Article published online: 2024-09-16

Case Report

Intraoperative Incidental Internal Carotid Artery Injury in Extended Endoscopic Endonasal Approaches—Causes, Prevention, and Management: A Technical Note

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Indian J Neurosurg

Abstract

In spite of good anatomical awareness, the position of internal carotid artery (ICA) can be tricky in an intraoperative setup with disease causing very significant distortion of anatomy and shift of carotid artery and its branches. A 45-year-old gentleman presented with complaints of left hemicranial headache and painless progressive vision loss in both eyes (left more than right) for 8 months. A probable clinico-radiological diagnosis of meningioma was reached. Intraoperatively, bleeding occurred from left side ICA, control of which was achieved using a long gauze piece used as conventional nasal pack with crushed muscle beneath the gauze piece along with abdominal fat, which was further reinforced with Surgicel. The parasellar ICA is the most common segment injured. Dehiscent or bulging canal of ICA, presence of pseudoaneurysm, attachment of sphenoid septae to the canal, displacement by the lesion, nonenlarged sella because of small size of lesion or vertically oriented lesions, and vessel wall abnormalities increase the risk of injury. It is very essential to have a preoperative discussion involving the skull base surgeons (neurosurgeons and otorhinolaryngologists), neuroradiologists, and neuroanesthetists regarding the complications expected in the case. In case of ICA bleed, the target should be to achieve a temporary hemostasis. In small tears, cottonoids for pressure and bipolar for cauterization will help stop the bleeding, while in larger tears, giving moderate pressure using crushed muscle and cottonoids to achieve intra-operative hemostasis should be tried. After intraoperative hemostasis, the patient needs to be shifted to angiography suite for endovascular stent placement.

Keywords
- carotid injury
- skull base surgery
- endoscopic endonasal surgery

DOI https://doi.org/10.1055/s-0044-1790533.
ISSN 2277-954X.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

The introduction of endoscopes in anterior skull base surgeries in the last couple of decades has expanded the limits of safe and comfortable access.

The intracranial portion (cavernous segment in particular) of the internal carotid artery (ICA) is the biggest roadblock for anterior skull base surgeons' path to achieve a complete resection of these pathologies. In spite of good anatomical awareness, the position of ICA can be tricky in an intraoperative setup with disease causing very significant distortion of anatomy and shift of carotid artery and its branches.

A discussion of the etiology and management aspects of ICA injury in extended endonasal approaches is thus extremely significant.

Case Report

A 45-year-old gentleman presented with complaints of left hemicranial headache and painless progressive vision loss in both eyes (left more than right) for 8 months. Visual acuity measurement was suggestive of no perception of light on left side while it was 6/9 on right side. Examination of fundi showed presence of optic atrophy bilaterally (more on left side than right). Contrast-enhanced magnetic resonance (MR) imaging of brain was suggestive of plaque-like, homogenous, enhancing lesion along the tuberculum sella. The lesion was isointense on T1-weighted images and hypointense on T2-weighted images. A probable clinico-radiological diagnosis of meningioma was reached.

After getting an informed consent, the patient was planned for an endoscopic endonasal transsphenoidal excision of the tumor. Sellar floor was intact but was found to be thinned out. On removal of the sellar floor, en plaque meningioma was visualized in the sellar region. Tumor was removed in piece-meal manner. Profuse bleeding occurred while tumor was being removed from the left side. Trials were made to stop bleeding with the help of gel foam packs, compressing with colloids, but the attempts were unsuccessful as the packs came out into the suction because of torrential bleed. Subsequently, hemostasis was achieved using a long gauze piece used as conventional nasal pack with crushed muscle beneath the gauze piece along with abdominal fat, which was further reinforced with Surgicel (►**Fig. 1**). Keeping the pack in situ the patient was shifted to digital subtraction angiography (DSA) suite for diagnostic DSA. DSA was suggestive of an injury (partial irregularities) in the left ICA (paraophthalmic segment). A good cross-flow was noted on balloon occlusion test. Thus, the left ICA coiling was done (►**Fig. 2**). The postoperative computed tomography (CT) showed no subarachnoid hemorrhage. Pack removal was done in the operation theater (OT) on the next day (►**Fig. 3**). The patient regained consciousness and was extubated. However, patient sensorium deteriorated by postoperative day 3 and right hemiparesis was noted. Noncontrast CT head revealed developing middle cerebral artery (MCA) infarct. Patient was immediately taken for a superficial temporal artery-MCA bypass. The power improved to 3/5, but then remained the same till discharge. Patient was gradually weaned off ventilator and discharged in conscious oriented status with tracheotomy in situ.

Discussion

A literature review suggests that ICA injuries in transnasal extended endoscopic surgeries are rare, mostly reported as

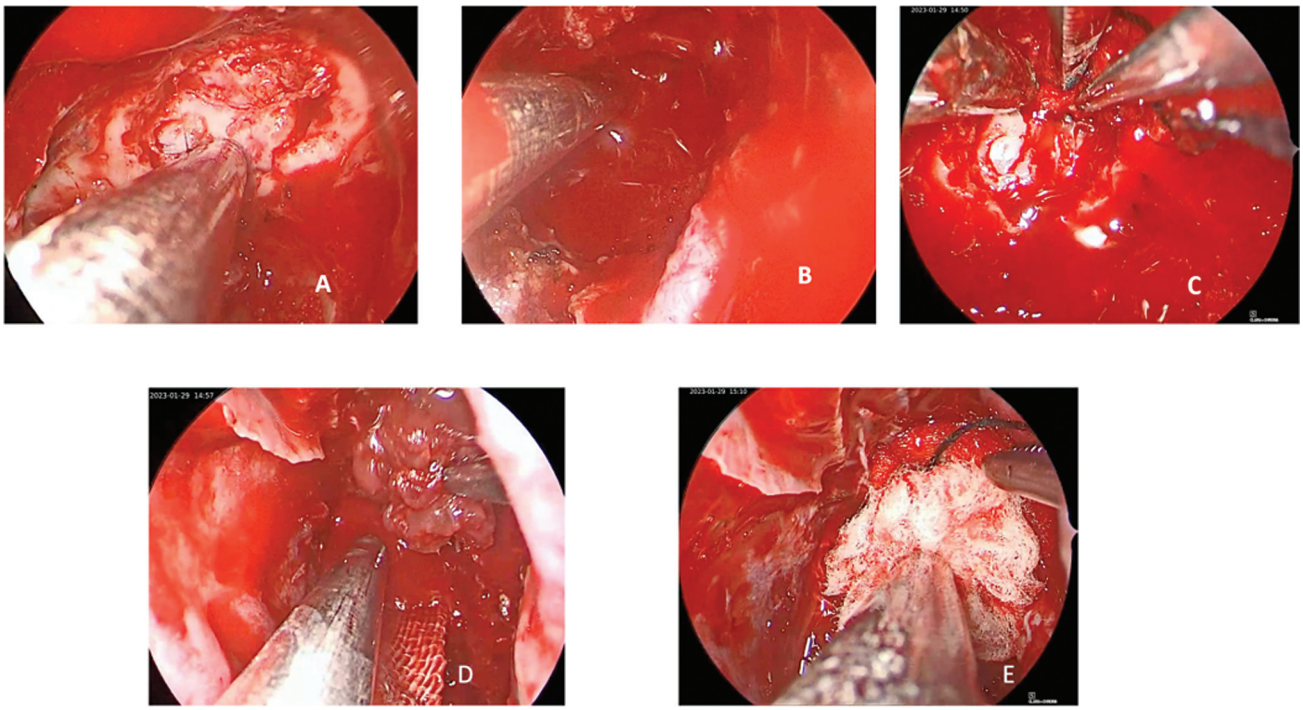

Fig. 1 (**A**) Showing exposure of sella, tuberculum sella region. (**B**) Bleed from internal carotid artery (ICA) injury after taking biopsy. (**C**) Primary pack with heavy cottonoids. (**D**) Packing using crushed muscle and nasal pack. (**E**) Further multilayer packing using gel foam and cottonoids.

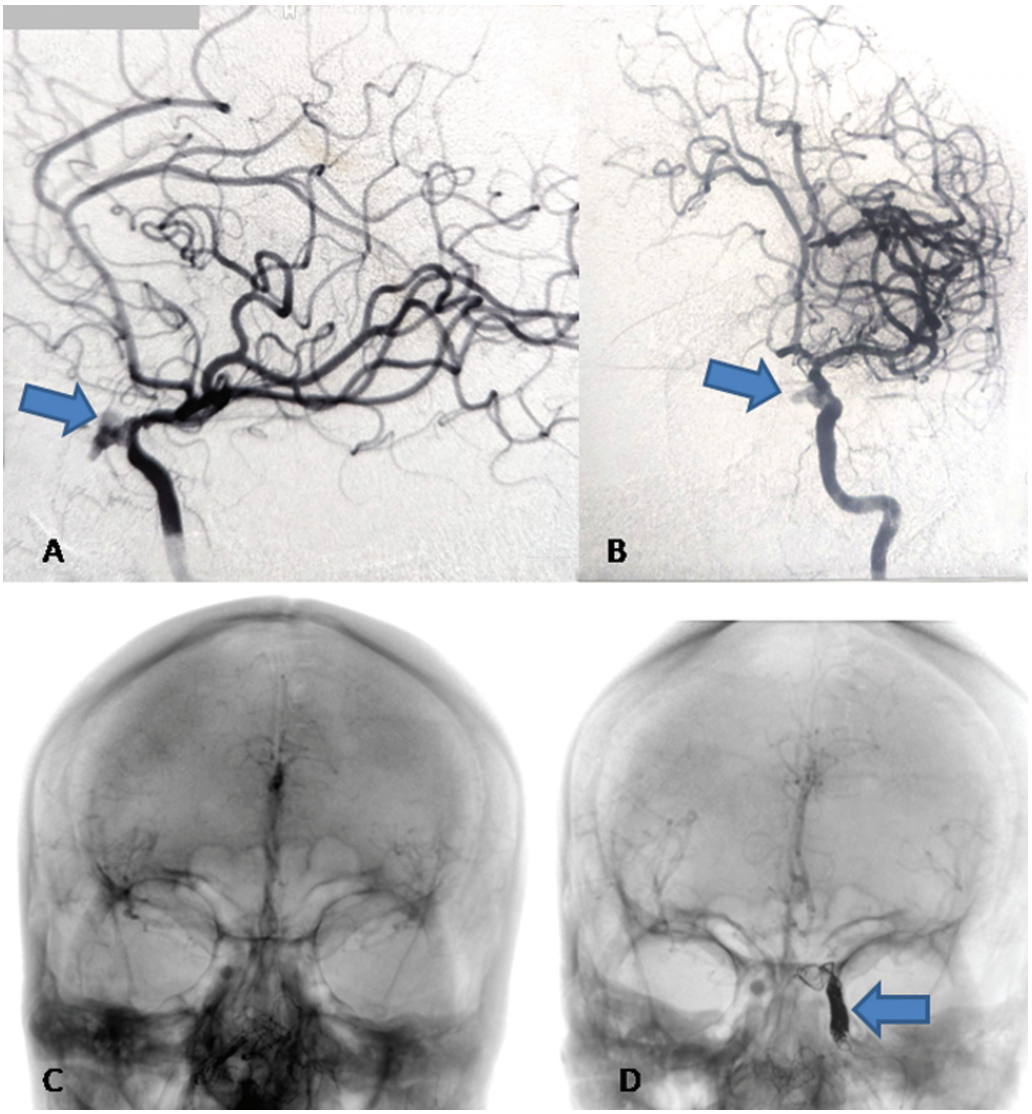

Fig. 2 (**A**, **B**) Digital subtraction angiogram (DSA) (**A**, lateral, and **B**, anterior view) showing contrast leak (arrow) from the ophthalmic segment of internal carotid artery (ICA). (**C**) Balloon occlusion test (DSA, anterior view, right ICA run) showing bilateral filling. (**D**) Post-coiling (left ICA) DSA, right ICA run showing the coils in situ (arrow) and bilateral filling.

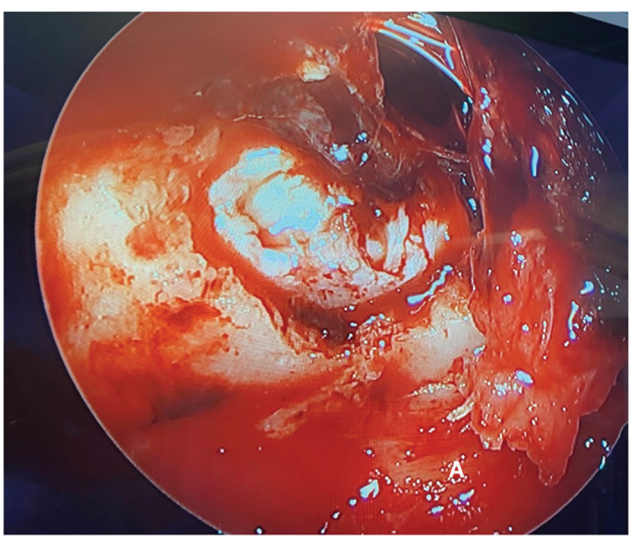

Fig. 3 Endoscopic image showing the post-coiling status of the injured internal carotid artery (ICA) segment following nasal pack removal.

case reports. The percentages are as less as 0.3%.[1] But there is a very high possibility of underreporting as evident from anonymous surveys which reports rate up to 12%.[2] Reports also suggest that around 52% of surgeons who have done more than 500 procedures have faced ICA injury at least once in their career.[3]

The parasellar ICA is the most common segment injured.[4] The ICA anatomically lies in the area of interest and encountering ICA in a transsphenoidal surgery is very common. It bulges into the sphenoid sinus in around 70% of the cases and the bony wall is dehiscent in 22%.[4]

Risk Factors

The working corridor in endoscopic endonasal approaches is very small and this makes control or repair of a major vascular injury near to impossible.

Dehiscent or bulging canal of ICA, presence of pseudoaneurysm, attachment of sphenoid septae to the

canal, displacement by the lesion, nonenlarged sella because of small size of lesion or vertically oriented lesions, and vessel wall abnormalities increase the risk of injury. Shortened ICA–nasopharyngeal distance and intercarotid distance are also factors that are found to increase the chances of surgical injury to ICA.[4,5] In our case, it was the small size of the sellar floor which resulted in the complication.

There are certain pathology-related factors which make surgery less safe including history of radiotherapy, history of bromocriptine use, adherence of the lesion to the carotid, erosion of carotid wall, and previous history of extended surgery.[6] While experience of both the surgical and assisting team matters, inadequate preoperative imaging is also an important risk factor. Extra care is also required while using new instruments or while using powered instruments near the skull base.[4] Certain cases are considered "high risk," including cases in which radical resection is planned in spite of encasement by tumor (especially more than 120 degrees) and also cases in which $\geq$ 2 segment exposure of the ICA is required.[6]

Preoperative Preparation—Key to Prevention

It is very essential to have a preoperative discussion involving the skull base surgeons (neurosurgeons and otorhinolaryngologists), neuroradiologists, and neuro-anesthetists regarding the complications expected in the case. In the designated "high-risk" cases it is advisable to get a CT or MR angiography.[6] It is also necessary to get a balloon test occlusion (BTO) to have an idea about the collateral circulation.[7] In high-risk cases where the balloon occlusion test is negative, preoperative stenting can be considered and if stenting is not possible a surgical bypass should be planned.

Neck, thigh and abdomen should be draped and prepared before the procedure is started as there remains no time to prepare these areas once rupture has already occurred. At least 4 units of packed red blood cells should available in the OT. Two wide bore cannulas along with an arterial line should be placed. A central venous catheter may be placed, preferably in the femoral vein.[6]

The use of image guidance in reducing the risk of carotid injury is controversial, especially in primary cases. It can be a useful adjunct along with acoustic Doppler, especially in revision cases. An endoscopic lens cleaning system, if available, would make life easy for the surgeon in case of bleed. It is also of utmost importance to securely place flaps, so as to prevent them from getting sucked into suction or blocking the scope while the surgeon is trying to improve visualization by suctioning.

Intraoperative monitoring especially in the form of somatosensory evoked potential or electroencephalogram is found to provide real-time feedback regarding cerebral perfusion and can be an additional tool in helping the surgeon decide whether to preserve or sacrifice the ICA.[8]

Intraoperative Management of ICA Bleed

In case of an unfortunate event of ICA injury, the whole team needs to chip in to make sure of the safe patient outcomes. The operation room team needs to double check the availability of the instruments and hemostatic materials, make warm saline available, keep two powered suction tubing ready, empty the suction jars, and confirm the functioning of the electrical devices. The availability of space to maneuver in the form of "two nostril four handed" approach also helps. The endovascular team needs to be informed. The anesthesia team needs to take care of the fluid resuscitation and make sure the patient is normotensive or in some cases in controlled hypertension. It is essential to avoid hypotension so as not to compromise on the cerebral perfusion.[3,6]

Meanwhile, the surgeons need to visualize the area of injury. This is extremely difficult once the injury has occurred. Two wide-bore suctions need to be employed. The target should be to achieve a temporary hemostasis—as soon as possible. Multiple strategies have been described for the same. In small tears, using cottonoids to give pressure and using bipolars have been recommended. In larger tears, cottonoids and crushed muscle are to be used for giving moderate pressure for hemostasis. Fibrin, gel foam, and aneurysm clips have also been used. The use of morselized gel foam and attempts at suturing are not recommended.[4,6,9] Sometimes none of these techniques might work, as in our case we failed three times to seal the rent as the cottonoids was getting sucked into suction every time the field was cleared. Hence, we resorted to inserting a large gauze piece soaked in warm saline which did not come out while suctioning the blood. Simultaneously, we could also identify the site of tear, vis-à-vis, it gave an access to put the sealing material beneath it without disturbing the area much while keeping bleeding under control by giving pressure using suction tip.

Heparin infusion can be used so as to prevent formation of thrombus. Adenosine-induced temporary cardiac arrest has also been described.[9]

After intraoperative hemostasis, the patient needs to be shifted to angiography suite for endovascular stent placement. Even in patients tolerating BTO, attempts should be made to avoid ligation of ICA.

Conclusion

The adage of "prevention is better than cure" holds true in case of ICA injuries during extended endoscopic endonasal approaches. The whole team needs to be prepared for any eventuality before any extended endonasal procedure which can make handling this dreaded complication, in case it happens, easier. Adequate preoperative analysis of imaging for aberrant anatomies is important. The role of anesthetists and interventional radiologists in effective and safe handling of ICA injuries cannot be overstated.

Conflict of Interest
None declared.

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