Internal carotid artery injuries secondary to endonasal surgery

TO THE EDITOR: We read with great interest the article by Sylvester et al.2 (Sylvester PT, Moran CJ, Derdeyn CP, et al: Endovascular management of internal carotid artery injuries secondary to endonasal surgery: case series and review of the literature. J Neurosurg [epub ahead of print January 15, 2016. DOI: 10.3171/2015.6.JNS142483]). They report on their experience in treating 7 internal carotid artery (ICA) injuries after endonasal surgery, and extensively review the literature on management of similar cases.

Iatrogenic ICA injury is an uncommon but potentially lethal complication that all skull base surgeons try to avoid. We share the authors’ opinion that ICA sacrifice, although providing confident hemostasis in acute ICA injury, carries significant risk of cerebral ischemia either immediately or in a delayed manner. This is evident in their literature review of patients who received endovascular ICA sacrifice after ICA injury. While none of the patients experienced a recurrence of bleeding, as many as 21.7% developed permanent neurological complications. With this in mind, vessel preservation should be attempted whenever possible to maintain adequate cerebral perfusion.

Nevertheless, we would like to provide a cautionary note regarding the use of stents in reconstructing the ICA, in particular the flow diverters in the setting of carotid pseudoaneurysms around the skull base. In their paper, Sylvester et al. reported a total of 5 cases in which the ICA pseudoaneurysm was reconstructed with the Pipeline Embolization Device (PED; Covidien Vascular Therapies) and all patients achieved satisfactory outcome without neurological complications. Our experience had been less reassuring in this regard. We recently reported 7 patients who suffered from carotid pseudoaneurysms related to skull base tumor treatment in whom we reconstructed the ICA using the PED. Although all patients attained hemostasis without recurrence of pseudoaneurysm, 1 developed perioperative ischemic stroke, 1 developed delayed infarct at 10 months, and 2 patients developed asymptomatic delayed ICA thrombosis at 5 and 8 months after PED placement, respectively.3 Alarming, 1 of the patients who had delayed ICA thrombosis in the series presented subsequent with PED extrusion and dislodgement from the nasopharynx (Fig. 1). This patient was initially treated with 3 PEDs in telescoping fashion for the pseudoaneurysm at the laceral ICA. The bleeding was controlled without neurological deficit, but the ICA was found to be occluded at 5 months. The PEDs eroded through the occluded ICA and extruded completely 2 years after initial treatment, fortunately without rebleeding. This case highlights the potential risks regarding the use of PEDs and stents in reconstructing ICA pseudoaneurysms where there is a lack of a true vessel wall, especially in cases with a weakened skull base related to surgery or radiation.

Extracranial-intracranial (EC-IC) bypass, on the other hand, provides a healthy alternative conduit to maintain cerebral perfusion while completely excluding the perforated ICA segment from circulation, and had been shown to achieve satisfactory outcome by Rangel-Castilla et al.1 In light of the above experience with PEDs, we have now adopted an approach to manage ICA pseudoaneurysms with endovascular flow diverters or stents only in the acute setting, utilizing the advantage of satisfactory hemostasis and flow preservation. This is followed by early EC-IC bypass together with trapping of the diseased ICA segment once the patient is stable and the primary disease under control.

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FIG. 1. Left: Plain CT scan of the brain showing PEDs in situ over the left laceral and cavernous ICA (arrow). Right: Plain CT scan of the brain of the same patient 2 years after PED extrusion from the nasopharynx, confirming the absence of flow diverters along the ICA (arrow).
While this is obviously not optimal, it is important to recall that among the patients who developed occlusions, these occurred at 5, 7, and 10 months after treatment with the PED. This latter patient experienced a lacunar infarct near the time of the discovered occlusion. One other patient had multiple bilateral, not unilateral, strokes and had the opposite ICA previously occluded. This patient underwent angioplasty and stenting of a more proximal lesion prior to placement of the PED. While the 3 occlusions are bothersome, as are the 2 infarctions (only 1 of which had an occlusion), there are several problems with their technique to consider.

Given the outcomes in their series of 7 patients, Tsang and colleagues recommend initial endoluminal vessel repair followed by EC-IC bypass and vessel trapping for sacrifice when there is iatrogenic injury to the ICA during surgery. This bypass strategy is similar to the methodology described by Rangel-Castilla et al. One wonders about the technical ease and safety of bypass in the type of patients in the series of Tsang et al., 3 of whom died from tumor progression. The quality of the recipient and donor vessels certainly could be unfavorable in patients with malignancy who had undergone prior surgery and radiation treatment of the head and neck.

In the Tsang et al. article, the authors hypothesize that the high rate of ischemic complications was potentially due to 1) delayed repair of the endothelium secondary to radiotherapy, 2) inadequate platelet regimen, and 3) use of multiple PEDs. It is our opinion that the high rate of PED failure in Tsang and colleagues’ cases was likely related to the prior radiotherapy effect, and possibly due to inadequate antiplatelet therapy. The patients received a clopidogrel loading dose, and received 75 mg of clopidogrel for at least 1 week afterward. In the cardiology literature it is well known that at least 30% of Asians are resistant to clopidogrel. It is also known that neointimal hyperplasia can be related to platelet deposition. All of our patients treated with the PED are maintained on aspirin and clopidogrel for a minimum of 6 months and if there is any observed narrowing (all angiographically confirmed), the aspirin and clopidogrel are continued. It is understandable that Dr. Tsang and his colleagues were worried about hemorrhage in their group of patients who were ill and had threatened carotid blowouts. However, none of their patients suffered bleeding from the pseudoaneurysm and all had the aneurysm obliterated as demonstrated on the available follow-up evaluations.

In our study and review, we reported on 5 cases of iatrogenic ICA pseudoaneurysms sustained during surgery (4 cases after transsphenoidal surgery, 1 case after endoscopic sinus surgery). None of these patients received radiotherapy or had ICA infections, both of which can cause disintegration of the vessel wall that is fundamentally different than the puncture or tear caused during surgery. Furthermore, typically our patients were generally in good health, with benign tumors (pituitary adenomas) rather than the more malignant tumors described in the report of Tsang and colleagues. Similar to the study of Tsang et al., a case was previously reported from our institution in which the PED was used in the setting of an ICA with poor vessel integrity, and a different etiology (osteomyelitis of the skull base) rather than malignancy. This did not provide a durable solution, and 12 days later after another hemorrhage, sacrifice of the ICA was performed.

Cases reported in our review also had a more aggressive antiplatelet medication regimen, likely with a lower risk of bleeding than cases reported by Tsang et al. Cases from our study and from Amenta et al. received preprocedural dual antiplatelet medication confirmed by Verify

**References**


**Disclosures**

The author reports no conflict of interest.

**Response**

Thank you for the opportunity to respond to Dr. Tsang’s letter regarding our paper “Endovascular management of internal carotid artery injuries secondary to endonasal surgery: case series and review of the literature.” The main concern raised in the letter relates to PED use for endoluminal repair of ICA pseudoaneurysms. The letter author states that concerns originate from their own published experience in 7 cases for which the PED was used for ICA pseudoaneurysms in patients with nasopharyngeal carcinoma that had undergone prior treatment with surgery and neck irradiation. The experience of Tsang and colleagues with the use of the PED for pseudoaneurysms is certainly of interest to this topic, but we believe that it is important to remember that Dr. Tsang’s 7 patients with radiation to the skull base were ill with threatened ICA “blowouts,” and that 3 of these patients died of progressive disease. In comparison, our series of patients with iatrogenic injuries did not harbor malignancies, but rather had benign pituitary adenomas, and had not undergone prior radiation.

In the series from Dr. Tsang and colleagues the patients received antiplatelet medications immediately prior to the procedure followed by a shortened course of dual antiplatelet medications (clopidogrel 1–4 weeks and aspirin 6 months) due to perceived risk of bleeding from pseudoaneurysm, necrotic nasopharynx, and recurrent nasopharyngeal carcinoma. Four cases had unintended outcomes, including 1 with periprocedural ischemic stroke, 1 with delayed ischemic infarct 10 months after PED placement, and 2 with asymptomatic PED occlusions. One of the PED occlusions subsequently extruded into the nasopharynx. While this is obviously not optimal, it is important to remember that this patient did not suffer a hemorrhage.

One of the patients in the series of Dr. Tsang and colleagues was treated successfully despite what is, in general, considered to be a contraindication to treatment with the PED, i.e., a previously placed covered stent. In the 3 patients who developed occlusions, these occurred at 5, 7, and 10 months after treatment with the PED. This latter patient experienced a lacunar infarct near the time of the discovered occlusion. One other patient had multiple bilateral, not unilateral, strokes and had the opposite ICA...