9 Cavernous Internal Carotid Artery Aneurysm: Giant Posttraumatic Carotid Cavernous Pseudoaneurysm, Presenting with Epistaxis; Treated in Two-Stage Strategy with Complete Occlusion and Delayed Coil Extrusion Through the Nostril

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Abstract

A giant, wide-necked pseudoaneurysm of the cavernous internal carotid artery (ICA) was found in a 17-year-old male patient who had suffered a high impact car accident. Four months after the accident, he presented with diplopia and facial pain associated with severe epistaxis. Coil occlusion of the aneurysm was performed and stopped the bleeding. One week later, a control DSA was carried out. Recanalization of the aneurysm due to coil compaction was observed, for which a Pipeline Embolization Device was implanted. The patient had a complete clinical recovery, and follow-up examinations confirmed aneurysm occlusion. Two years later, he presented to the emergency department with a coil protruding through his nostril. The actions taken following this event are explained below. The management of posttraumatic cavernous ICA aneurysms is the main topic of this chapter.

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Keywords

Cavernous internal carotid artery · Posttraumatic aneurysm · Epistaxis · Coil occlusion · Coil compaction · Flow diversion

Patient

A 17-year-old male patient with no relevant medical history suffered a car accident with severe head trauma and multiple skull fractures. Four months after the car accident, the patient presented with diplopia and facial pain. Severe epistaxis appeared 24 h before the arrival to the emergency department.

Diagnostic Imaging

A noncontrast cranial computed tomography (NCCT) showed a giant erosive dense mass in the skull base with the destruction of the sphenoidal sinus, ethmoidal cells, and the internal wall of the orbit. Mass effect was being exerted on the medial rectus muscle. On the NCCT, the superior wall of the frontal sinus and orbit floor were fractured. Digital subtraction angiography (DSA) was carried out, showing a giant carotid-cavernous pseudoaneurysm of 27 × 25 mm diameter with a wide neck of 8 mm (Fig. 1).

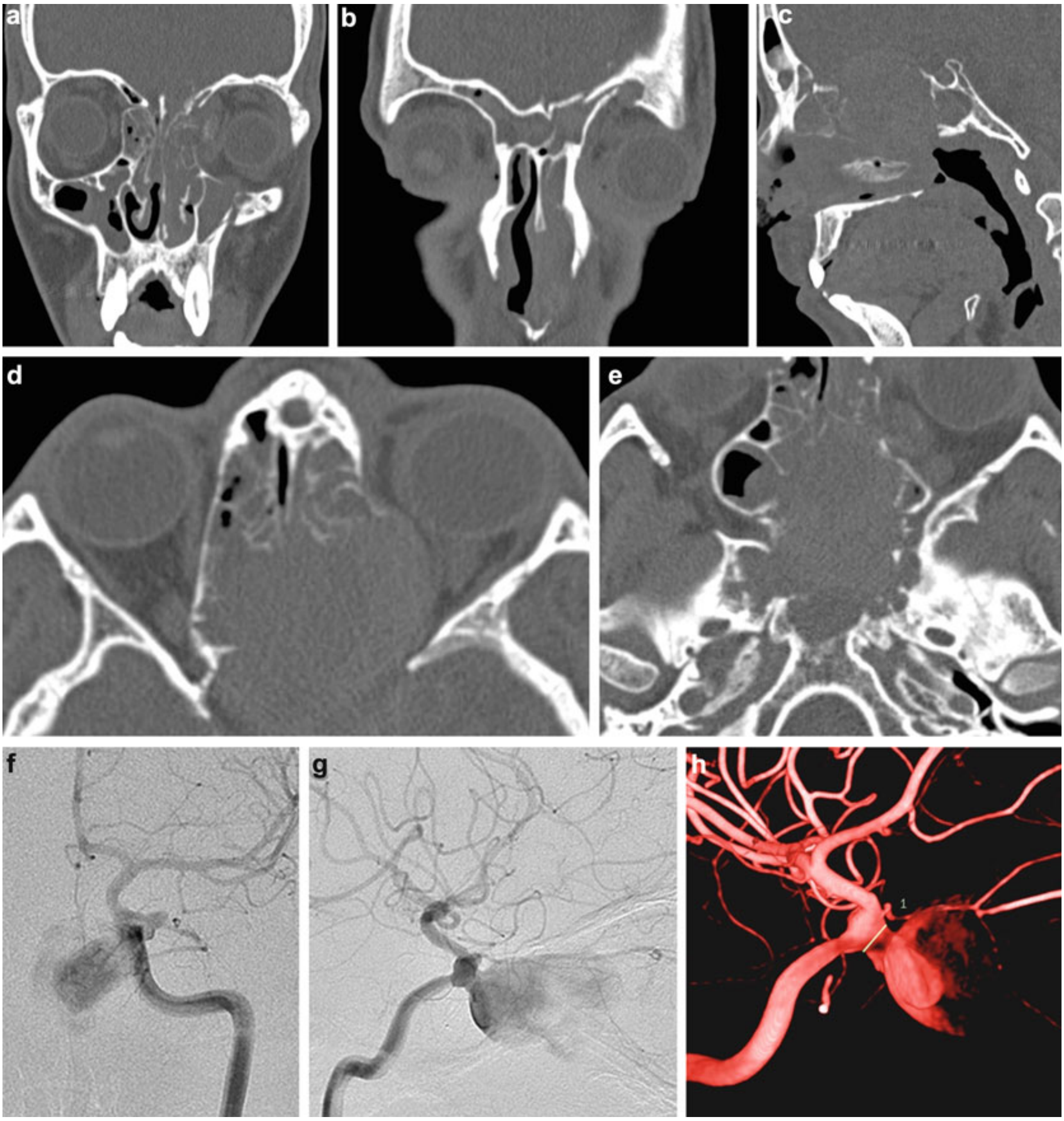

Fig. 1 Diagnostic imaging in a young male patient 4 months after severe head trauma. NCCT with coronal (**a**, **b**), sagittal (**c**), and axial (**d**, **e**) reconstructions showed fractures of the left orbital floor, the superior wall of the left frontal sinus (red circles), erosion of the sphenoidal sinus and ethmoidal cells with a dense mass, and compression of the medial components of the orbit (**d, e**). DSA showed a giant carotid-cavernous pseudoaneurysm with 27 × 25 mm diameter with a wide neck of 8 mm (posterior-anterior view (**f**), lateral view (**g**), 3D reconstruction of a rotational DSA (**h**))

Treatment Strategy

The primary goal of the treatment was to stop the epistaxis and decrease the mass effect. Due to the acute bleeding from the pseudoaneurysm, initial coil occlusion was performed, and endovascular repair of the carotid artery was planned for a second treatment session using flow diversion.

Treatment

Procedure #1, 23.08.2010: endovascular coil occlusion of the carotid-cavernous pseudoaneurysm with coil occlusion

Anesthesia: general anesthesia: 10,000 IU unfractionated heparin (Riveparin, Rivero) IV

Premedication: none

Access: right femoral artery, 7F sheath (Terumo); *guide catheter:* 6F Envoy (Codman); *microcatheter*: Tracker Excel-14 (Boston Scientific); *micro-guidewire*: Transend 0.014″ (Stryker)

Implants: 18 coils: 3× Microcoil GDC -18 360° Standard 24/40, 3× Microcoil GDC -18 360° Standard 22/40, 7× Microcoil GDC -18 360° Standard 20/33, 2× Microcoil GDC -18 360° Standard 18/40, 1× Microcoil GDC -18 2D 18/30, 1× Microcoil GDC -18 2D 16/30, 1× Microcoil GDC -18 360° Standard 14/30 (then Boston Scientific, now Stryker)

Course of treatment: The left internal carotid artery was catheterized with a 6F Envoy catheter. A Tracker Excel-14 microcatheter with a 0.014″ microwire was navigated inside the pseudoaneurysm sac. Then, conventional coil occlusion was successfully carried out (Fig. 2).

Duration: 1st – 14th DSA run: 79 min; fluoroscopy time: 51 min.

Complications: none

Postmedication: none

Clinical Outcome

The procedure was well tolerated, and the epistaxis stopped after the procedure. The patient remained in the ICU for 5 days.

Follow-Up Examinations

Follow-up MRI and DSA examinations were done 7 days after the first treatment session and showed early aneurysm recanalization (Fig. 3).

Treatment Strategy

A second treatment appeared necessary in order to avoid further growth of the pseudoaneurysm, which might have resulted in recurrent episodes of epistaxis or emboli into the dependent vasculature. Coil occlusion alongside flow diversion was considered the most appropriate treatment strategy.

Treatment

***Procedure #2, 01.09.2010*:** repeated endovascular coil occlusion of a cavernous ICA pseudoaneurysm remnant and endovascular reconstruction of the ICA with a flow diverter stent

Anesthesia: general anesthesia; 10,000 IU unfractionated heparin (Riveparin, Rivero) IV

Premedication: 1× 100 mg ASA (Aspirin, Bayer Vital) PO daily and 1× 75 mg clopidogrel (Troken, Laboratio Bagó) PO daily, both starting 2 days before the intervention

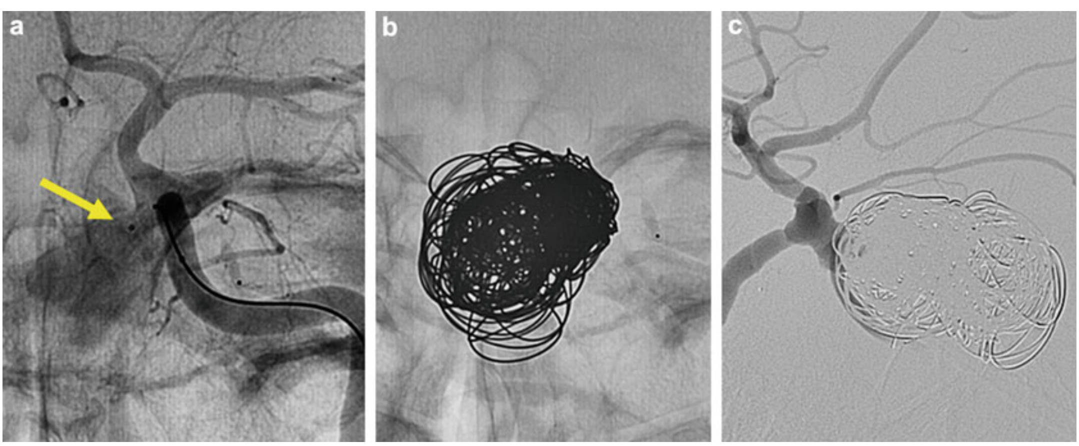

Fig. 2 Endovascular treatment of a posttraumatic left-hand cavernous ICA aneurysm causing epistaxis. The aneurysm was catheterized (arrow, the tip of the microcatheter, posterior-anterior view (**a**)) and occluded with 18 GDC platinum microcoils (posterior-anterior view (**b**), lateral view (**c**))

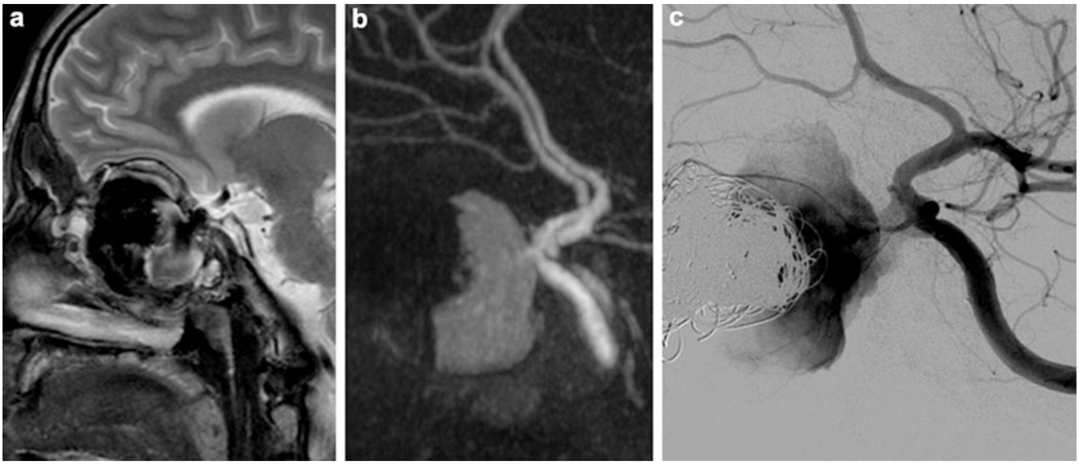

Fig. 3 Follow-up imaging only 7 days after the endovascular coil occlusion of a posttraumatic left-hand cavernous ICA aneurysm. MRI/MRA including sagittal T2WI (**a**), sagittal TOF MRA (**b**), and DSA (**c**) showed the early recanalization of the pseudoaneurysm

Access: right femoral artery, 7F sheath (Terumo); *guide catheter:* 6F Envoy (Codman); *microcatheter*: Tracker Excel-14 (Boston Scientific) for coil insertion and Marksman 27 (Medtronic) for the flow diverter deployment; *microguidewire*: Transend 0.014″ (Stryker)

Implants: 11 coils: 1× Microcoil GDC -18 360° Standard 24/40, 1× Microcoil GDC -18 360° Standard 22/40, 2× Microcoil GDC -18 360° Standard 22/33, 2× Microcoil 360° GDC -18 20/33, 2× Microcoil GDC -18 360° Standard 18/40, 1× Microcoil 360° GDC -18 18/40, 2× Microcoil GDC -18 360° Standard 16/40 (Boston Scientific); 2 flow diverters: Pipeline Embolization Device (Medtronic) 2× 4/20

Course of treatment: The left internal carotid artery was catheterized with a 6F Envoy guide catheter. A Tracker Excel-14 microcatheter with a 0.014″ microguidewire was navigated into the pseudoaneurysm. The pseudoaneurysm was occluded with 11 coils, after which the endovascular reconstruction of the cavernous ICA segment was achieved using two PEDs. A Marksman 27 microcatheter was placed into the left MCA, and a PED 4/20 was deployed. Due to the continuous filling of the pseudoaneurysm, a second PED 4/20 was added in a telescoping fashion. Adequate apposition of the two devices with a reconstruction of the cavernous segment and a significantly reduced flow in the pseudoaneurysm were accomplished (Fig. 4).

Duration: 1st – 16th DSA run: 72 min; fluoroscopy time: 43 min

Complications: none

Postmedication: 1× 100 mg ASA PO daily for life and 1× 75 mg clopidogrel PO daily for 6 months

Clinical Outcome

The second procedure was well tolerated. The patient remained in the ICU for 2 days and was discharged home after another 2 days. Cavernous sinus syndrome progressively improved. After 3 months, his diplopia and facial pain had ceased.

Follow-Up Examinations

Follow-up MRI/MRA exams at 6 and 15 months showed progressive shrinkage and thrombosis of the aneurysm. DSA at 6 and 15 months confirmed the complete occlusion of the aneurysm (Fig. 5).

Two years later, the patient consulted the medical department because metallic material was extruding through his nose. An NCCT was done, showing a coil protruding through the left nostril.

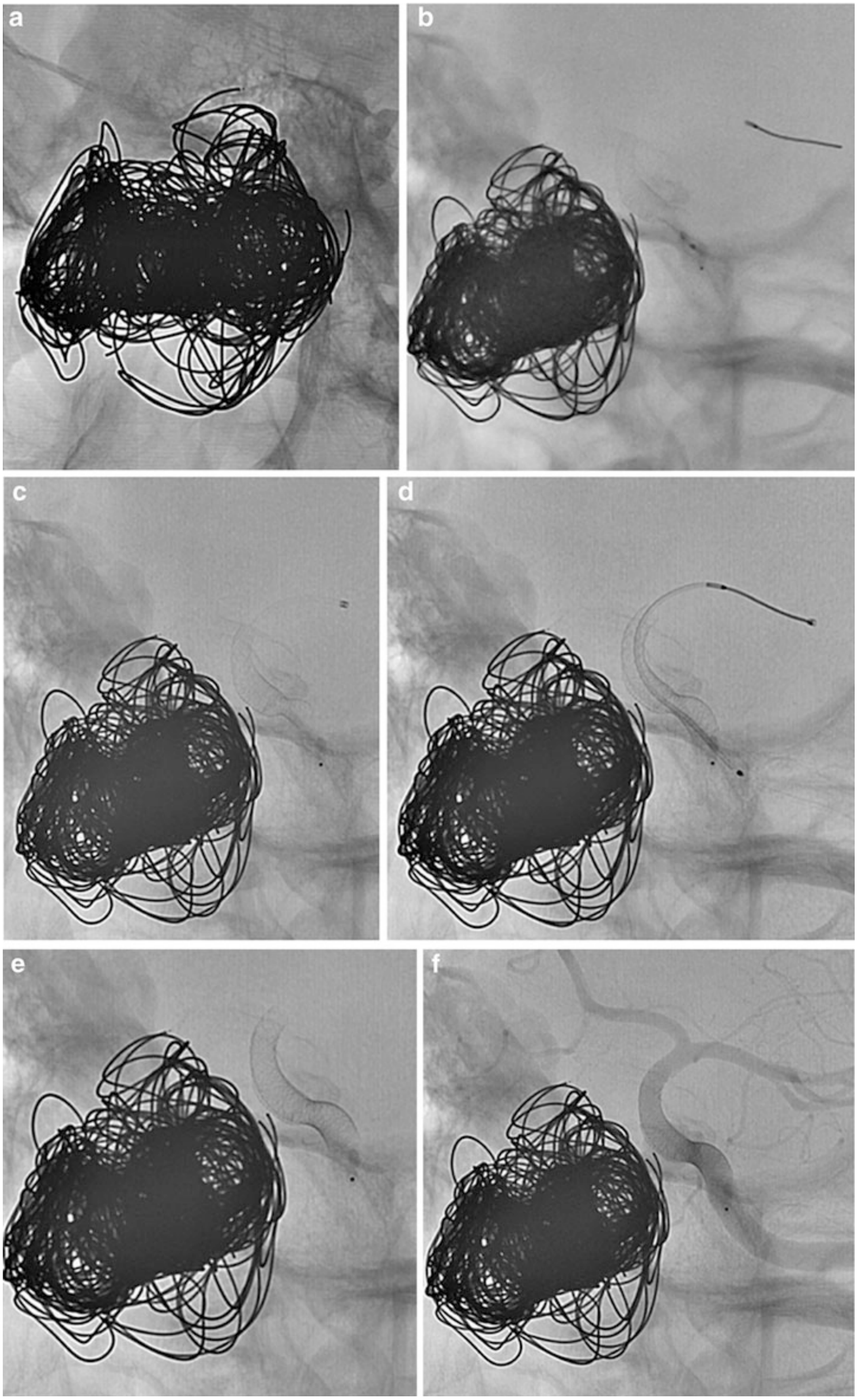

Fig. 4 (continued)

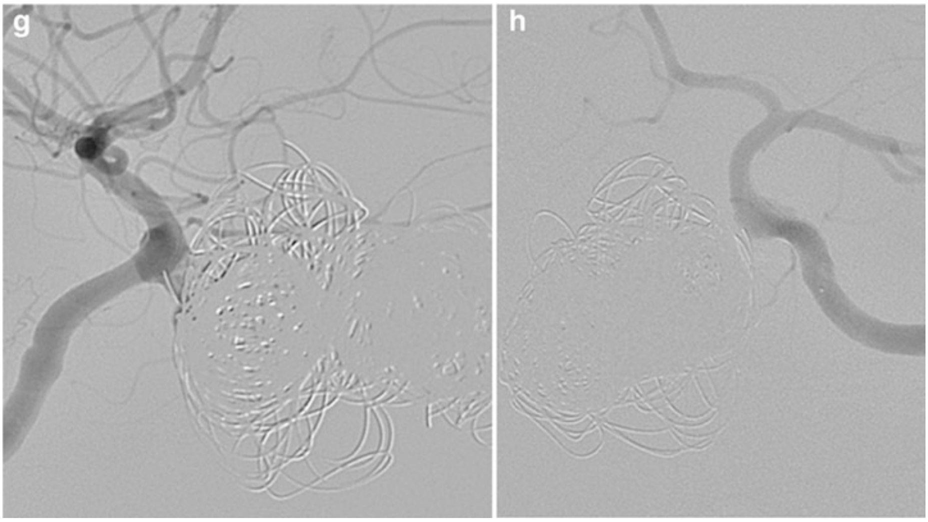

Fig. 4 Endovascular management of early reperfusion of a traumatic cavernous ICA pseudoaneurysm after initial coil occlusion. The second treatment session was carried out 1 week after the coil occlusion of a posttraumatic left-hand cavernous ICA pseudoaneurysm with early reperfusion. Coil occlusion of the pseudoaneurysm remnant with 11 coils (**a**). A first PED 4/20 was deployed covering the aneurysm neck (**b**, **c**). A second PED 4/20 was inserted in a telescoping fashion into the first PED (**d**, **e**). Adequate apposition of the two PED devices with a reconstruction of the cavernous segment was achieved (**f**) with a significant reduction of the flow into the pseudoaneurysm (**g**, **h**)

The coil was gently pulled out and cut off without being completely removed. Subsequent DSA showed a fully occluded aneurysm (Fig. 6).

Discussion

Direct ICA injuries are rare yet potentially lethal conditions. The resulting pseudoaneurysms or "false aneurysms" by definition consist of a hematoma surrounded by a fibrous layer, rather than a "true" arterial wall (Wang et al. 2018). Due to the influence of continuous, pulsatile arterial forces, these expand to a more spherical shape (Sirakov et al. 2019). They are extremely prone to rupture and may cause life-threatening epistaxis resulting from the disruption through the sphenoid sinus (Chaboki et al. 2004). Cadaveric dissection has revealed that 71% of cavernous carotid arteries project into the lateral sphenoid sinus, 66% have a bony covering of less than 1 mm, and 4% are dehiscent (Chaboki et al. 2004).

Although rare, aneurysmal rupture may result due to the anteromedial expansion of the pseudoaneurysm sac directly into the ethmoid sinus or into the petrous bone. In such cases, the epistaxis is characterized by repeated episodes, with bleeding increasing over time (Sridharan et al. 2014). Mauner's triad

- Unilateral blindness
- Orbital fracture and
- Massive epistaxis

has been observed in some cases and is considered pathognomonic for ICA pseudoaneurysms.

ICA pseudoaneurysms may result from several conditions and events, including sphenoidal and transsphenoidal surgery, a neoplastic process, local intracranial pyogenic or "mycotic" infections, and congenital collagen vascular diseases.

While severe hemorrhage due to an ICA pseudoaneurysm is a dreadful condition, direct microsurgical management of such lesions usually proves to be complicated. The constant need for hemostasis and an extensive skull base exploration when attempting direct arterial repair are sometimes considered obstacles. Definitive microsurgical treatment may often require parent vessel sacrifice or microvascular arterial reconstruction with bypass grafting. These techniques often bear some limitations, in that the patient might not fully tolerate the procedure, resulting in a significant stroke unless there is patent and adequate collateral circulation. As a result, the management of these unique entities has shifted towards endovascular methods.

However, treating a cavernous ICA pseudoaneurysm by endovascular means is more complicated than for regular true cerebral aneurysms. Endovascular reconstruction of the parent vessel is considered a safe and effective procedure with a complication rate of up to approximately 10% (Mohan et al. 2017). Moreover, the endovascular coil embolization of cerebral pseudoaneurysms is commonly associated with some unusual and rare complications in terms of delayed coil extrusion and migration. According to a report by Struffert et al. (2009), pseudoaneurysms within the sphenoid sinus are most likely to have arisen secondary to previous surgical intervention. Coil extrusion into the nostril and oropharynx up to 26 months after neurointerventional therapy was reported in two cases (Struffert et al. 2009). Nasi et al. (2019) reported on a case in which coil extrusion had actually happened 10 years after the treatment was conducted.

The absence of a real arterial wall combined with a perianeurysmal hematoma- and thrombus resolving, thus causing coils to loosen and migrate via preexisting fractures, is a possible mechanism behind coil herniation hypothesized by Singh et al. (2018). Pseudoaneurysmal walls are inherently unstable, and metallic coils have the

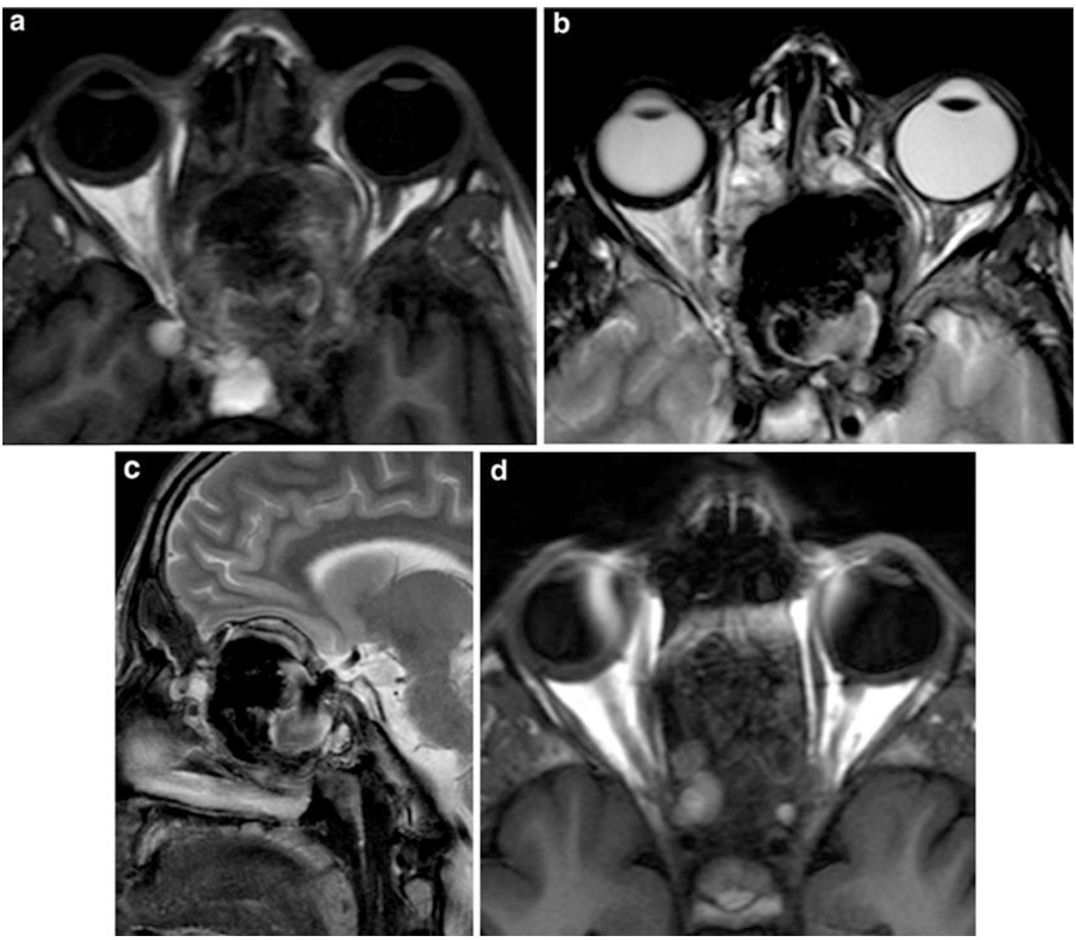

Fig. 5 (continued)

Fig. 5 Follow-up imaging after the endovascular management of a posttraumatic cavernous ICA aneurysm. MRI/MRA at 6 months (**a**, **b**, **c**) and 15 months (**d**, **e**, **f**) including axial T1WI (**a**), axial T2WI (**b**), and sagittal T2WI (**c**) showed a modification in the signal intensity of the thrombus. No evidence of any growth of the aneurysm was seen, and a decrease in mass effect was also noted on the 6-month follow-up. The mass effect and the pseudoaneurysm size had decreased by the 15-month follow-up (T1WI (**d**), axial T2WI (**e**), FLAIR image (**f**)). Note the disappearance of the mass effect of the aneurysm on the adjacent orbit (**e**). Follow-up DSA at 6 months confirmed the complete occlusion of the aneurysm and the reconstruction of the cavernous ICA segment (**g**)

potential to dislodge and escape out of the confines of the pseudoaneurysm (Chen et al. 1998). Some authors reported iatrogenic perforation of the aneurysmal wall during coiling (Aoun et al. 2013) or the force of blood flow compressing the coils against the aneurysmal dome resulting in coil extrusion either through an already vulnerable site or by creating a new tear in the aneurysm wall (Wilseck et al. 2018). The mechanics and process described above usually take time and reflect the fact that the extrusion is reported from several months to years after the endovascular coiling procedure (Nasi et al. 2019). Extruded coils have the potential to destabilize prior arterial embolization, and they should be managed emergently. It is crucial in such cases to take a multidisciplinary approach, and intraoperative angiography and endovascular procedures must

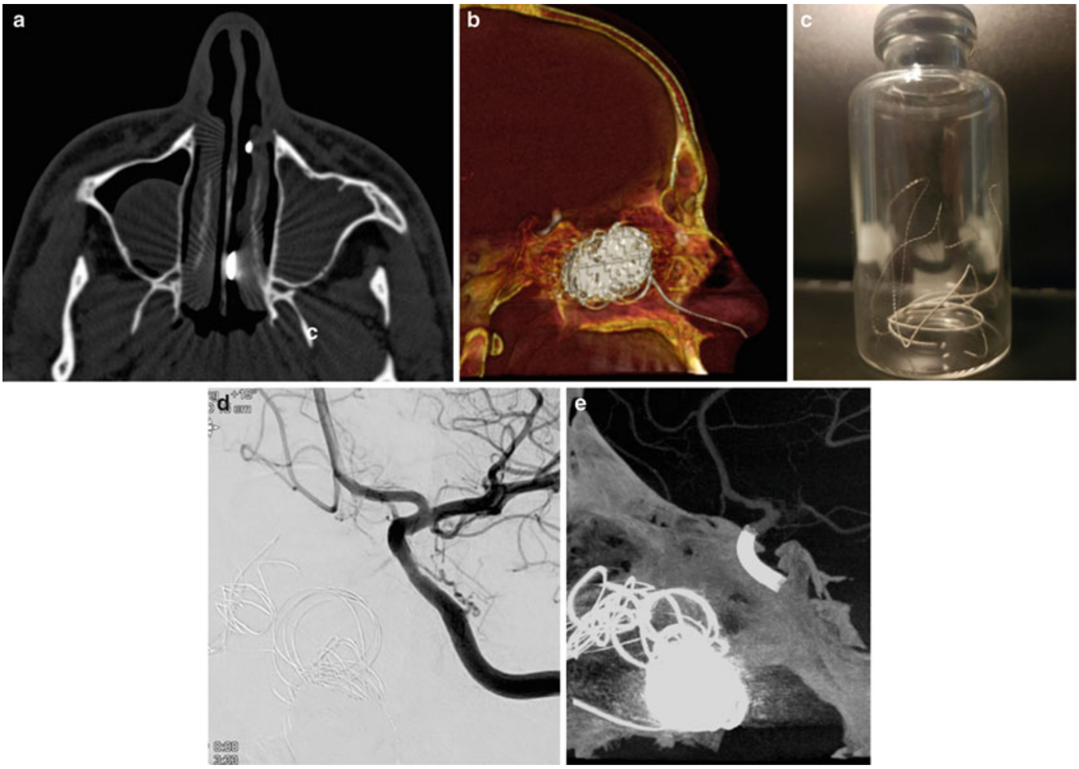

Fig. 6 Long-term follow-up after coil occlusion and flow diverter treatment of a posttraumatic aneurysm of the left-hand cavernous ICA. The patient presented with a coil loop protruding from his left nostril. Axial NCCT (**a**) and volume rendering NCCT reconstruction (**b**) confirmed the coil extrusion. The coil material was cut off (**c**). Subsequent DSA (**d**) and VasoCT (**e**) confirmed the persistent occlusion of the pseudoaneurysm with the migration of the coil cast through the sphenoid sinus

be in place in case of hemorrhage occur (Dedmon et al. 2014). The extruded coil loop should be treated by trimming at the level of the defect, while the embedded portions of the coil wire must be left in place in order to minimize the risk of possibly destabilizing the occlusive matrix (Nasi et al. 2019).

Other cases of coil extrusion have been reported in the literature. Chow et al. (2004) reported on the case of a 70-year-old male patient with a medical history of nasopharyngeal carcinoma treated with radiotherapy 7 years previously, which had resulted in temporal bone radionecrosis. He presented with bleeding from the ear due to a pseudoaneurysm of the proximal petrous left internal carotid artery, complicated by a foreign body sensation in the left ear. Upon examining the patient with an otoscope, a tympanic membrane perforation was found, with a coil wire protruding through. The wire was cut flush to the tympanic membrane, and the patient was discharged home. The fibred steel coils used before the GDC coils carry a very low uncoiling rate because steel has a strong coiling memory. In contrast, a GDC has a much finer caliber and is softer; it is made of platinum and has a relatively poor coiling memory. It also lacks fibers and is less thrombogenic (Chow et al. 2004).

Therapeutic Alternatives

Parent Vessel Occlusion
Stent Graft
Stent-Assisted Coiling

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