

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,^{2,4} intraarterial 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 nasopharyngeal 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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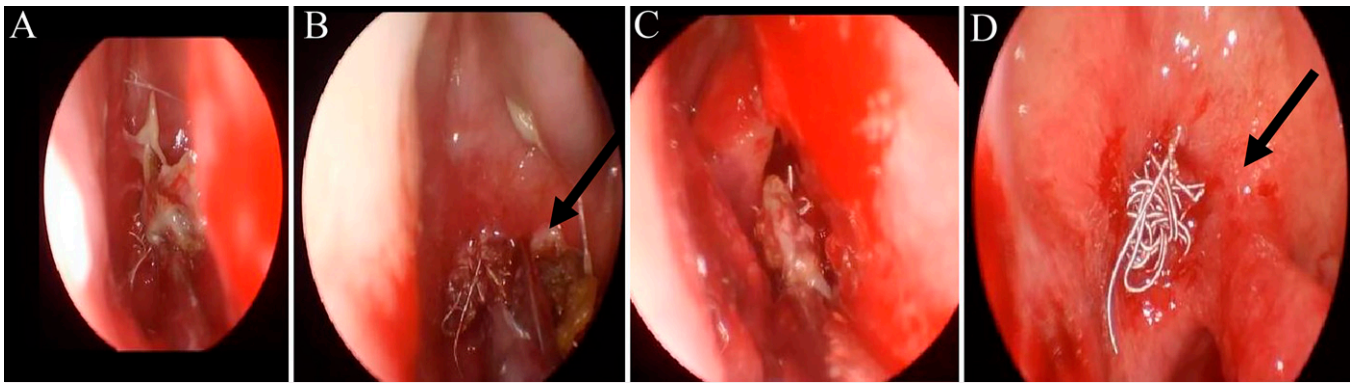


FIG. 1. In the endoscopic nasal examination, coil protrusion (A) with purulent discharge was observed, showing a single coil emerging from the right sphenoid ostium and extending into the nasal cavity. The infected area was cleaned, crusts were removed endoscopically, and the coil material was cut from 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).

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 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 they entered the sphenoid sinus (Figs. 1C, 1D, 2C, and 3C; Video 1). Utmost care was taken to avoid applying tensile force during the process. The coil mass was cut so that the coil material remained at the base of the sphenoid sinus (Fig. 1C and D; Video 1). Pseudoaneurysm patency was not found. Because no endonasal procedure was performed during acute nosebleed, no bleeding was observed. Due to the natural appearance of the mucosa, we did not think that previous bleeding was due to mucosal damage. Based on the patient's history when he presented to the emergency department in another center and the bleeding stopped after aggressive nasal packing, we concluded

that he had arterial bleeding. After cutting the coil, no packaging or nasoseptal flap was applied because of the lack of sufficient experience and the risk of massive bleeding at the ICA level. No complication was observed during and after the surgery, and the patient was discharged 1 day later.

VIDEO 1. Clip showing that the infected area and crusts around the coil are cleaned endoscopically. The coils are cut from the pieces at the base of the skull at the level where they enter 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. 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.

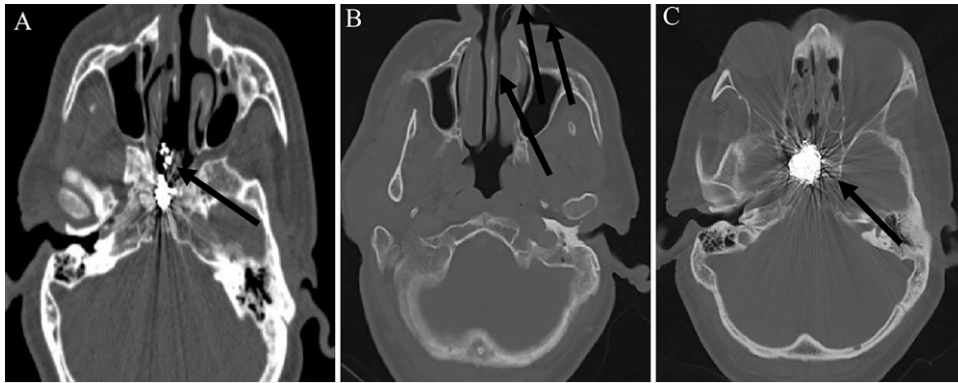


FIG. 3. Preoperative CT scan demonstrating the aberrant coil (**A and B**). The coil material is seen protruding up to the outside of the nose (*arrows*). Cranial CT image after the second embolization application (**C**). The coil material has been cut to leave a piece of the sphenoid sinus roof. No coil material is noted along the arrow.

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.⁷ 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 coiling 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

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

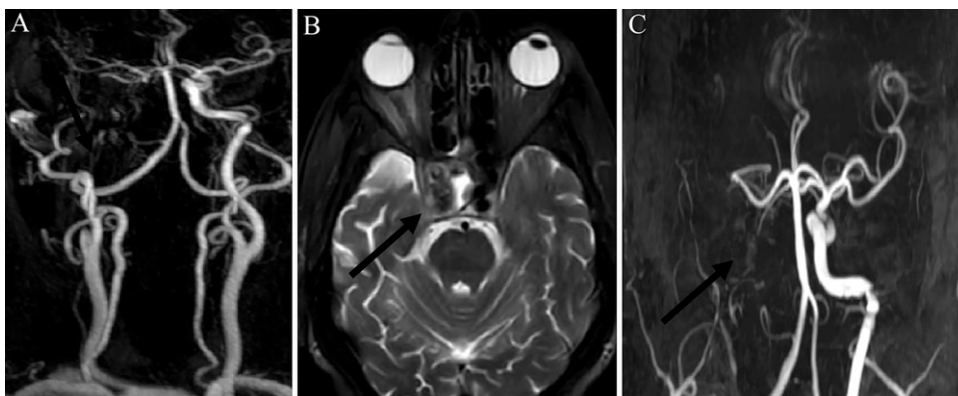


FIG. 4. Arterial MRA (**A and C**) shows that the right ICA is totally occluded and there is no blood flow (*arrows*). On the axial T2-weighted MRI sequence (**B**), no flow is evident in the right ICA and there is coil material (*arrow*).

TABLE 1. Literature review of nine cases of endovascularly treated aneurysm with coil migration

Authors & Year	Diagnosis	Management of Pseudoaneurysm	Migration Time	Treatment	Ipsilateral ICA Sacrificed	Site of Aneurysm
Sirakov et al., 2019 ²	Pituitary adenoma	Coil & stent	6 mos	Repeated trimming in same-day surgery	No	Cavernous segment
Nasi et al., 2019 ⁴	Clival giant cell	Coil	10 yrs	Trimmed in same-day surgery	No	Cavernous segment
Haley et al., 2020 ⁸	Pituitary macroadenoma	Coil	5 yrs	Trimmed in same-day surgery	No	Cavernous segment
Anup et al., 2018 ³	Fracture	Coil	18 mos	Trimmed in same-day surgery	Yes	Cavernous segment
Dedmon et al., 2014 ⁹	Sinus surgery	Coil & onyx	4 mos	Coil mostly resected w/ trimming to embedded portion	Yes	Cavernous segment
Fassnacht et al., 2013 ¹⁹	Tonsillectomy	Coil	11 mos	Coil removed	No	External carotid artery
Struffert et al., 2009 ¹⁶	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., 2007 ¹⁸	Pituitary adenoma	Stent & coil	9 days	Operation, sinus packing	No	Cavernous segment
Zhuang et al., 2007 ¹⁷	Endoscopic sinus surgery	Coil	24 mos	Platinum coil	Yes	Cavernous segment

material may protrude into the sinonasal space or migrate to the intracranial cavity.⁵

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.^{13,14}

In our patient, massive bleeding caused by ICA injury occurred during transsphenoidal pituitary surgery, and coil application was performed through the endovascular approach. Although the patient had no complaints in the early postoperative period, he had intermittent nosebleeds, and metallic coils were observed in the nostril 3 years after the surgery. The patient was treated endoscopically and the coils were removed from the skull base at the level where they entered the sphenoid sinus in conjunction with the ENT consultation. Approximately 7 months after this treatment, the patient had intermittent epistaxis and the coils were replaced using an endovascular approach in the center where endovascular coiling was applied. In later periods, no epistaxis was observed in the patient for 6 months.

To date, numerous theories have been proposed regarding the causes of coil protrusion, ranging from iatrogenic perforation to blood flow pushing the coils against the aneurysm dome during coiling.^{2,9,15-17} This and similar mechanisms that have been described in the literature are highly time consuming, which explains why aneurysm permeability following coil embolization may occur within a few months to several years after coil application.^{2,3} In our patient, this period was 3 years.

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

complete ICA coil embolization.⁹ Sirakov et al. reported a case of intranasal coil extrusion 6 months after endovascular treatment with flow-diverter stenting and coiling for iatrogenic ICA pseudoaneurysm.² In another study, coil migration was also reported 18 months after embolization of posttraumatic ICA pseudoaneurysm without previous surgery.³ Literature indicates that coil protrusion usually develops 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

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.^{18,19} 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.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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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