Embolization after internal carotid artery injury secondary to transsphenoidal pituitary surgery and delayed intranasal coil protrusion: illustrative case

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BACKGROUND The authors presented a case of spontaneous nasopharyngeal coil migration that occurred 3 years after a patient had undergone transsphenoidal resection due to pituitary macroadenoma and was treated with coil application because of internal carotid artery injury secondary to transsphenoidal resection of the pituitary macroadenoma.

OBSERVATIONS In the literature, eight cases of coil migration that occurred between 2 and 120 months after coil application have been reported, most of which were treated with surgical removal of the coil in a same-day surgery setting.

LESSONS The case presented emphasized that coil protrusion and migration may lead to destruction in the skull base, thereby leading to serious consequences if left untreated, even in the absence of history of trauma. To the authors' knowledge, this is the first case in the literature that required additional invasive procedures due to recurrent bleeding that occurred several months after surgical removal of coils. Also, this report underlined the need for careful and long-term follow-up of coil materials used for the treatment of pseudoaneurysms caused by vascular injuries secondary to skull base injury during surgery.

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KEYWORDS coil extrusion; embolization; endoscopic endonasal approach; internal carotid artery injury

Intraoperative internal carotid artery (ICA) injury is a leading complication of transsphenoidal pituitary surgery. The prevalence of ICA injury in aggressive endonasal skull base and pituitary surgeries varies between 1% and 9%.1 This complication has a high mortality and morbidity, requiring urgent endovascular coil embolization.1,2 In case of ICA injury, long-term extravasation of emergency endovascular coil application is a potential complication. Although this complication is rare after standard endonasal transsphenoidal surgery, it is more common in extended endonasal surgery.1,2

ICA injury may lead to a pseudoaneurysm, which in turn may result in delayed bleeding, even when intraoperative bleeding is controlled.2 This cascade of events may eventually cause various pathological conditions ranging from recurrent epistaxis to coil protrusion into the sinus,3 nasopharynx,4 intracranial region, and intracranial region.5 Although the migration of the coil from the cavernous carotid artery to the sphenoid sinus and subsequently to the nasopharynx is highly rare,5 and although it is considered to have a benign nature, it is a potentially life-threatening occurrence.2 In the present study, we report on an extremely rare case with no prior history of trauma in a patient who developed spontaneous coil migration to the nasooropharyngeal region 3 years after an ICA coil application performed for the treatment of massive hemorrhage due to an ICA injury secondary to transsphenoidal resection of a pituitary macroadenoma.

Illustrative Case

A 70-year-old male patient had been operated on for a pituitary macroadenoma via the standard endonasal endoscopic transsphenoidal route 3 years earlier, and massive bleeding due to ICA injury developed during the operation. Subsequently, the ICA injury was treated by interventional radiology with emergency coil application without sacrificing the ICA. After this procedure, the patient developed an infarction in the right middle cerebral artery distal branch.

ABBREVIATIONS CT = computed tomography; DSA = digital subtraction angiography; ENT = ear-nose-throat; ICA = internal carotid artery; MRA = magnetic resonance angiography; MRI = magnetic resonance imaging.

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The patient had left hemiparesis. In the following months, he had monoparesis only in the left upper extremity. Digital subtraction angiography (DSA) was performed 1 month later and it revealed no leakage of contrast material. The patient had been smoking one pack/day for 20 years and stopped smoking after pituitary adenoma surgery. The patient is still using antihypertensive drugs because of hypertension.

Although the patient did not have any other complaints for 3 years after the operation, he had complaints of decreased smell and a foul smell emanating from the nose for the last 2 months. Additionally, he had nosebleeds that did not require immediate medical attention twice over the last month. The patient had also been experiencing a foreign body-like pricking sensation in the nose for the last 2 weeks and had no CSF discharge or headache. On admission, the patient had a complaint of chronic constipation and stated that he had had a mild nosebleed due to coughing that resulted from difficulty in passing stools, during which he observed coil protrusion from the nostril.

The patient was referred to the ear-nose-throat (ENT) department. In the endoscopic sinus examination, coil protrusion with purulent discharge was observed (Fig. 1A). Because the patient had a high risk of massive rebleeding due to prior ICA coil application, the metallic wire was left unmanipulated.

The patient received CT, CT angiography, MRI, and MRA. In conjunction with the ENT consultation, it was decided to clean the infected area and remove the coil using the endoscopic endonasal approach. Subsequently, the patient was transferred to the operating room and the infected area and crusts were cleaned endoscopically (Fig. 1A and B; Video 1). The coils were cut from the pieces at the base of the skull at the level where they entered the sphenoid sinus (Figs. 1C, 1D, 2C, and 3C; Video 1). Utmost care was taken not to apply a pulling force during the process. The coil mass was cut so that the coil material remained at the base of the sphenoid sinus. In addition, utmost care was taken not to apply a pulling force during the process. The coil mass was cut so that the coil material remained at the base of the sphenoid sinus. Click here to view.

**FIG. 1.** In the endoscopic nasal examination, coil protrusion (A) with purulent discharge was observed, showing a single coil emerging from the right sphenoid ostium and extending into the nasal cavity. The infected area was cleaned, crusts were removed endoscopically, and the coil material was cut from the roof of the sphenoid sinus (B, arrow). Part of the coils was removed from the skull base at the level where they entered the sphenoid sinus (C). The end of the endoscopic view, showing the remaining coil material on the roof of the sphenoid sinus (D, arrow).

**FIG. 2.** Preoperative skull radiographs, lateral (A) and Towne (B) views. The coil material goes to the outside of the nose (arrows). Postoperative lateral radiograph (C) showing the coil has been cut up to the roof of the sphenoid sinus.
Approximately 8 months after discharge, the patient had intermittent massive epistaxis, and reembolization was performed at another center by interventional radiology. During this procedure, the left ICA had to be sacrificed. The images could not be accessed because DSA angiography was performed in a center other than in our province. However, after ICA total occlusion, noninvasive MRA was performed in our hospital upon request of the patient. MRA showed that the right ICA was sacrificed (Fig. 4A–C). To our knowledge, this is the first case in the literature that required reembolization as a result of bleeding after the removal of coil from the skull base following coil protrusion.

Discussion

ICA injury after routine transsphenoidal pituitary surgery is a rare occurrence, and only a few cases have been reported in the literature.1 Although they are extremely rare in endoscopic sinus surgery, ICA injuries are more common in endoscopic transsphenoidal pituitary approaches and extended endonasal skull base approaches, with their estimated incidence ranging from 1% to 9%.1,6 Because of the high risk of mortality and morbidity in ICA injury, utmost care should be taken to avoid this devastating complication during surgery. Imaging techniques such as CT, CT angiography, and DSA are the gold standard in the diagnosis of pseudoaneurysm, which is the cause of this devastating complication and recurrent epistaxis that may occur in the future.1 In the treatment of such cases, endovascular therapy is the most ideal technique for closure of pseudoaneurysm and stopping the bleeding with or without closure of the main artery after intraoperative control of bleeding and reduction of arterial pressure. Most commonly used treatment methods include coil alone, stent-assisted coiling, and coil with onyx.8 The development and improvement of new endovascular techniques (balloon occlusion, flow diversion, stent-assisted coiling or coil alone) have changed the treatment of these complex vascular lesions.2,9–11

Observations

In arterial injuries that develop after such traumatic events, the endovascular approach is the mainstay treatment option due to its rapid recovery rate, immediate results, and low complication rates. However, the efficacy of the procedure is significantly affected by appropriate case selection.3 Because of the high risk of mortality and morbidity in ICA injury, utmost care should be taken to avoid this devastating complication during surgery. Imaging techniques such as CT, CT angiography, and DSA are the gold standard in the diagnosis of pseudoaneurysm, which is the cause of this devastating complication and recurrent epistaxis that may occur in the future.1 In the treatment of such cases, endovascular therapy is the most ideal technique for closure of pseudoaneurysm and stopping the bleeding with or without closure of the main artery after intraoperative control of bleeding and reduction of arterial pressure. Most commonly used treatment methods include coil alone, stent-assisted coiling, and coil with onyx.8 The development and improvement of new endovascular techniques (balloon occlusion, flow diversion, stent-assisted coiling or coil alone) have changed the treatment of these complex vascular lesions.2,9–11

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The walls of an arterial pseudoaneurysm are inherently unstable, and metallic coils have the potential to dislodge and escape the boundaries of the pseudoaneurysm.12 High blood pressure in the ICA may cause movement of the coil material toward the nearest defect, that is, toward the ceiling of the sphenoid sinus damaged after transsphenoidal surgery. As seen in the case presented, the coil
As a result of our literature research, we found that coil protrusion usually occurs between 2 and 12 months although there are rare cases that exceed 1 year (Table 1). In the case presented by Dedmon et al., coil protrusion was detected 2 months after transsphenoidal pituitary surgery, and coil application was performed through the endovascular approach undertaken by an ENT specialist, neurosurgeon, and interventional radiology team in the operating room.13,14

Although rare, coil protrusion is a possible occurrence arising from the causes of coil protrusion, ranging from iatrogenic perforation to blood flow pushing the coils against the aneurysm dome during coiling.2,9,15 This and similar mechanisms that have been described in the literature are highly time consuming, which explains why aneurysm permeability following coil embolization may develop within the first year of embolization. Nasi et al. presented a case of coil protrusion in the 10th year of embolization, which is considered the longest lasting case of postprocedural coil protrusion.4 Accordingly, the case presented in the current study could be the second longest case because the protrusion occurred 3 years after the procedure.

**Lessons**

In the current study, we present a unique case of nasal coil protrusion that occurred 3 years after embolization of iatrogenic ICA aneurysm secondary to transsphenoidal pituitary surgery. The case presented highlights the likelihood of complications caused by coil embolization even 3 years after the procedure. This case is also interesting because the ICA coils in the patient were replaced due to occurrence of intermittent massive epistaxis within several months after surgical removal of protruding coils from the skull base at the level where they entered the sphenoid sinus. This case is the first in the literature with this feature.

We present a case of coil protrusion from the nasal hole 3 years after endovascular treatment of ICA bleeding secondary to traumatic injury during routine transsphenoidal endoscopic pituitary surgery. Although rare, coil protrusion is a possible occurrence arising from a pseudoaneurysm caused by simultaneous separation of the skull base, typically resulting from previous transsphenoidal surgery or

| Authors & Year | Diagnosis | Management of Pseudoaneurysm | Migration Time | Treatment | Ipsilateral ICA Sacrificed | Site of Aneurysm |
|----------------|-----------|------------------------------|---------------|-----------|--------------------------|------------------|
| Sirakov et al., 2019² | Pituitary adenoma | Coil & stent | 6 mos | Repeated trimming in same-day surgery | No | Cavernous segment |
| Nasi et al., 2019⁴ | Clival giant cell | Coil | 10 yrs | Trimmed in same-day surgery | No | Cavernous segment |
| Haley et al., 2020⁸ | Pituitary macroadenoma | Coil | 5 yrs | Trimmed in same-day surgery | No | Cavernous segment |
| Anup et al., 2018³ | Fracture | Coil | 18 mos | Trimmed in same-day surgery | Yes | Cavernous segment |
| Dedmon et al., 2014⁹ | Sinus surgery | Coil & onyx | 4 mos | Coil mostly resected w/ trimming to embedded portion | Yes | Cavernous segment |
| Fassnacht et al., 2013¹⁹ | Tonsillectomy | Coil | 11 mos | Coil removed | No | External carotid artery |
| Struffert et al., 2009¹⁶ | Pituitary adenoma | Coil & stent | 9 mos | Operation, majority coil resection, & sinus packing | Yes, open ligation of carotid at 5 days post embolization | C4-C5 segment |
| Scholz et al., 2007¹⁸ | Pituitary adenoma | Stent & coil | 9 days | Operation, sinus packing | No | Cavernous segment |
| Zhuang et al., 2007¹⁷ | Endoscopic sinus surgery | Coil | 24 mos | Platinum coil | Yes | Cavernous segment |

The ideal treatment involves urgent application of a set of treatment procedures, including intravascular angiography using a multidisciplinary approach undertaken by an ENT specialist, neurosurgeon, and interventional radiology team in the operating room.³,¹⁴

**TABLE 1. Literature review of nine cases of endovascularly treated aneurysm with coil migration**
trauma. Patients in this situation require careful and long-term follow-up for coil migration, which may occur a few years after a blood vessel wall is injured. This report underlines the need for careful and long-term follow-up of coil materials used for the treatment of pseudoaneurysms caused by vascular injuries secondary to skull base injury during surgery.

The management of coil protrusion can usually be performed in a same-day surgery setting by the removal of coil material via endoscopic endonasal approach under the guidance of promising imaging techniques. Nevertheless, in case of recurrent bleeding, the coil must be strengthened via endovascular approach or treated with interventional radiology applications such as stenting to prevent mortality and morbidity.

References
1. Valentine R, Wormald PJ. Carotid artery injury after endonasal surgery. *Otolaryngol Clin North Am.* 2011;44(5):1059–1079.
2. Sirakov S, Panayotova A, Sirakov A, Minkin K, Hristov H. Delayed intranasal coil extrusion following internal carotid artery pseudoaneurysm embolization. *Interv Neuroradiol.* 2019;25(2):139–143.
3. Anup S, Kapil S, Nishchint J, et al. Delayed endovascular coil extrusion presenting as a foreign body of the throat: a case report. *Neurointervention.* 2018;13(1):66–69.
4. Nasi D, Dobran M, di Somma L, Di Rienzo A, De Nicola M, Iacoangeli M. Coil extrusion into the naso-and oropharynx ten years after internal carotid artery pseudoaneurysm embolization: a case report. *Case Rep Neurol.* 2019;11(1):4–9.
5. Wada H, Tokumitsu N, Shirai W, Sako K, Kamada K. Ruptured aneurysm with delayed distal coil migration requiring surgical treatment. Case report. *Neurol Med Chir (Tokyo).* 2012;52(6):439–442.
6. Gardner P, Tomrenti M, Pant H, et al. Carotid artery injury during endoscopic endo-nasal skull base surgery: incidence and outcomes. *Neurosurgery.* 2013;73(2 suppl):261–269.
7. Mazumdar A, Derdeyn CP, Holloway W, Moran CJ, Cross DT 3rd. Update on endovascular management of the carotid blowout syndrome. *Neuroimaging Clin N Am.* 2009;19(2):271–281.
8. Haley M, Kumaria A, Lenthall R, McGonachie N, Smith S, Dow G. Coughing on the coil: a case report and literature review of eight cases of endovascularly treated ICA pseudoaneurysms with coil migration into the oropharynx. *Br J Neurosurg.* Published online January 29, 2020. doi:10.1080/02688697.2020.1716944.
9. Dedmon M, Meier J, Chambers K, et al. Delayed endovascular coil extrusion following internal carotid artery embolization. *J Neuroradiol Surg Rep.* 2014;75(2):e255–e258.
10. Higashida RT, Halbach VV, Dowd CF, Barnwell SL, Hieshima GB. Intracranial aneurysms: intervention neurological treatment with detachable balloons. Results in 215 cases. *Radiology.* 1991;175(3):663–670.
11. Maras D, Lioupis C, Magoufis G, Tsamopoulos N, Moulakakis K, Andrikopoulos V. Covered stent-graft treatment of traumatic internal carotid artery pseudoaneurysms: a review. *Cardiov Intervent Radiol.* 2006;29(6):958–968.
12. Chen D, Concus AP, Halbach VV, Cheung SW. Epistaxis originating from traumatic pseudoaneurysm of the internal carotid artery: diagnosis and endovascular therapy. *Laryngoscope.* 1998;108(3):326–331.
13. Iacoangeli M, Di Rienzo A, Re M, et al. Endoscopic endonasal approach for the treatment of a large clival giant cell tumor complicated by an intraoperative internal carotid artery rupture. *Cancer Manag Res.* 2013;5:21–24.
14. Jafari A, Nuyen B, Kedarisetty S, Fordham CA, Nation J. Sequential treatment of delayed endovascular coil extrusion from a carotid artery pseudoaneurysm after tonsillectomy. *JAMA Otolaryngol Head Neck Surg.* 2017;143(2):193–195.
15. Aoun SG, Rahme RJ, El Ahmadieh TY, Bendok BR, Hunt Balter J. Incorporation of extruded coils into the third nerve in association with third nerve palsy. *J Clin Neurosci.* 2013;20(9):1299–1302.
16. Struffert T, Buhk JH, Buchfelder M, Rohde V, Doerfler A, Knauth M. Coil migration after endovascular coil occlusion of internal carotid artery pseudoaneurysms within the sphenoid sinus. *Minim Invasive Neurosurg.* 2009;52(2):89–92.
17. Zhuang Q, Buckman CR, Harrigan MR. Coil extrusion after endovascular treatment. Case illustration. *J Neurosurg.* 2007;106(3):512.
18. Scholz KB, Buchfelder M, Knauth M. Coil dislocation and collection as a treatment for an iatrogenic intracavernous pseudoaneurysm of the internal carotid artery. *Article in German. Röfo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr.* 2007;179(8):862–863.
19. Fassnacht W, Hammer F, Gardner Q, Desuter G. Delayed endovascular coil extrusion after embolisation for post-tonsillectomy haemorrhage: case report and literature review. *J Laryngol Otol.* 2013;127(1):88–91.

Disclosures
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Author Contributions
Conception and design: Aycan, Tas, Bozan. Acquisition of data: Aycan, Bozan, Akin. Analysis and interpretation of data: Tas. Drafting the article: Aycan, Tas, Bozan. Approved the final version of the manuscript on behalf of all authors: Aycan. Statistical analysis: Akin. Administrative/technical/material support: Aycan, Bozan, Akin. Study supervision: Tas.

Supplemental Information
Video
*Video 1.* https://vimeo.com/681911399.

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