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Case Report

Unexpected internal carotid artery injury during endoscopic transsphenoidal surgery

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ABSTRACT

Background: Internal carotid artery (ICA) injury is a rare but severe complication of transsphenoidal surgery.

Case Description: A 69-year-old woman presented with progressive visual disturbance secondary to pituitary adenoma. The patient underwent subtotal tumor resection through endoscopic transsphenoidal surgery. The residual tumor in the cavernous sinus gradually enlarged over the next 3 years. During a second surgical intervention, an inadvertent scratch, with the worn-out tip of the micro-suction device, on the partially calcified medial wall of the C4 segment resulted in ICA rupture, leading to uncontrollable hemorrhage. After provisional hemostasis, the patient was transported to the angiography suite, where an irregularly shaped leak of contrast on the medial aspect of C4. A stent-assisted coil embolization was successfully performed, resulting in complete aneurysm isolation. The patient underwent revisional surgery on postoperative day (POD) 14, in which the coils exposed from the ICA laceration were covered with fascia lata, muscle, and surgical glue. After a lumboperitoneal shunt placement for progressive hydrocephalus, the patient was discharged on POD 82 without focal neurological deficits.

Conclusion: During transsphenoidal surgery, ICA injury can result from inadvertent manipulation using a micro-suction device. Careful manipulation and conservative resection followed by stereotactic radiosurgery may be a valid strategy for managing pituitary adenomas invading the cavernous sinus.

Keywords: Cavernous sinus, Endovascular therapy, Internal carotid artery injury, Pituitary adenoma, Transsphenoidal surgery

INTRODUCTION

Pituitary adenomas are common intracranial tumors, with prolactin-secreting and incidental lesions representing the majority of cases.[2] These tumors are typically managed through endoscopic transsphenoidal resection. Potential complications of transsphenoidal surgery include vascular and nerve injuries, in addition to nervous system infections. Among them, internal carotid artery (ICA) injury is the most severe, associated with high mortality and disability rates.[4,5,7,9-11] Most ICA injuries occur in the petrous and cavernous segments where the artery lies in close proximity to the tumor. Even in individuals with normal anatomy, these ICA segments are obscured and difficult to access.[12] The incidence of ICA injury during transsphenoidal surgery is estimated to be 0.1–0.4%.[4,5,11] Immediate bleeding control, endovascular management, and consideration of revascularization are essential to prevent catastrophic outcomes of ICA

injury.[3,5,8] Muto *et al*. devised an instructive training model for managing ICA injuries during transsphenoidal surgery.[6]

Stereotactic radiosurgery has been demonstrated to have high tumor control rates for recurrent or residual nonfunctioning pituitary adenomas.[1]

Herein, we report a case of unexpected ICA injury during endoscopic transsphenoidal surgery, which was successfully managed with endovascular therapy.

CASE PRESENTATION

A previously healthy 69-year-old woman presented with a progressive visual disturbance that was caused by a pituitary tumor invading the right cavernous sinus. The patient underwent subtotal resection through endoscopic transsphenoidal surgery, with residual tumor tissue in the right cavernous sinus. Histopathological findings confirmed a nonfunctioning pituitary adenoma. Over the next 3 years, the residual tumor remarkably enlarged. After thorough discussions on the treatment options, the patient requested a second transsphenoidal surgery to reduce tumor volume, followed by stereotactic radiosurgery for residual lesions. Cerebral magnetic resonance imaging (MRI) performed at the time detected a complete encasement of the cavernous portion of the right ICA by the tumor. Magnetic resonance (MR) angiography revealed an intact arterial flow [Figure 1]. During the second surgery, a pressure-adjustable micro-suction device, 2.5 mm in outer diameter, was used for the removal of the soft tumor in the cavernous sinus. It was removed through an incision made in the medial wall. However, during traction of the cavernous ICA with the suction device for removing the tumor, the worn-out tip of the suction device inadvertently scratched on the lumpy, partially calcified medial wall of the C4. It resulted in a rupture of the vessel wall and uncontrollable profuse bleeding (3800 mL intraoperative blood loss). Temporary hemostasis was achieved through sustainable compression of the injured arterial wall using cotton patties. The patient was immediately transferred to the angiography suite. Catheter angiography revealed an irregularly shaped leak of contrast on the medial aspect of C4 [Figure 2a]. Coil embolization was performed under general anesthesia through two-ply stents (Lvis stent , Terumo Corp., Tokyo, Japan) deployed from C3 to C5 that achieved complete elimination of the aneurysm [Figures 2b and c]. No intraprocedural rebleeding occurred. Following endovascular treatment, the patient presented with mild right-sided oculomotor nerve paresis, which resolved within 2 months. Oral cilostazol (100 mg/day) was administered as an adjunct therapy. Computed tomography (CT) performed on postoperative day (POD) 1 revealed diffuse subarachnoid hemorrhage [Figure 3]. Histopathological findings of the resected specimen during the second surgery confirmed pituitary adenoma [Figure 4].

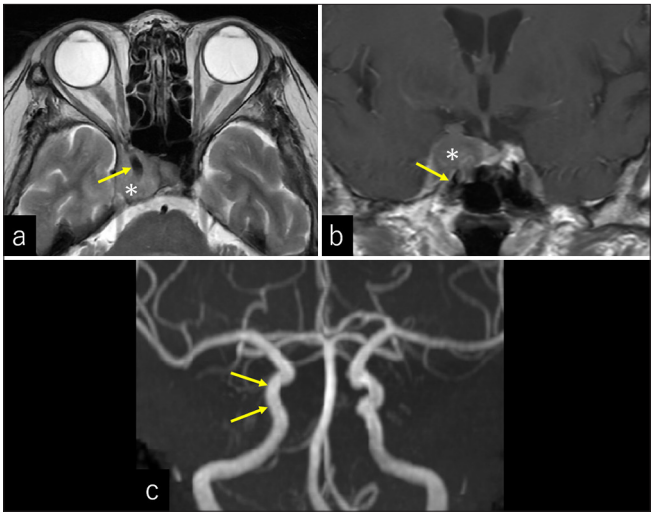

Figure 1: (a and b) Axial (a) T2-weighted and (b) contrast-enhanced coronal T1-weighted cerebral magnetic resonance (MR) images, showing the cavernous portion of the right internal carotid artery (*arrow*) completely encased by tumor (*asterisk*). (c) Anteroposterior view of the cerebral MR angiography demonstrating intact flow of the cavernous segment of the right internal carotid artery (*arrows*).

The patient underwent revisional surgery on POD 14. Upon removing the cotton patties placed in the sphenoid sinus, partial protrusion of the embolized coils through the medial wall of the C4 segment was observed [Figure 5a]. The exposed coils were covered with autologous fascia lata, muscle, and surgical glue [Figure 5b]. MRI performed on the POD 21 confirmed a patent cavernous ICA on the affected side. MR angiography demonstrated irregular flow in the right C3–C5 segments, while flow in the remaining ICA segments and the anterior and middle cerebral arteries were intact [Figure 6]. Subsequently, the patient developed progressive gait disturbances and cognitive impairment, coupled with ventricular dilation detected on CT [Figure 7a]. She underwent lumboperitoneal shunting, leading to symptomatic resolution and improvement of the ventriculomegaly [Figure 7b]. The patient was discharged on POD 82 without any focal neurological deficits.

DISCUSSION

ICA injury is a rare but serious complication of transsphenoidal surgery.[4,5,11] In this case, the curved tip of the micro-suction device caused a laceration of the ICA wall. No prior reports have documented ICA injury specifically due to a micro-suction device.[3-5,9-11] In our case, scratching on the lumpy ICA wall with the worn-out, curved tip of the suction device resulted in a laceration of the wall. It is essential to recognize that worn-out instruments used in microsurgery can cause ICA injury, and consistently gentle maneuvers using degradation-free instruments are

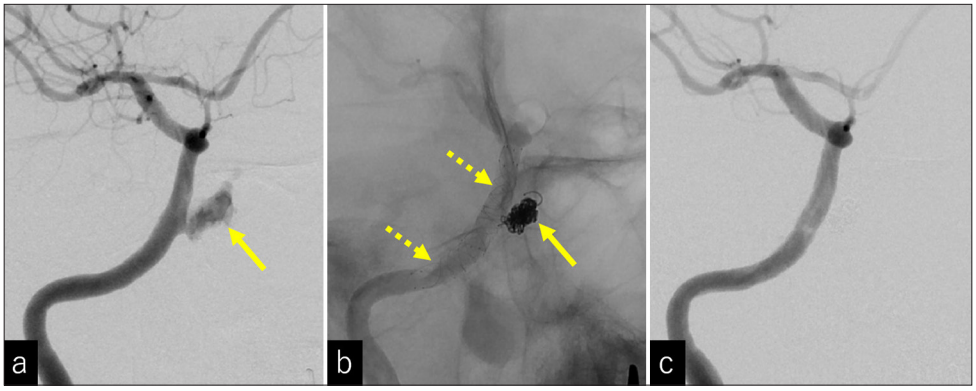

Figure 2: (a-c) Oblique views of the right internal carotid arteriography in (a) before, (b) during, and post (c) coil embolization, showing a medially projecting, irregularly shaped leak of contrast on the medial aspect of C4 segment (a, arrow), embolized coils (b, arrow) through two-ply stents deployed from C3 to C5 (b, dashed arrows), and complete elimination of the aneurysm (c).

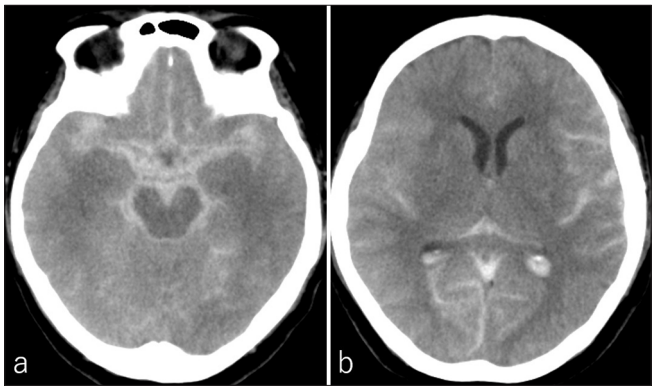

Figure 3: (a and b) Cranial computed tomography performed on postoperative day 1 showing diffuse subarachnoid hemorrhage without ventricular dilation.

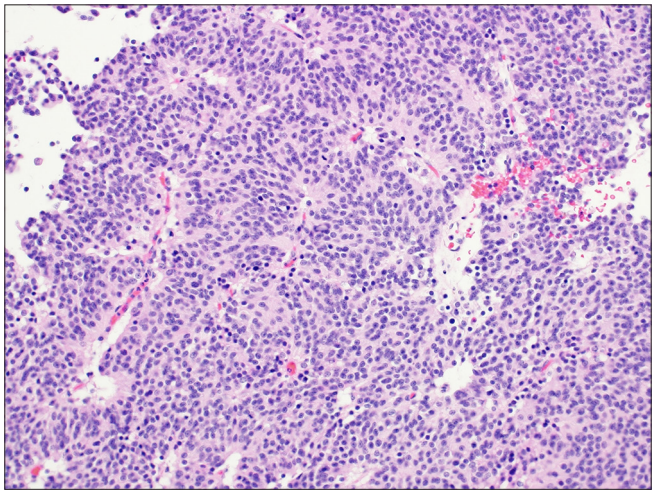

Figure 4: Photomicrograph of the resected specimen showing tumor cells with oval-shaped nuclei and eosinophilic cytoplasm, arranged in perivascular pseudorosette patterns, within vascularized interstitial tissues. Neither cell atypia nor mitotic figures are observed. Hematoxylin and eosin staining, ×20.

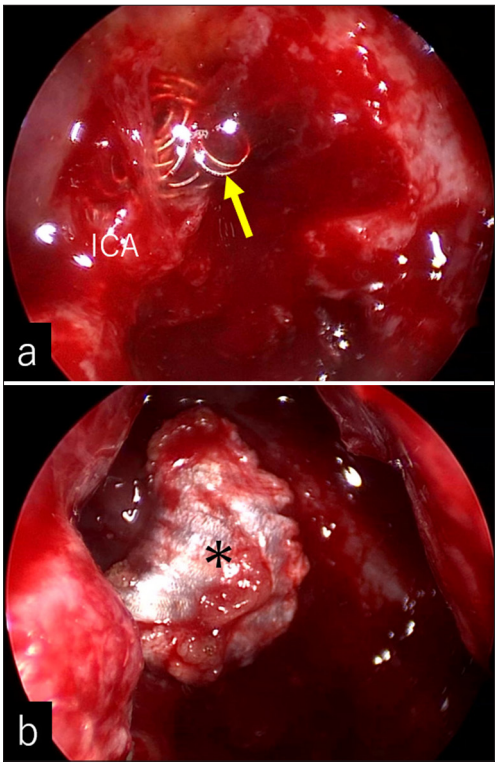

Figure 5: (a and b) Intraoperative photographs during revisional surgery, performed on postoperative day 14, showing embolized coils (a, arrow) partially exposed from the lacerated medial wall of the C4 after removal of cotton patties used for compression hemostasis, then covered with fragments of autologous fascia lata, muscle, and surgical glue (b, asterisk). ICA: Internal carotid artery

mandatory, especially around the ICA segments in the cavernous sinus. Immediate bleeding control, endovascular management, and consideration of revascularization surgery are essential to prevent catastrophic outcomes of ICA

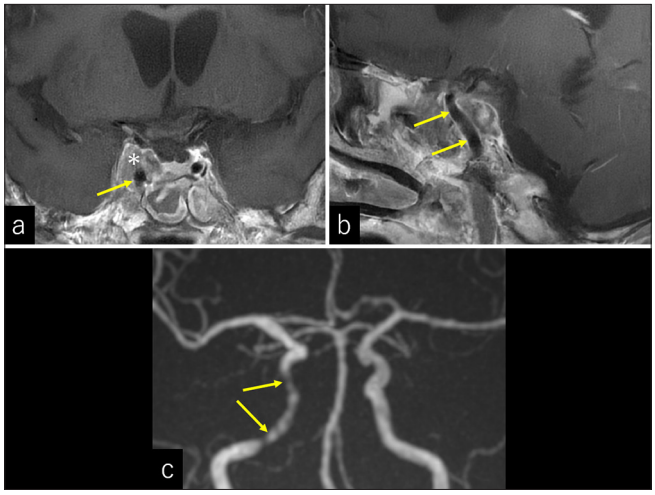

Figure 6: (a and b) Contrast-enhanced (a) coronal and (b) sagittal T1-weighted magnetic resonance (MR) images, performed on postoperative day 21, showing the patent cavernous portion of the right internal carotid artery (*arrows*). (c) Anteroposterior view of the cerebral MR angiography showing irregular flow in the right C3–C5 segments (*arrows*), while flows in other segments of the internal carotid, anterior cerebral, and middle cerebral arteries are intact. *Asterisk:* Residual tumor in the cavernous sinus.

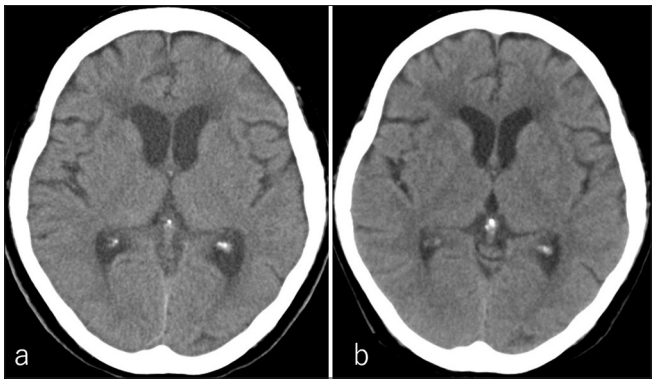

Figure 7: (a and b) Computed tomography performed on (a) postoperative day (POD) 48 and (b) POD 59 showing resolution of ventricular dilation after placement of lumboperitoneal shunt.

injury.[3,5,8] In our case, prompt bleeding control was not amenable due to technical difficulty, resulting in significant blood loss before temporary hemostasis was achieved. Regular training using models to control profuse ICA bleeding can aid in preparing for such events.[6] In contrast, coil embolization combined with stenting was successfully performed without any adverse events. Previous studies have documented satisfactory outcomes of endovascular therapy for ICA injuries associated with transsphenoidal surgery without requiring subsequent revascularization.[3,5,8] Endovascular therapy can be the first line of treatment for most ICA injuries. In the present case, revascularization was unnecessary because the flow in the affected ICA segments was maintained. In our case, diffuse subarachnoid hemorrhage was present on CT performed after ICA injury. Given the ipsilateral oculomotor nerve paresis presented after the surgery, profuse bleeding from the intracavernous ICA and following compression maneuver might have injured the fibrous tissue adjacent to the oculomotor cistern, a small cistern surrounding the intracavernous segment of the oculomotor nerve and communicating with the basal cistern. A large amount of hemorrhage might be spread into the cranial cavity through the cistern.

The petrous and cavernous segments of the adult ICA are frequently tortuous and exhibit significant variability in length and angulation. Furthermore, longer ICAs are more tortuous with acute bends.[12] These anatomic characteristics increase the difficulty of gaining intraoperative proper orientation in the cavernous sinus and raise the risk of ICA injury during surgical manipulations, especially when tumorous lesions invade the sinus. Preparation of temporal clipping is a preventive act when exposing the anterior loop and paracavernous ICA for possible ICA laceration. When such a laceration has happened, compressing on the neck can be effective.

Stereotactic radiosurgery is effective in managing recurrent or residual nonfunctioning pituitary adenomas and achieving high tumor control rates.[1] In our case, ICA injury occurred by an inadvertent scrapping of the wall in the narrow space of the cavernous sinus. To prevent such injury, gentle manipulation, conservative resection, and consideration of postoperative stereotactic radiosurgery may be a valid treatment strategy for pituitary adenomas invading the cavernous sinus. In our case, the embolized coils were partially exposed from the lacerated ICA wall, which was covered with a fragment of autologous fascia lata and surgical glue. Long-term follow-ups are required to evaluate the durability of this approach.

CONCLUSION

During transsphenoidal surgery, ICA injury can result from inadvertent manipulation using a microsuction device. Careful manipulation and conservative resection followed by stereotactic radiosurgery may be a valid strategy for managing pituitary adenomas invading the cavernous sinus. Endovascular therapy is valuable for treating ICA injuries occurring during transsphenoidal surgery.

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