Prevention and Management of Vascular Injuries in Endoscopic Surgery of the Sinonasal Tract and Skull Base

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- Vascular injury • Carotid artery injury

In the past 2 decades, endoscopic sinus surgery has been widely used as a safe and effective treatment for disorders of the paranasal sinuses that are refractory to medical therapy. Advances in surgical technique, including powered instrumentation and stereotactic image-guided surgery, have improved the efficiency and safety of this procedure. These techniques have been further expanded to manage skull base pathologies. This expansion has been facilitated by a better understanding of the endonasal skull base anatomy. Despite these advances, complications are still encountered. Vascular injuries are particularly troublesome. In a recent issue of this journal, Welch and Palmer[1] extensively discussed interior ethmoid artery injuries during sinus surgery that led to orbital hematoma. Therefore, this article focuses mainly on inadvertent carotid artery injuries during routine sinus surgery and vascular injuries during endoscopic skull base surgery.

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OVERVIEW

Avoidance of unintentional injury and complications is an important cornerstone of surgery. The introduction of minimally invasive techniques in any surgical subspecialty has been universally associated with a higher frequency of surgical complications. This increase in complications during the implementation of new techniques, commonly known as the learning curve, can be reduced through proper training and mentorship that promotes and facilitates sequential and progressive learning. Despite its minimally invasive connotation, endoscopic endonasal surgery presents many of the risks and potential for major complications associated with open approaches. Inexperience and lack of proper training with new instruments or techniques, and disorientation with the endoscopic anatomic perspective, are important factors leading to catastrophic vascular injuries.

Although endoscopic sinus surgery has become the standard of care and is taught in residency training programs, endoscopic endonasal skull base surgery is a relatively new concept. In the authors' experience, including more than 1400 endoscopic endonasal skull base surgeries, the incidence and morbidity of catastrophic vascular complications compares favorably with those of traditional approaches. However, otolaryngologists must recognize that endoscopic and traditional approaches are often complementary, and therefore their indications and limitations preclude a direct comparison.

INCIDENCE OF COMPLICATIONS

The literature contains sparse case reports of carotid injuries during endonasal endoscopic surgery;[2–8] however, the true incidence of all vascular injuries during endonasal endoscopic surgery is unknown. In one literature review, Koitschev and colleagues[4] identified 26 cases of carotid artery injuries during sinus surgery, with only 8 occurring during endoscopic sinus surgery. Two additional reports, totaling 3 cases, have since been published.[2,3]

The advent of endoscopic skull base surgery added another level of complexity to endoscopic endonasal procedures, begging the question of whether this operation is associated with an increased incidence of vascular complications. Kassam and colleagues[9] reviewed the early experience at the University of Pittsburgh Medical Center to determine the incidence and nature of complications during endoscopic skull base surgery. Intraoperative vascular injuries were rare and included seven major vascular complications (0.9%). The vascular complications encountered during the first 800 cases performed by the authors' group are listed in **Table 1**. One patient experienced an avulsion of a P1 perforator during the resection of a craniopharyngioma. Two patients experienced an internal carotid artery (ICA) injury, and one an avulsion of the ophthalmic artery. All injuries were controlled intraoperatively before the patients were transferred to the endovascular suite for additional control or sacrifice of the vessel. None of these four patients sustained a new permanent deficit, although the patient with the PCA branch injury had a stroke with a severe aphasia that eventually recovered completely.

The remaining three patients sustained permanent neurologic deficits (0.4%). One patient experienced an avulsion of a frontopolar artery (A2) during the resection of an olfactory groove meningioma. Approximately 2 weeks later, the patient experienced a frontal lobe hemorrhage from a pseudoaneurysm, which required sacrifice of the A2 and the recurrent artery of Huebner, leading to a permanent right hemiparesis and cognitive deficit. Another patient who underwent resection of a clival chordoma with brainstem involvement experienced a delayed postoperative pontine