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CORRESPONDENCE

Cerus Endovascular Contour Neurovascular System Protrusion into Parent Artery Successfully Managed with Post-detachment Bail-out PTA

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Introduction

Intrasaccular flow disruption radically changed the approach to wide-necked complex bifurcation intracranial aneurysms (WNBAs), leading to a widespread use and a rapid technological evolution [1, 2].

The Cerus Endovascular Contour Neurovascular System (CNS; Cerus Endovascular, Fremont, CA, USA) is a recently approved flow disruptor, constructed from dual-layer radiopaque nitinol memory mesh composed by 72 wires which originate and terminate at the marker band [3].

A crucial step in operative planning is establishing the appropriate size of the device. Nevertheless, unlike other flow disruptors, sizing of the CNS should be relatively straightforward and essentially based on the maximum diameter of the aneurysm and the neck [3]. In fact, in a real-life scenario retrieval of the device and replacement with a different size was found to be quite common [4].

We describe the case of a basilar tip wide-necked unruptured aneurysm treated with CNS. Device protrusion into parent artery led to delayed occlusion of the parent artery and clinical deterioration. Percutaneous transluminal angioplasty (PTA) restored flow inside the parent vessel by compressing the device inside the aneurysm without any neurological deficit.

Case Description

A 65-year-old woman without any notable past medical history was found to harbor a basilar tip aneurysm after cerebral magnetic resonance imaging (MRI) performed for headache.

Subsequent cerebral angiography confirmed an irregularly shaped, wide-necked aneurysm located on the basilar artery, involving the P1 segment of right posterior cerebral artery (PCA) and measuring 9 × 9 mm with a 7 mm neck (Fig. 1a,b). Considering morphology and anatomical features, we decided to treat the aneurysm with CNS flow disruptor.

The device selection is based on the maximum diameter of the sac on the equatorial plane and on the diameter of the neck [5]. According to that we opted for a CNS014-15; this size is suggested in aneurysms with 7–10 mm neck and 8–10.5 mm width [5].

The procedure was performed with the patient under systemic heparinization (i.e. 70 UI/kg heparin + in flushing lines 5000 UI/l). Activated clotting time (ACT) was maintained between 200 s and 260 s for the entire duration of the procedure. The patient was premedicated with double antiplatelet therapy (DAPT, i.e. ASA 100 mg per os daily and clopidogrel 75 mg per os daily starting 5 days prior to intervention) as part of our protocol for flow disruption procedures. A femoral approach and triaxial system were used.

After deployment of the device through a Headway 0.027 microcatheter (Microvention, Tustin, CA, USA), we noticed partial protrusion of the proximal part inside the right PCA, confirmed by a Vaso-CT (Figs. 2 and 3). We waited 20 min in order to identify any late flow slowdown or embolic complications. Final angiograms showed patency of the basilar artery and the right PCA. Therefore, the result was considered acceptable, and the patient woke up without any neurological deficits. Just before the transfer to the postanesthesia care unit (approximately 20–30 min after awakening), rapid

Availability of Data and Material The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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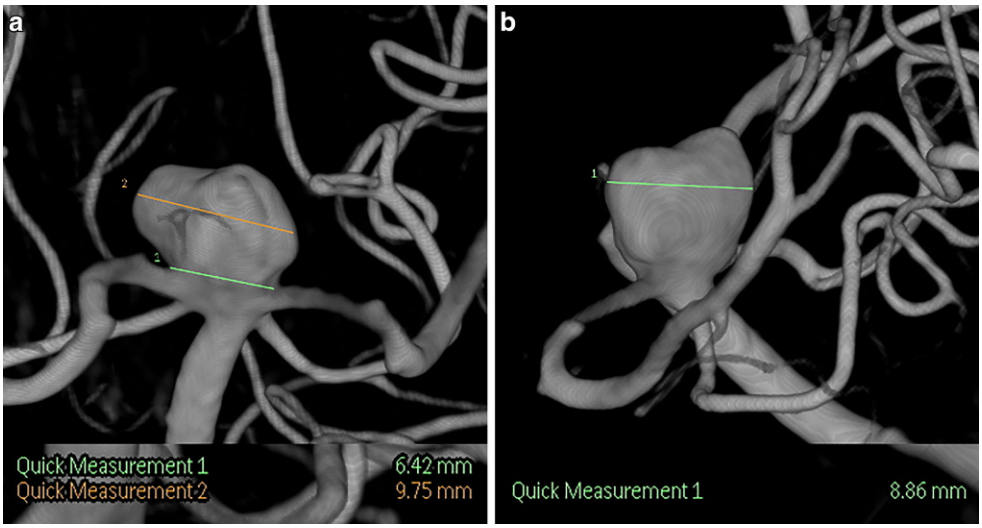

Fig. 1 Posteroanterior (**a**) and laterolateral (**b**) 3d preprocedural reconstructions demonstrating a 9 × 9 mm basilar tip aneurysm with a 7 mm neck

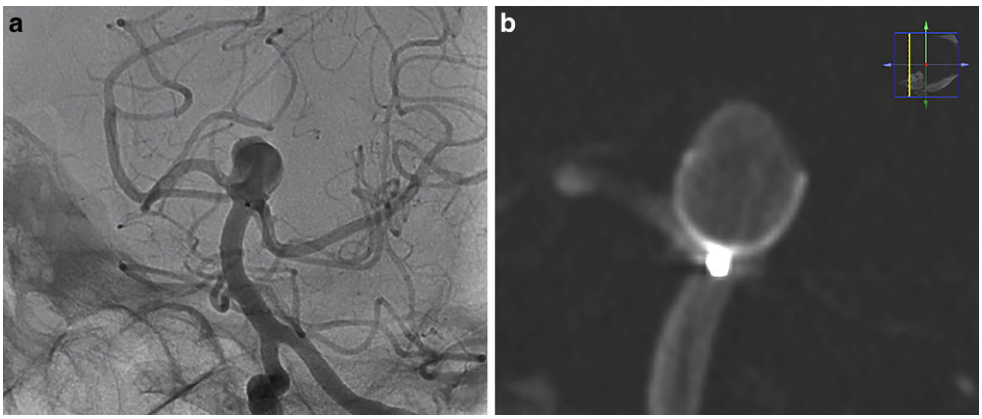

Fig. 2 DSA (**a**) and VasoCT (**b**) showing CNS device inside the aneurysm sac protruding in the parent artery

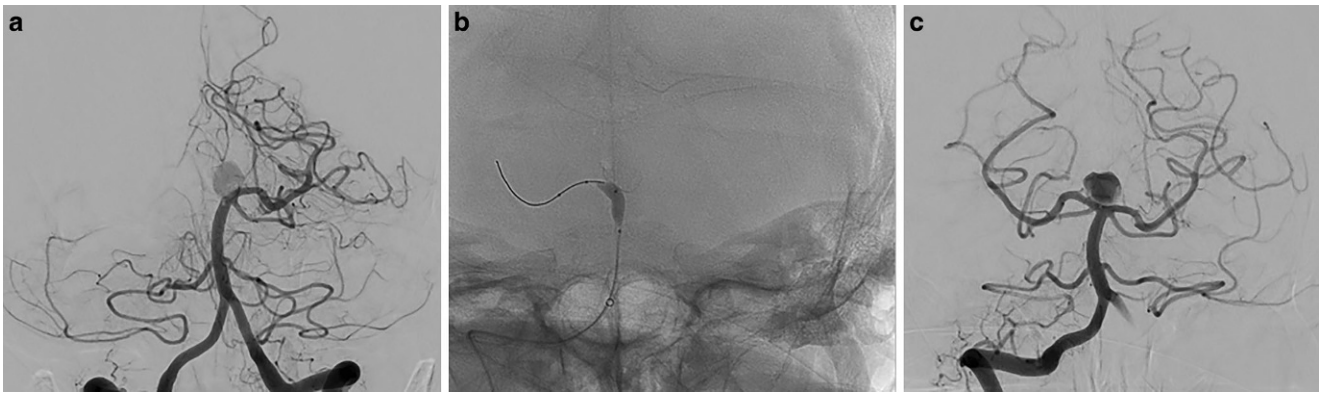

Fig. 3 DSA pre- (**a**) and post- (**c**) PTA in the right PCA. Unsubtracted image showing inflated Scepter 4 × 15 balloon in the right PCA (**b**)

neurological deterioration was noticed with slurred speech and fluctuating state of consciousness. On suspicion of delayed embolic complications an emergency angiography was performed and confirmed occlusion of the right PCA (Fig. 4a). Internal carotid artery (ICA) angiograms showed a tiny posterior communicating artery (pCOM), without visualization of distal PCA. A 4 × 15 mm Scepter C balloon (Microvention) was therefore navigated into the right PCA. A percutaneous transluminal angioplasty (PTA) allowed postdetachment adjustment of the CNS and restored flow inside the vessel (Fig. 4b,c). Pre-PTA and post-PTA unsubtracted images confirmed shape change of the device (Fig. 5a,b). Postoperative MRI demonstrated anterior pons and mesencephalon ischemic lesions. Nevertheless, the pa-

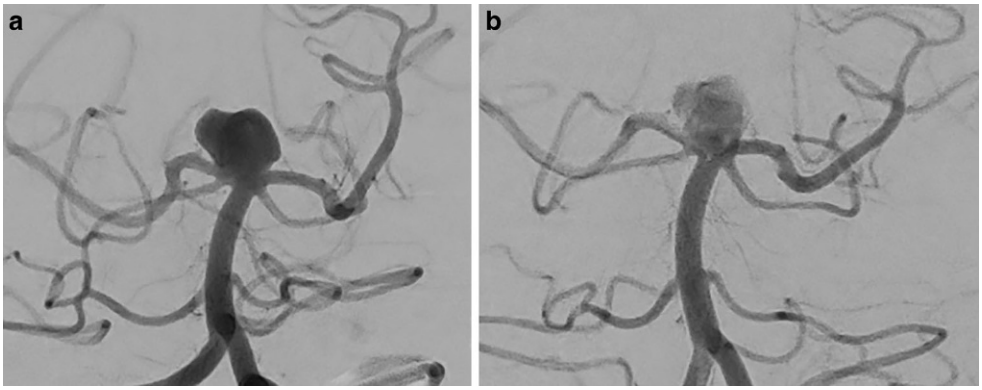

Fig. 4 DSA pre (**a**) and post (**b**) placement of the CNS device

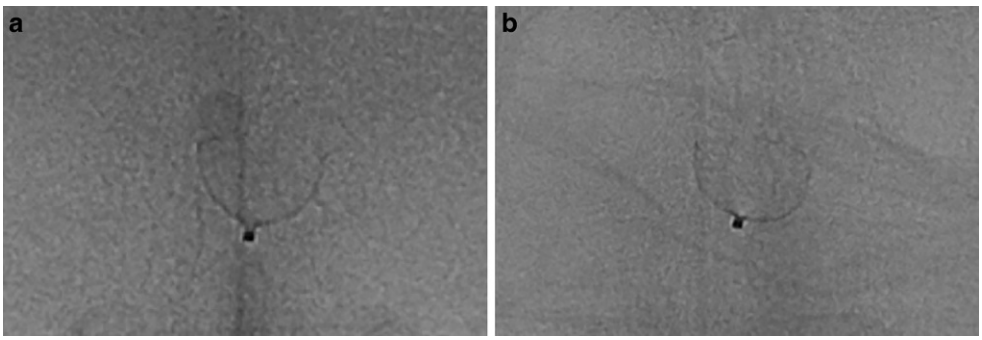

Fig. 5 Unsubtracted images showing shape differences between pre- (**a**) and post- (**b**) PTA

tient fully recovered immediately after the procedure and was discharged free of any neurological deficit (mRS 0) on the 10th postoperative day.

Discussion

Endovascular treatment of WNBAs is still challenging because it requires embolization of the aneurysm while preserving the bifurcation of vessels [6]. In this scenario, flow disruptors demonstrated safety and efficacy [7, 8]. Indeed, five types of devices have already obtained the CE mark for use in Europe [1].

The CNS device is a nitinol micro-braided mesh implant containing a platinum core wire for visualization, available in a range of five sizes, compatible with 0.021″ and 0.027″ microcatheters [5]. The device is designed to reconstruct the natural bifurcation of the artery [9]. In its unconstrained configuration the device adopts a flat disc-like shape; however, on deployment in the aneurysm and at the aneurysm neck, the device adopts a cup-like configuration [3]. Manufacturer's sizing table provides recommended implant size based on the aneurysm neck width and equatorial diameter [5].

The best studied and most used flow disruptor, the Woven EndoBridge (WEB) device (Microvention) was introduced in 2010 to specifically treat wide-necked aneurysms [1]. A properly sized device selection was found to be essential in order to avoid both incomplete occlusion of the aneurysm and protrusion of the device in the parent artery [6]. The same reasoning applies for other flow disruptors, including CNS [9]. Indeed, Liebig et al. found a 34% rate of retrieval and redeployment of a different size device after the first attempt [4]. Nevertheless, in some cases, protrusion still may occur such as for other flow disruptors mainly due to improper sizing or irregular morphology and orientation of the aneurysm on parent vessels [6, 8]. In these cases, alternative techniques are carried out such as the balloon remodeling-assisted WEB technique prior to detachment [10] in order to tilt the device in the proper position or rescue stenting [8] after detachment with the aim of compressing the protruding part against the vessel wall and maintain the patency of the parent vessel. The rate of thromboembolic complications due to device prolapse in the parent artery after CNS deployment is still unknown. With respect to the other more studied flow disruptors, the rate of treatment with the WEB and additional stent placement mainly due to device protrusion inside the artery ranges between 5% and 18% [11].

In our case, with respect to aneurysm measurements, different sizing devices (i.e., CNS011-15 (4)) would have been too small. The wide neck involving the origin of the right PCA, more than aneurysm angulation or diameters may be responsible for vessel occlusion.

The patient was under DAPT so a stent could be deployed along the right PCA; however, rescue stenting is

mainly performed for protrusion in a still patent vessel [6, 8] and the complete occlusion of the artery harboring the stent may prevent proper stent delivery and opening.

Mihalea et al. described the balloon remodeling-assisted WEB technique to avoid protrusion into the parent vessel [10]. Nevertheless, this technique was always used prior to detachment. Moreover, this technique may result in a different outcome with CNS considering the distinct structure, shape of the devices and the free loops of the CNS, implying different axial stability and consequent adaptability to PTA.

To our knowledge no protrusion of the CNS into parent artery after detachment has been described. Nevertheless, this may be due to the relative novelty of this device and a possible future increase of its employment may lead to an increment of this complication to occur as for other more used flow disruptors.

According to the authors' opinion, the different structure of the CNS (i.e. mainly the incomplete filling of the sac), may allow also a slight postdetachment tilting and repositioning. Postdetachment PTA should be limited to those cases in which bail-out techniques are required in order to avoid parent vessel occlusion and the involved vessel is already occluded.

Conclusion

Ischemic complications due to flow disruptor protrusion into the parent artery may occur. Appropriate sizing and case selection are crucial in order to avoid this potentially catastrophic event. Considering CNS, bail-out PTA may allow in selected cases to change the already detached device positioning by compressing the device inside the aneurysm sac.

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Declarations

Conflict of interest R. Russo, S. Molinaro and M. Bergui declare that they have no competing interests.

Ethical standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Consent to participate/consent for publication: not required considering the retrospective nature of the study according to the local institutional review board.

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