invasive percutaneous pedicle fixation strategy was successfully employed, subsequent to the sacral fracture complication, to correct the spondylolisthesis. A solid fusion was achieved at the 12 month follow-up, with complete relief of the initial radiculopathy and low back pain. Given the unique axial loads and shear stresses at the L5–S1 level, supplemental posterior screw fixation is advised when using a stand-alone ALIF device for isthmic spondylolisthesis. The choice of a minimally invasive percutaneous strategy may also reduce extensive tissue dissection and the intraoperative blood loss [10].

4. Conclusion

We described a man with L5–S1 isthmic spondylolisthesis who experienced a follow-up sacral fracture. This was successfully managed using a minimally invasive percutaneous posterior fixation strategy. This man confirms the essential role of fusion in achieving good functional results for isthmic spondylolisthesis with neurological symptoms.

Conflicts of Interest/Disclosures

The authors declare that they have no financial or other conflicts of interest in relation to this research and its publication.

http://dx.doi.org/10.1016/j.jocn.2015.03.051

References

[1] Wiltse LL, Winter RB. Terminology and measurement of spondylolisthesis. J Bone Joint Surg Am Vol 1983;65:768–72.
[2] Wang SJ, Han YC, Liu XM, et al. Fusion techniques for adult isthmic spondylolisthesis: a systematic review. Arch Orthop Trauma Surg 2014;134:777–84.
[3] Rao PJ, Maharaj MM, Phan K, et al. Indirect foraminal decompression after anterior lumbar interbody fusion: a prospective radiographic study using a new pedicle-to-pedicle technique. Spine J 2015;15:817–24.
[4] Riouallon G, Lachaniette CH, Poignard A, et al. Outcomes of anterior lumbar interbody fusion in low-grade isthmic spondylolisthesis in adults: a continuous series of 65 cases with an average follow-up of 6.6 years. Orthop Traumatol Surg Res 2013;99:155–61.
[5] Kwon BK, Hilibrand AS, Malloy K, et al. A critical analysis of the literature regarding surgical approach and outcome for adult low-grade isthmic spondylolisthesis. J Spinal Disord Tech 2005;18:S30–40.
[6] Jacobs WC, Vreeling A, De Kleuver M. Fusion for low-grade adult isthmic spondylolisthesis: a systematic review of the literature. Eur Spine J 2006;15:391–402.
[7] Phan K, Tian DH, Cao C, et al. Systematic review and meta-analysis: techniques and a guide for the academic surgeon. Ann Cardiothorac Surg 2015;4:112–22.
[8] Kwon YK, Jang JH, Lee CD, et al. Fracture of the L-4 vertebral body after use of a stand-alone interbody fusion device in degenerative spondylolisthesis for anterior L3–4 fixation. J Neurosurg Spine 2014;20:653–6.
[9] Lastfogel JF, Altstadt TJ, Rodgers RB, et al. Sacral fractures following stand-alone L5–S1 anterior lumbar interbody fusion for isthmic spondylolisthesis. J Neurosurg Spine 2010;13:288–93.
[10] Raley DA, Mobbs RJ. Retrospective computed tomography scan analysis of percutaneously inserted pedicle screws for posterior transpedicular stabilization of the thoracic and lumbar spine: accuracy and complication rates. Spine (Phila Pa 1976) 2012;37:1092–100.

Endovascular flow diversion therapy for an actively hemorrhaging aneurysm after intraoperative rupture

Daniel S. Ikeda *, Evan S. Marlin, Andrew Shaw, David Dornbos, Ciarán J. Powers

Department of Neurological Surgery, The Ohio State University, Wexner Medical Center, N-1019 Doan Hall, 410 West 10th Avenue, Columbus, OH 43210, USA

ARTICLE INFO

Article history:
Received 22 January 2015
Accepted 28 March 2015

Keywords:
Endovascular therapy
Flow diverter
Intracranial aneurysm
Intraoperative rupture
Pipeline embolization device
Subarachnoid hemorrhage

ABSTRACT

We report a 56-year-old woman who had an unruptured posterior communicating artery aneurysm. Given the size and location of the aneurysm, as well as her history of smoking and age, she received endovascular treatment with the pipeline embolization device (PED; ev3 Endovascular, Plymouth, MN, USA), complicated by intraoperative rupture (IOR). Flow diversion therapy with the PED has become an increasingly popular method of aneurysmal embolization and parent vessel remodeling. While its on-label approval is for large unruptured aneurysms of the internal carotid artery, success in off-label scenarios has been reported, including ruptured aneurysms. IOR complicates endovascular aneurysm treatment and can cause devastating morbidity or mortality, necessitating acute embolization of the hemorrhaging aneurysm. This patient illustrates the feasibility of treating an IOR with a stand-alone flow diversion device by using PED.

1. Introduction

Since the USA Food and Drug Administration approval of the pipeline embolization device (PED; ev3 Endovascular, Plymouth, MN, USA) in 2011, and the subsequent publication of the Pipeline for Uncoilable or Failed Aneurysms (PUFS) trial, the endovascular treatment of intracranial aneurysms with flow diverters has become increasingly popular [1]. Rather than direct aneurysm embolization, endoluminal flow diversion therapy, including PED, enables progressive aneurysm thrombosis and reconstruction of the parent artery as neointimal growth occurs within the device [2]. The PED was originally designed and approved for use in large, intracranial, unruptured internal carotid artery (ICA) aneurysms.

Intraoperative rupture (IOR) of aneurysms during endovascular procedures is a devastating complication, with increased rates of morbidity and mortality reported [3]. Once recognized, IOR requires expeditious embolization of the aneurysm and reversal of anticoagulation, and some patients require placement of an external ventricular drain. We report a patient in whom an IOR occurred during PED placement for a previously unruptured aneurysm. This patient demonstrates the feasibility and effectiveness of flow diversion to aid in hemostasis for actively hemorrhaging aneurysms.

* Corresponding author. Tel.: +1 614 293 0821; fax: +1 614 293 4281.
E-mail address: daniel.ikeda@osumc.edu (D.S. Ikeda).

2. Case report

A 56-year-old woman was found to have a posterior communicating artery (PComA) aneurysm on CT scans and CT angiography of the brain, after complaints of a retroorbital headache (Fig. 1). Her CT scans and lumbar puncture were negative for subarachnoid hemorrhage (SAH), and she was found to be neurologically intact without any evidence of cranial neuropathy. Given the size and location of the aneurysm, as well as her history of smoking and age, endovascular treatment with the PED was recommended.

She was started on 325 mg of aspirin and 75 mg of clopidogrel daily for 5 days prior to surgery. With the woman under general anesthesia, diagnostic cerebral arteriography (DCA) confirmed a 12 × 11 mm PComA aneurysm (Fig. 2A). She was then anticoagulated with heparin for a goal activated clotting time of 250 seconds, and a guide catheter was positioned within the petrous segment of the ICA.

Secondary to an acute turn in the communicating segment of the ICA and the large aneurysmal neck, tracking the Marksman microcatheter (ev3 Endovascular) past the neck of the aneurysm was quite challenging. After several failed attempts to pass the aneurysm primarily, intraaneurysmal navigation of the microcatheter was performed, and a loop of the catheter was created in the dome of the aneurysm. The microcatheter was successfully placed in the proximal middle cerebral artery, however, she acutely developed tachycardia accompanied by increased blood pressure. The DCA confirmed contrast extravasation and the IOR (Fig. 2B). The increased aneurysm wall stress from the catheter caused the aneurysm to rupture.

The loop of catheter was subsequently reduced, her blood pressure was controlled, and protamine was given to reverse the anticoagulation. With the microcatheter already positioned, a single 4.25 × 18 mm PED was delivered successfully across the neck of the aneurysm. After placement of the PED, an immediate DCA demonstrated continued but decreased contrast extravasation (Fig. 2C). The repeated arteriography revealed layering of contrast within the aneurysm, without evidence of contrast extravasation (Fig. 2D–F).

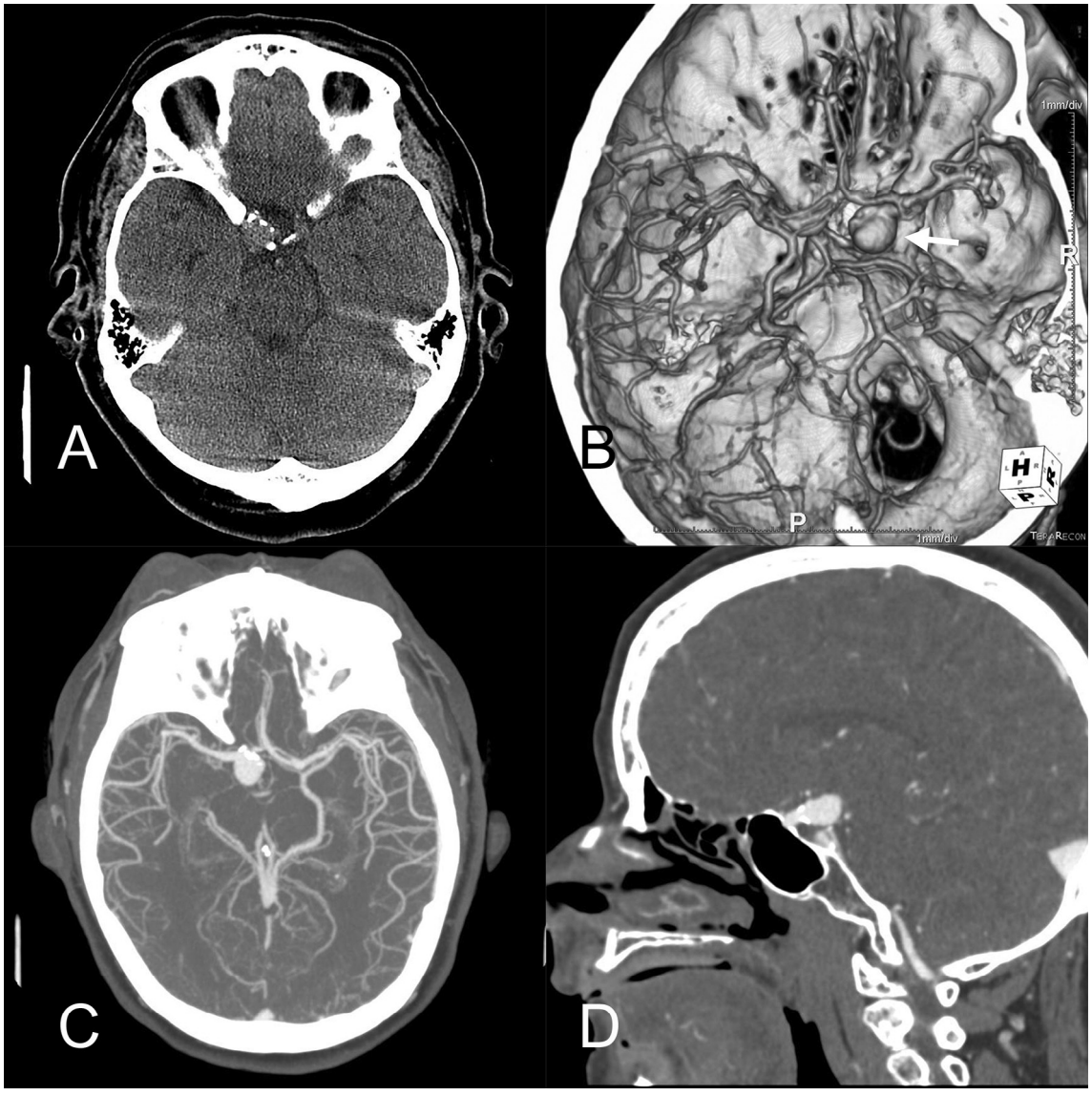

Fig. 1. Posterior communicating artery aneurysm. (A) A non-contrast enhanced axial head CT scan demonstrated a calcified aneurysmal lesion adjacent to the right anterior clinoid, without evidence of subarachnoid hemorrhage. (B) CT angiography with 3D reconstructions and (C) axial and (D) sagittal views confirmed the posterior communicating artery aneurysm (arrow).