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CASE REPORT - VASCULAR NEUROSURGERY - OTHER

Delayed coil migration into oropharynx following endovascular coiling of a traumatic carotid cavernous fistula: management considerations

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Abstract

Carotid-cavernous fistulas (CCFs) are abnormal vascular shunts between the carotid artery and the cavernous sinus. A 37-year-old male presented with a traumatic CCF and basal skull fracture extending through the medial wall of the cavernous sinus and sphenoid sinus. The CCF was treated with endovascular coiling. Three months after this procedure, he was found to have coil migration through the traumatic sphenoid defect into the pharynx. He underwent urgent endonasal endoscopic surgery to disconnect and remove the extruded coil. Post-operative coil migration is a rare but serious complication following endovascular treatment of traumatic CCF.

Keywords Cavernous fistula · Endovascular treatment · Coiling · Trauma

Introduction

Carotid-cavernous fistulas (CCFs) are abnormal vascular shunts between the carotid artery and the cavernous sinus that can arise spontaneously or traumatically. Traumatic CCFs account for nearly 75% of all CCFs and are classified almost exclusively as type A, which indicates a direct high-pressure high-flow anomalous fistula between the cavernous portion of the internal carotid artery (ICA) and cavernous sinus [1, 12]. They most commonly occur in young males following closed head injuries with associated basal skull fractures [3].

Traumatic CCFs are optimally treated by completely occluding the fistulous connection between the ICA and cavernous sinus while preserving normal patency of the ICA. Transarterial or transvenous coiling and/or embolization, often using detachable coils, is the first line treatment with a success rate of over 90% [6]. In this case report, we describe a case of delayed coil migration into the pharynx following endovascular treatment of traumatic CCF in a patient with basal skull fractures. Based on our experience, we discuss management considerations for coil migration following endovascular coiling.

Case report

A previously healthy 37-year-old male presented to the regional trauma center approximately 6 hours after falling 20 feet at work. As part of local trauma protocol, upon presentation he underwent a CT rapid imaging protocol in trauma with CT angiogram (CTA) from arch-to-vertex. Imaging revealed a left traumatic CCF and a basal skull fracture extending through the left side of the clivus across the medial wall of the cavernous sinus into the sphenoid sinus (Fig. 1). He denied any ocular symptoms and had a normal ophthalmologic exam. A diagnostic four-vessel cerebral angiogram performed 24 hours after his initial presentation revealed a direct CCF arising from the proximal cavernous segment of the left ICA draining primarily

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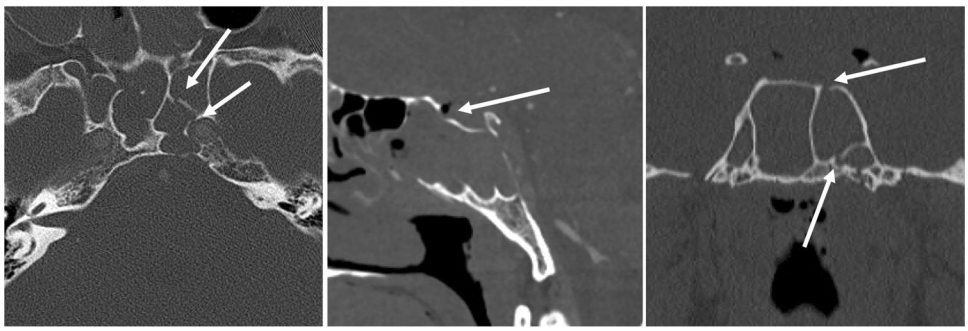

Fig. 1 Pre-treatment axial (left), sagittal (middle), and coronal (right) non-contrast CT scan of the head demonstrating a fracture (white arrow) extending through the left side of the clivus across the medial wall of the cavernous sinus into the sphenoid sinus

through the ipsilateral inferior petrosal sinus. There was no visible dissection or aneurysm, with no arterial stenosis or occlusion. The left superior ophthalmic vein was enlarged and had retrograde flow (Fig. 2).

The CCF was treated endovascularly (Fig. 2). A microcatheter was advanced via the left inferior petrosal sinus into the left cavernous sinus and then advanced anteriorly into the enlarged left superior ophthalmic vein. Penumbra PC 400 neurovascular coils (Penumbra Inc., Alameda, California), which are large volume platinum coils, were inserted starting from the junction of the cavernous sinus and superior ophthalmic vein then working backwards along the superior and medial cavernous sinus. A total of 21 regular, soft, and extra soft coils were inserted.

During the procedure note was made of transient herniation of a coil loop into the sphenoid sinus, reflecting passage through the sphenoid fracture and dissection of the traumatized ICA in this region (Fig. 3). This was partially withdrawn, with completion of CCF coil embolization. At the end of the procedure, no filling of the left cavernous sinus was seen, consistent with cure of the CCF, and no coils seen within the sphenoid sinus. Post-procedurally, he continued to deny any ocular symptoms, had normal ophthalmologic exams, and was transferred back to his local hospital for convalescence.

At 3-month follow-up, the patient reported a globus sensation while eating and a foreign body sensation in his throat. His neurological and ophthalmic exams were

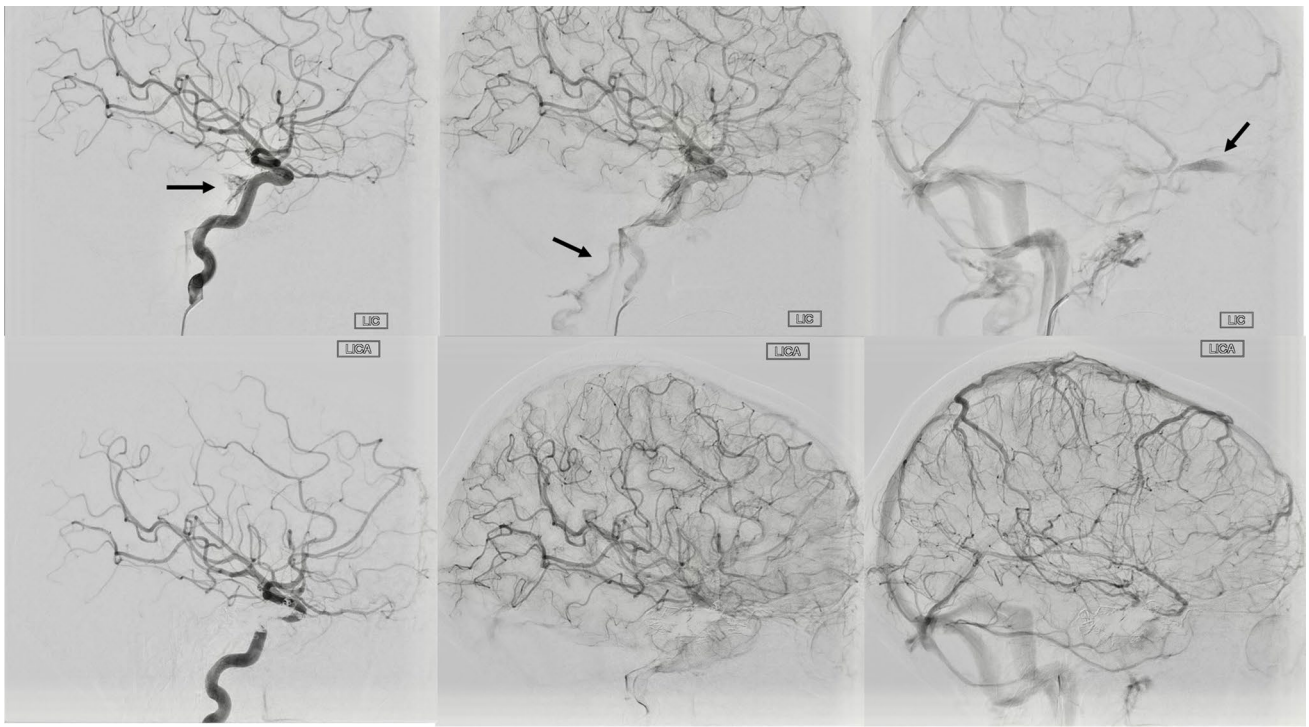

Fig. 2 Pre-treatment DSA demonstrating a direct left carotid-cavernous fistula (CCF) with drainage via the inferior petrosal sinus, as well as, the superior ophthalmic vein (filling later; top row). Immediate post-treatment DSA demonstrating resolution of the CCF and no filling of these outflow venous pathways (bottom row)

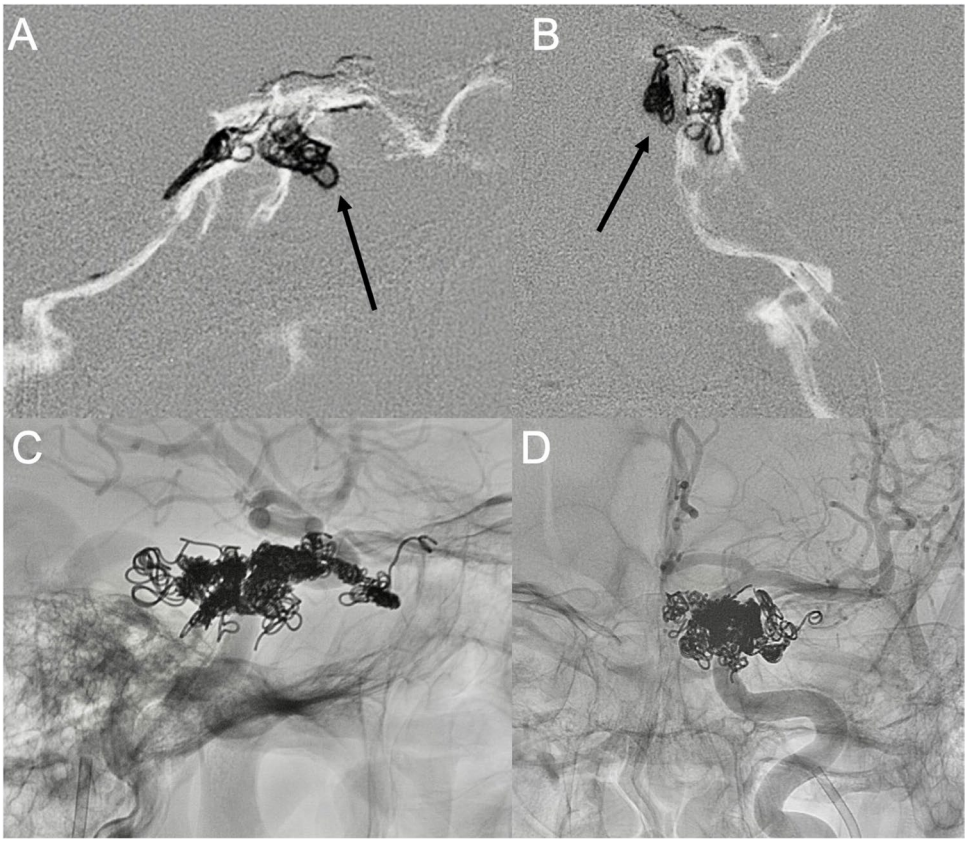

Fig. 3 Intra-procedural images from treatment of left ICA direct carotid-cavernous fistula with endovascular coiling demonstrating transient herniation of a coil loop into the sphenoid sinus (arrow; top row); lateral (**A**) and AP (**B**) projections. Final coil mass within cavernous sinus immediately post-treatment (bottom row); lateral (**C**) and AP (**D**) projections

unremarkable. However, on CT and CTA, a coil was seen extending from the left cavernous sinus through a traumatic defect into the sphenoid sinus, and extending down to the hypopharynx (Fig. 4). Cerebral digital subtraction angiography (DSA) confirmed an intact coil mass within the left cavernous sinus with no residual filling of the CCF, reflecting its cure, but with the aberrant coil seen extending into the hypopharynx (Fig. 4).

The patient was taken urgently to the operating theater for endonasal endoscopic surgery to disconnect and remove the extruded coil. The coil was visualized within the sphenoethmoid recess exiting the sphenoid ostium into the nasopharynx (Fig. 5). To maximize access to the sphenoid sinus, a complete right-sided ethmoidectomy and skeletonization of the skull base and orbit was performed. The sphenoid ostium was expanded to facilitate a trans-ethmoid sphenoidectomy, exposing the planum superiorly and the orbital apex laterally, thereby providing maximal exposure of the sphenoid sinus. This wide exposure provided excellent visualization and working space in case of inadvertent carotid injury with coil cutting.

The coil was identified exiting the floor of the sella and traversing the sphenoid sinus to exit into the nasopharynx. Using endoscopic scissors and thru-cutting forceps, the coil was sharply cut flush with the sellar floor mucosa and removed in one piece without any complications (Fig. 5). A maxillary antrostomy and a Draf IIa frontal sinusotomy were then performed to ensure maximal post-operative patency. Post-operatively, he was discharged home with 7-day course of clarithromycin as antibiotic prophylaxis.

Three months post-operatively, a nasoendoscopy was performed which revealed a small remnant of the aneurysm coil submucosally (Fig. 5). Otherwise, the sphenoid sinus, clival recess, and sellar floor were well-healed. A CTA performed at this time confirmed no further coil extrusion.

Discussion

Coil migration is a rare but serious complication following endovascular treatment of CCF. In severe cases, it can lead to refractory epistaxis, hypoxia, and potentially respiratory arrest if not promptly addressed [10, 11]. Here we present, to our knowledge, the first case of coil migration following treatment of traumatic CCF. Based on our experience, we propose management considerations for this rare complication.

During the initial endovascular treatment, there was transient coil herniation into the sphenoid sinus which likely occurred through the sphenoid fracture and a direct perforation of the cavernous sinus walls [4, 7]. Upon conclusion of the embolization procedure, there was no

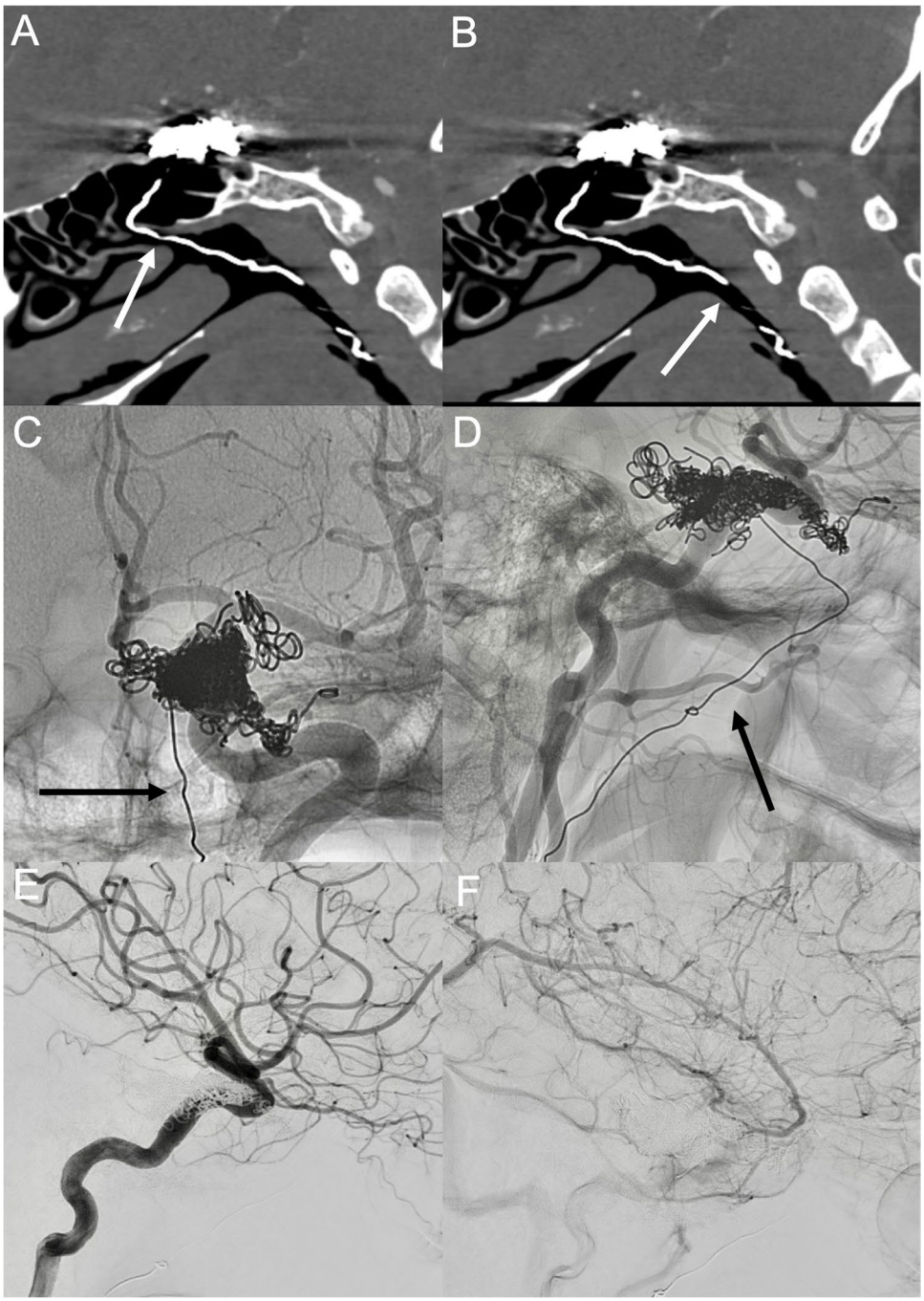

Fig. 4 Top row: CTA 3 months post-treatment demonstrating coil migration from the left cavernous sinus through an old fracture in the sphenoid sinus (**A**) extending into the pharynx (**B**). Middle row: DSA 3 months post-treatment demonstrating coil migration from cavernous sinus into pharynx on anterior–posterior views (**C**) and lateral views (**D**). Bottom row: successful treatment of left carotid-cavernous fistula without any residual filling on lateral (**E**) and anterior–posterior (**F**) views

herniation of coils noted. Given the traumatic etiology of the CCF and sphenoid fracture, we suspect there was initial clot and thrombus formation at the sphenoid sinus fracture site. We hypothesize that this clot provided initial stabilization and prevented early herniation of the coil. As the clot lysed over the sequent few weeks, we suspect that a combination of continuous outward radial force exerted by the platinum coils, combined with pulsation of the ICA through this area, led to coil extrusion through the sphenoid fracture [4, 7].

This case highlights the importance of vigilant follow-up for patients with basal skull fractures undergoing endovascular coiling within the cavernous sinus. Most cases of coil migration occur in the first year post-treatment; however, some have been reported up to 10 years following treatment [7]. Given that a basal skull fracture can create a potential track for coil extrusion, these patients should have more frequent imaging follow-up to ensure no coils have migrated. We recommend that any patient diagnosed with a traumatic CCF, traumatic pseudoaneurysm, or basal skull fracture, that

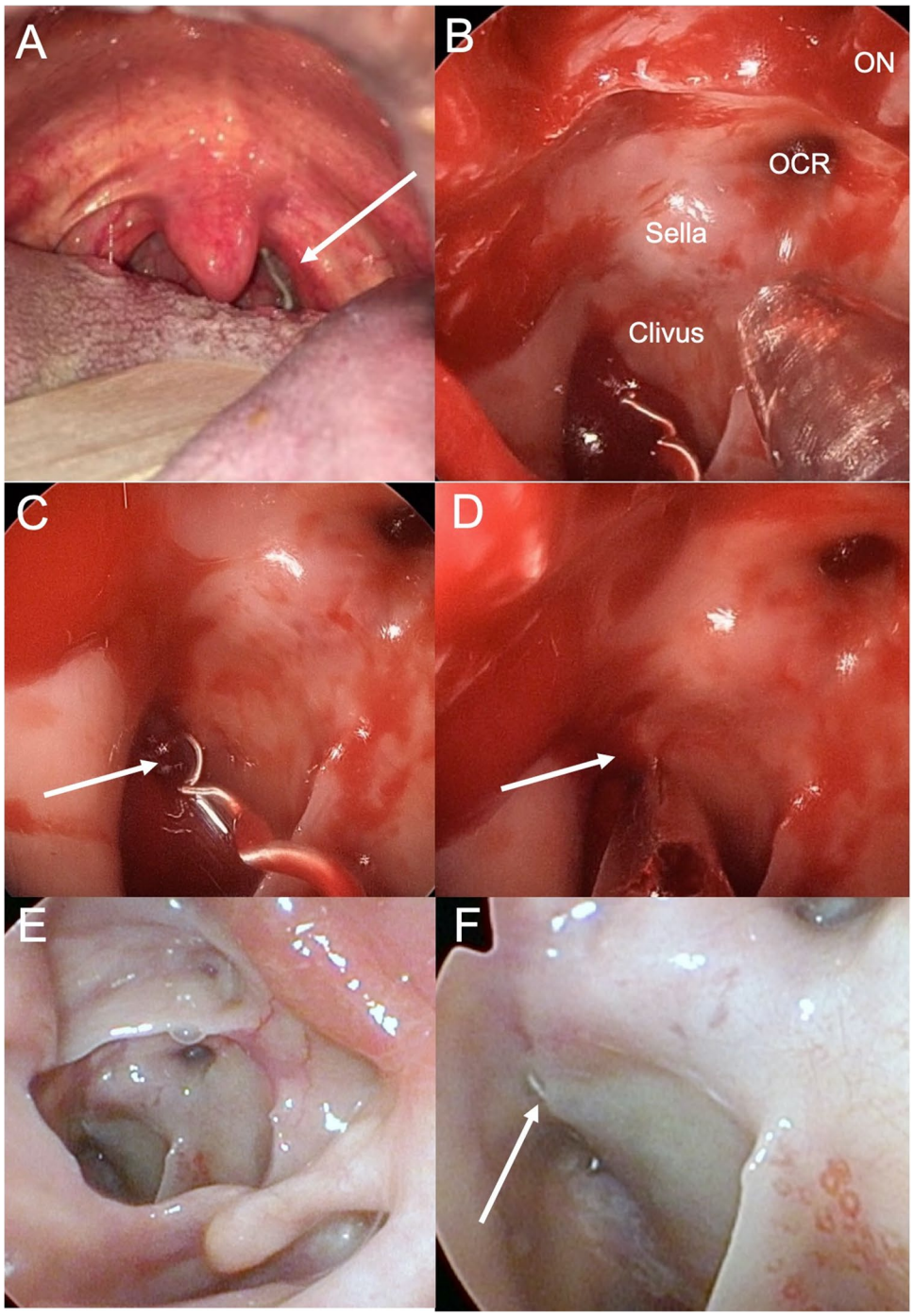

Fig. 5 Intraoperative view of coil migration showing an extruded coil within the left pharynx (**A**); coil exiting the sellar floor (**B**); magnified view of coil exiting the sellar floor (**C**); cutting of the coil flush with sellar floor (**D**). Three months post endoscopic surgery endoscopy demonstrating no further coil extrusion into the nasopharynx (**E**) and a remnant of aneurysm coil submucosally (**F**). OCR = opticocarotid recess, ON = optic nerve

is treated with endovascular coiling in the cavernous sinus, undergo routine plain film imaging follow-up. The specific schedule of follow-up imaging may be center and/or physician specific; however, we propose early plain film imaging 6–8 weeks post-treatment and at 1-year intervals thereafter for 5 years. Plain film imaging is likely sufficient to monitor for coil migration because it is accessible, readily available, and adequately visualizes coil migration. To confirm the successful endovascular treatment of CCF, our center typically obtains DSA 1-year post-treatment, which we also recommend. Long-term angiographic follow-up is usually not necessary to confirm durable treatment of the CCF.

Cases of coil migration often present with chronic foreign body sensation in the nasopharynx or oropharynx [4, 7–9], and a wire visible upon direct inspection of the pharynx [2, 4, 7–10, 13]. Given these coils are tightly meshed into each other within the cavernous sinus and possibly other venous outflow pathways, utmost care must be taken to avoid

any inadvertent manipulation of the coil. These coils are prone to unravel into a single fine strand when pulled [5]. Furthermore, in the early post-embolization period, there is a potential risk of torquing the entire coil mass if the extruded coil is pulled. Extremely worrying, some patients have reported removing the extruded coil themselves with scissors [9, 10]. Patients should be counselled to present to the emergency department if they develop any symptoms raising concern of coil migration. For initial management, if the patient is stable, we recommend leaving the protruding coil in situ and obtaining urgent CT head and neck and CTA arch-to-vertex imaging for diagnostic purposes. If the patient is unstable, resuscitation should proceed according to advanced trauma life support principles. Primary care or emergency physicians should avoid pulling on any protruding coils and instead should urgently refer the patient to a center with neurosurgical, otolaryngological, and/or neurointerventional services for definitive management.

Definitive management of extruded coils involves a multidisciplinary treatment approach [2, 7]. Removal of extruded coils may destabilize the occlusive matrix from prior embolization, especially early in the post-embolization period. We recommend that a CTA and/or DSA be performed prior to any coil manipulation to confirm arterial patency, the status of CCF treatment and to assess for any local thrombotic complications [7]. Endovascular coils are very soft and easy to cut [5], therefore, we recommend attempting to cut the extruding coil as close as safely possible to the point of penetration of the sinus wall using endoscopic visualization. By cutting the coil flush to the sinus wall, it allows the mucosa to cover the cut end and leaves the embedded portion in place within the occlusive matrix. We observed mucosa healing over the coil remnant 3 months following the procedure, thereby preventing the need for a delayed nasoseptal flap. Although some authors describe performing this procedure under local anesthesic [7–9], we recommend performing this procedure under general anesthetic in the operating room, with a wide endonasal exposure, given the theoretical risk to the internal carotid artery with manipulation of the coil.

Conclusion

Coil migration is a rare complication following treatment of traumatic CCF. The sequelae of coil migration into the pharynx may cause complications such as airway compromise, severe epistaxis, or even disruption of the coil mass. Neurosurgeons, interventional neuroradiologists, otolaryngologists, and other clinicians involved in the care of these patients need to be aware of management strategies for coil migration. Initial management should involve leaving the protruding coil in situ and obtaining dedicated vascular imaging. Definitive management includes cutting the extruding coil as close as safely possible to the sinus exit point, thereby allowing the mucosa to cover the cut end, and leaving the embedded portion in place.

Declarations

Conflict of interest The authors declare no competing interests.

References

1. Barrow DL, Spector RH, Braun IF, Landman JA, Tindall SC, Tindall GT (1985) Classification and treatment of spontaneous carotid-cavernous sinus fistulas. J Neurosurg 62(2):248–256
2. Dedmon M, Meier J, Chambers K, Remenschneider A, Mehta B, Lin D, Yoo AJ, Curry W, Gray S (2014) Delayed endovascular coil extrusion following internal carotid artery embolization. J Neurol Surg Rep 75(2):e255–e258
3. Ellis JA, Goldstein H, Connolly ES Jr, Meyers PM (2012) Carotid-cavernous fistulas. Neurosurg Focus 32(5):E9
4. Haley M, Kumaria A, Lenthall R, McConachie N, Smith S, Dow G (2020) Coughing on the coil; a case report and literature review of eight cases of endovascularly treated ICA pseudoaneurysms with coil migration into the oropharnyx. British Journal of Neurosurgery 1–3. https://doi.org/10.1080/02688697.2020.1716944
5. Milburn J, Pansara AL, Vidal G, Martinez RC (2014) Initial experience using the Penumbra coil 400: comparison of aneurysm packing, cost effectiveness, and coil efficiency. J Neurointerv Surg 6(2):121–124
6. Miller NR (2007) Diagnosis and management of dural carotid-cavernous sinus fistulas. Neurosurg Focus 23(5):E13
7. Nasi D, Dobran M, di Somma L, Di Rienzo A, De Nicola M, Iacoangeli M (2019) Coil extrusion into the naso- and oropharynx ten years after internal carotid artery pseudoaneurysm embolization: a case report. Case Rep Neurol 11(1):4–9
8. Singh A, Sikka K, Jain N, Devarajan LJ (2018) Delayed endovascular coil extrusion presenting as a foreign body of the throat: a case report. Neurointervention 13(1):66–69
9. Sirakov S, Panayotova A, Sirakov A, Minkin K, Hristov H (2019) Delayed intranasal coil extrusion after internal carotid artery pseudoaneurysm embolization. Interv Neuroradiol 25(2):139–143
10. Struffert T, Buhk JH, Buchfelder M, Rohde V, Doerfler A, Knauth M (2009) Coil migration after endovascular coil occlusion of internal carotid artery pseudoaneurysms within the sphenoid sinus. Minim Invasive Neurosurg 52(2):89–92
11. Wilseck Z, Savastano L, Chaudhary N, Pandey AS, Griauzde J, Sankaran S, Wilkinson D, Gemmete JJ (2018) Republished: delayed extrusion of embolic coils into the airway after embolization of an external carotid artery pseudoaneurysm. J Neurointerv Surg 10(7):e18
12. Yoo K, Krisht AF (2000) Etiology and classification of cavernous carotid fistulas. The cavernous sinus: a comprehensive text. Lippincott Williams and Wilkins, Philadelphia, pp 191–200
13. Zhuang Q, Buckman CR, Harrigan MR (2007) Coil extrusion after endovascular treatment. Case illustration. J Neurosurg 106(3):512