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Operative Techniques in

Neurosurgery

Endoscopic, Expanded Endonasal Approach to the Jugular Foramen

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A fully endoscopic, completely transnasal approach to the jugular foramen has been developed. Technical nuances are discussed outlining the operative technique using this approach to resect a variety of tumors affecting the jugular foramen. An illustrative case of a large recurrent glomus jugulare tumor is used to describe the expanded endoscopic endonasal approach to the jugular foramen. Key anatomic considerations, equipment and patient outcomes are reported. The operative technique is described in stepwise fashion using intraoperative photographs and schematic illustrations. The endoscopic endonasal approach provides complete access to the jugular fossa.
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Tumors involving the jugular foramen range from "benign" paragangliomas, originating in the glomus jugular and jugular bulb to lower cranial nerve schwannomas, meningiomas, chordomas, and malignant nasopharyngeal carcinomas. Treatment for these tumors primarily consists of surgical resection and radiation therapy. In the last few decades, both forms of therapy have been improved with a significant decrement in related morbidity and mortality. The introduction and refinement of microsurgical techniques helped popularize skull base techniques in the 1980s.[10] Simultaneously, the development of radiosurgical techniques produced an additional tool that complements surgical resection.[3-5] These advances have provided hope for long-term control and even cure of these tumors with the goal of minimizing neurological complications.

However, given the complex location of these lesions, room remains for improvement. The ideal treatment for many of these lesions remains controversial.[1] Modern microsurgical skull base techniques still require extensive dissections and manipulation of critical neurovascular structures to access lesions, with potential for long operative times and associated morbidities. Furthermore, the risk to lower cranial nerves[6-9] and vascular structures as result of the dissection required for access are significant. Theoretically, minimally invasive strategies may reduce the risk to these structures by reducing the need to manipulate neurovascular structures.

Recent developments in endoscopic technique provide the potential for direct transnasal access to the jugular foramen. This article discusses the technical nuances, operative technique and equipment and outlines the key anatomical steps to access the jugular fossa through the expanded endoscopic endonasal approach.

Case Illustration

A 64-year-old woman with a medical history of left skull base tumor resection sought treatment for left otalgia, face pain, temporoparietal headache, and multiple episodes of recurrent epistaxis. Her prior surgeries included resection of a paraganglioma in 1970 and 1995, including left radical mastoidectomy and obliteration of the left external auditory canal. The patient was anacoustic on the left but otherwise neurologically intact. All other cranial nerve function was intact.

Magnetic resonance imaging (MRI) (Fig. 1A) showed a left parapharyngeal mass. The tubular mass extended along the Eustachian tube, originating and expanding the left jugular fossa with an unusual exophytic growth into the nasopharynx. Given the patient's multiple medical comorbidities, age, and previous surgeries, an EEA approach was selected rather than a conventional skull base approach.

Postoperative MRI (Fig. 1B) confirmed resection of the exophytic nasopharyngeal portion as well as the portion *within* the jugular fossa. Residual enhancement present

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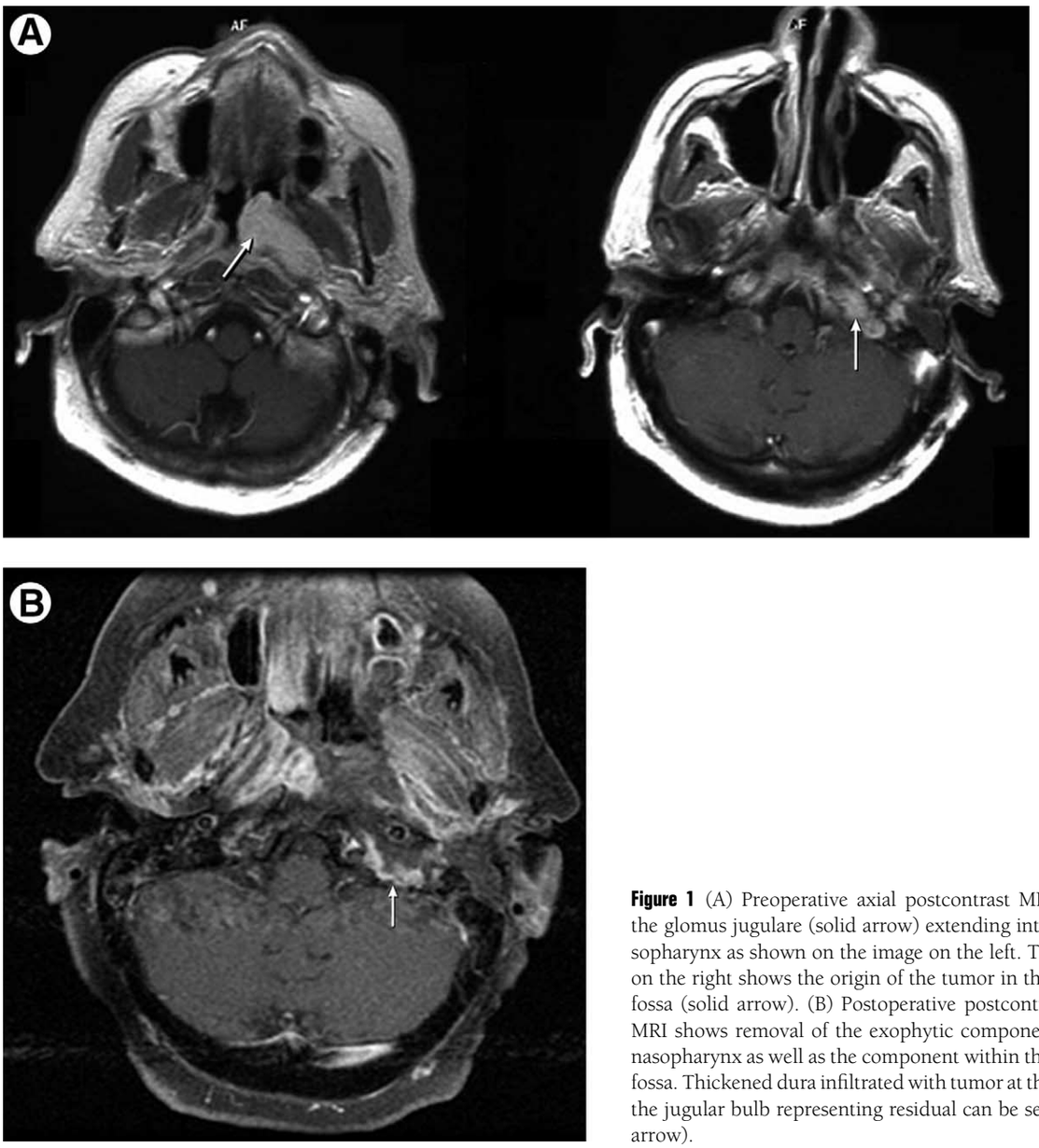

Figure 1 (A) Preoperative axial postcontrast MRI shows the glomus jugulare (solid arrow) extending into the nasopharynx as shown on the image on the left. The image on the right shows the origin of the tumor in the jugular fossa (solid arrow). (B) Postoperative postcontrast axial MRI shows removal of the exophytic component in the nasopharynx as well as the component within the jugular fossa. Thickened dura infiltrated with tumor at the level of the jugular bulb representing residual can be seen (solid arrow).

along the jugular bulb and lower cranial nerves likely represented residual tumor. Given her preoperative function and advanced age, this residual was left intentionally to preserve the patient's lower cranial nerve function. Subsequently, it was treated with Gamma knife radiosurgery. The patient was discharged home the morning after surgery (postoperative day 1). The facial palsy related to the embolization had resolved to House-Brackman grade II at 6 months. At her 1-year follow up, there was no evidence of tumor growth.

Operative Technique

Patient Positioning and Preparation

All patients undergo fine-cut computed tomography (CT) angiography, which is used for frameless stereotactic image guidance during the procedure (Stryker, Kalamazoo, Michigan). After endotracheal intubation the patient is positioned supine, in Mayfield pins in neutral position. Somatosensory evoked potentials, brain stem evoked responses and the electromyographic response of the lower cranial nerves are monitored. At this point, pseudoephedrine-soaked pledget packing is placed in both nares.

Next, the image guidance is registered, with mandatory inclusion of the retromastoid fiducials, to ensure accuracy of less than 2 mm, especially in the area of the jugular foramen. Potential sources of error and means of minimizing them are described in a separate report.[12] Adequate preparation (resoaking the pledget packing) and sterilization (betadine) of the nares are undertaken. The patient is given a fourth-generation cephalosporin antibiotic for perioperative prophylaxis against nasopharyngeal flora.

General Exposure

A zero-degree endoscope with an irrigating sheath is used via a bilateral approach with the endoscope and suction in