in various circumstances. One such finding is that of persistent aneurysmal remnants; the finding of non-regression of the aneurysmal mass on cross sectional imaging despite non-perfusion.

Various articles have suggested that this aneurysmal remnant may be biologically active,^{4–6} however, most of these address early rupture rather than delayed recanalization. Our case is unusual and unique as reopening of the previously ‘thrombosed’ aneurysmal remnant has, to our knowledge, not previously been documented in the literature. It is possible this developed as a

Figure 3 Coronal 3T T1 weighted 2 mm vessel wall imaging (A) pre-contrast and (B) post-contrast demonstrates prominent enhancement of the aneurysmal remnant.

Learning points

- ▶ The Pipeline Embolization Device has now been safely used in many patients with long term follow-up, demonstrating its efficacy, but questions remain as to its occasional non-efficacy and unusual but rare complications.
- ▶ Previous articles have suggested that a non-perfused aneurysmal remnant can be biologically active, and the development of a new area of perfusion within our patient’s remnant with small vascular channels reconstituting antegrade flow within the distal stent construct in our patient further highlights this possibility.
- ▶ Late MRI follow-up of flow diverted aneurysms presents a non-invasive option but there should be a low threshold for use of catheter angiography for more detailed analysis.
- ▶ Dual volume cone beam CT angiography and other advanced angiographic techniques can be useful in analysis of complex lesions.

response to increasing flow demand from the brain parenchyma distal, as the stent lumen was no longer available to carry blood flow. This further suggests that non-opacified aneurysmal remnants that have not regressed are biologically active. It is questionable whether the vascular channels we visualized represent development of ‘vasa vasorum’ collaterals, such as has been described in carotid stenosis,⁷ or non-endothelialized flow channels through a biologically active thrombus. To confirm this histology would be required.

The inability of MRI to identify the thrombosed lumen directly, due to the susceptibility artifact from the stent construct itself, also raises concerns regarding the use of MRI for long term follow-up, given the discovery that antegrade flow can continue to exist via collaterals such as those discovered in our patient.

Contributors AHYC conceived the paper and drafted the article. Both authors revised it for content and gave final approval for the version to be published.

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Patient consent Obtained.

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REFERENCES

- 1 Chiu AH, Cheung AK, Wenderoth JD, *et al.* Long-term follow-up results following elective treatment of unruptured intracranial aneurysms with the pipeline embolization device. *AJNR Am J Neuroradiol* 2015;36:1728–34.
- 2 Deutschmann HA, Wehrschoetz M, Augustin M, *et al.* Long-term follow-up after treatment of intracranial aneurysms with the pipeline embolization device: results from a single center. *AJNR Am J Neuroradiol* 2012; 33:481–6.
- 3 Saatci I, Yavuz K, Ozer C, *et al.* Treatment of intracranial aneurysms using the pipeline flow-diverter embolization device: a single-center experience with long-term follow-up results. *AJNR Am J Neuroradiol* 2012;33:1436–46.
- 4 Szikora I, Turányi E, Marosfoi M. Evolution of flow-diverter endothelialization and thrombus organization in giant fusiform aneurysms after flow diversion: a histopathologic study. *AJNR Am J Neuroradiol* 2015;36:1716–20.
- 5 Kulcsár Z, Houdart E, Bonafé A, *et al.* Intra-aneurysmal thrombosis as a possible cause of delayed aneurysm rupture after flow-diversion treatment. *AJNR Am J Neuroradiol* 2011;32:20–5.
- 6 Hampton T, Walsh D, Tolias C, *et al.* Mural destabilization after aneurysm treatment with a flow-diverting device: a report of two cases. *J Neurointerv Surg* 2011;3:167–71.
- 7 Martin MA, Marotta TR. Vasa vasorum: another cause of the carotid string sign. *AJNR Am J Neuroradiol* 1999;20:259–62.

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