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Endoscopic Transvestibular Paramandibular Exploration of the Infratemporal Fossa and Parapharyngeal Space: A Minimally Invasive Approach to the Middle Cranial Base

Jason Y. K. Chan, MBBS; Ryan J. Li, MD; Michael Lim, MD;
Alfredo Quinones Hinojosa, MD; Kofi D. Boahene, MD

Objectives/Hypothesis: To describe a novel transvestibular endoscopic approach for the exposure, exploration, and resection of lesions in the infratemporal fossa (ITF) and parapharyngeal space (PPS).

Study Design: Surgical technique and clinical feasibilty of a novel approach to the middle cranial base.

Methods: The transvestibular endoscopic approach was applied to four patients with lesions involving the ITF and PPS. Through a vertical oral mucosal incision along the ascending ramus of the mandible, an optical corridor to the ITF and PPS was created and maintained with the aid of a Hardy speculum. The contents of the ITF and PPS were explored with the aid of a 0-degree 4-mm rigid endoscope.

Results: Four patients underwent exploration of their right-sided ITF and PPS. The approach provided exposure and access from the middle cranial base at the level of the foramen ovale to the mid-PPS. Branches of the trigeminal nerve in the ITF were safely explored and preserved. Exposure and visualization of the internal maxillary artery and branches were achieved. Of the four patients, two underwent resection of a primary and a recurrent pleomorphic adenoma, one had chronic pain relief from a large synovial chondromatosis, and one had debulking of a recurrent mucoepidermoid carcinoma. The only complications were self-limiting hypoesthesia of the lip in one patient and transient dysphagia in another patient.

Conclusions: The transvestibular endoscopic approach to the ITF and PPS offers direct and minimally invasive access to select lesions within this region. Further use of this approach will allow us to determine its potential and limitations.

Key Words: Endoscopy, infratemporal fossa, skull base, parapharyngeal space.

Level of Evidence: 4.

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INTRODUCTION

The infratemporal fossa (ITF) and parapharyngeal space (PPS) are two intimately related areas in the cranial base with a complex neurovascular anatomy. Lesions occurring in this region are difficult to reach, with lateral approaches to the ITF and PPS often requiring temporalis muscle, parotid gland, and facial nerve mobilization, combined with variations of mandibular and orbitozygomatic osteotomies.[1] Although the transcervical approach provides adequate exposure to the inferior PPS, it is limited in its superior exposure. Sublabial anterior approaches traversing the maxillary sinus spare external incisions and provide excellent access but involve bone removal and disruption of a functioning sinus. At present, the use of rigid endoscopes remains a powerful tool in skull base surgery. Where optical working corridors exist, endoscopic assisted surgery has proven versatile in reaching target lesions along the skull base. In this report, we present our early experience with a novel, minimally invasive, transvestibular endoscopic approach to the ITF and PPS. We illustrate the technique, surgical corridor, and feasibility of this approach with four clinical cases.

From the Department of Otolaryngology–Head and Neck Surgery (J.Y.K.C., R.J.L., K.D.B.) and Department of Neurosurgery (M.L., A.Q.H.), Johns Hopkins Medical Institutions, Baltimore, Maryland, U.S.A.

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Send correspondence to Kofi D. Boahene, MD, FACS, Department of Otolaryngology–Head and Neck Surgery, Johns Hopkins Medical Institutions, 601 N. Caroline Street, Suite 6240, Baltimore, MD 21287. E-mail: dboahen1@jhmi.edu

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MATERIALS AND METHODS

Surgical Anatomy

Anatomically, the ITF is bordered superiorly by the greater wing of the sphenoid bone with its foramina (ovale, rotundum, and spinosum) and the zygomatic arch; inferiorly by fascicles of the medial pterygoid muscle (MPM); medially by the pterygoid processes, tensor veli palatine muscle, and the anterior half of the fibers of the MPM (with its fascia); laterally by the medial surface of the ascending ramus of the mandible; anteriorly by the maxillary tuberosity; and posteriorly by the anterior surface of the parotid gland, posterior fibers of the MPM, and medial pterygoid fascial layer (Fig. 1). The PPS is bordered superiorly by the skull base, anteromedially by the superior constrictor muscle, laterally by the MPM, inferiorly by the greater cornu of the hyoid bone, and posteromedially by the prevertebral muscle. The prestyloid PPS is occupied by the retromandibular portion of the parotid gland, fat, and lymph nodes. The poststyloid PPS is traversed by the carotid sheath contents and multiple cranial nerves (Fig. 1).

Fig. 1. High-resolution coronal T1-weighted magnetic resonance imaging of brain and skull base with gadolinium enhancement demonstrating the infratemporal fossa. The greater wing of the sphenoid (GWS) comprises the skull base in this image. The right lateral pterygoid muscle (LPM) and medial pterygoid muscle (MPM) are shown inserting into the mandible at the condyle and angle, respectively. The parapharyngeal space (PPS) is located medial and inferior to the MPM. The pterygopalatine fossa is located medial to the infratemporal fossa and the two spaces are connected by the pterygomaxillary fissure.

Surgical Approach

The surgical corridor begins at the natural bony window between the mandibular ramus and maxillary tuberosity (Fig. 2). Computed tomography and magnetic resonance imaging stereotactic navigation is calibrated for use throughout the case as seen in Figure 3. The patient's head is flexed and rotated toward the side of the lesion for the most ergonomic position. After infiltration of 1% lidocaine with 1:100,000 epinephrine, a 2-cm vertical mucosal incision is made along the ascending mandibular ramus, extending superiorly toward the maxillary tuberosity. The inner aspect of the mandibular ramus then provides a reliable lateral reference point throughout the procedure, as seen in Figures 4A and 4B. Blunt dissection then exposes the temporalis tendon along the coronoid process down to the buccinator line on the mandibular ramus. A long Killian speculum is then introduced to provide retraction for introduction of the endoscope.

From the superior aspect of the incision, prolapsing buccal fat usually obscures the optical corridor and requires lateralization, which is achieved with a Hardy speculum introduced through the Killian speculum that effectively retracts the surrounding soft tissues and creates a wider optical corridor. The first reliable structure to identify endoscopically is the MPM, as seen in Figure 4C. Fibers of the MPM are seen running posterior medially from the lateral pterygoid plate toward the angle of the mandible. Medializing the MPM along its fascial border exposes the inferior alveolar nerve. The inferior alveolar nerve, a key endoscopic landmark, crosses the working corridor obliquely and can be followed superiorly to identify the lingual nerve that is located medially. Both nerves can then be followed superiorly to the foramen ovale as they converge, allowing access to the Gasserian ganlion (Fig. 4D).[2]

The lateral pterygoid muscle (LPM) occupies most of the ITF, as can be seen in Figure 5A. As the LPM is exposed and manipulated, the pterygoid plexus of veins and branches of the maxillary artery comes into view. The veins are cauterized, clipped, or controlled with hemostatic agents. The inferior alveolar artery may be isolated and retracted, as seen in Figure 5B. The lower head of the LPM is the next main structure along the surgical corridor. The lower head of LPM arises from the lateral surface of the lateral pterygoid plate and runs horizontally towards the mandibular condyle. The inferior alveolar and lingual nerves can be followed around the lower head of the LPM to reach the foramen ovale. Dividing the pterygoid muscle exposes the roof of the ITF and the middle meningeal artery entering the foramen spinosum (Fig. 6). Posteromedial pulsation from the C1 segment of the internal carotid artery (ICA) is

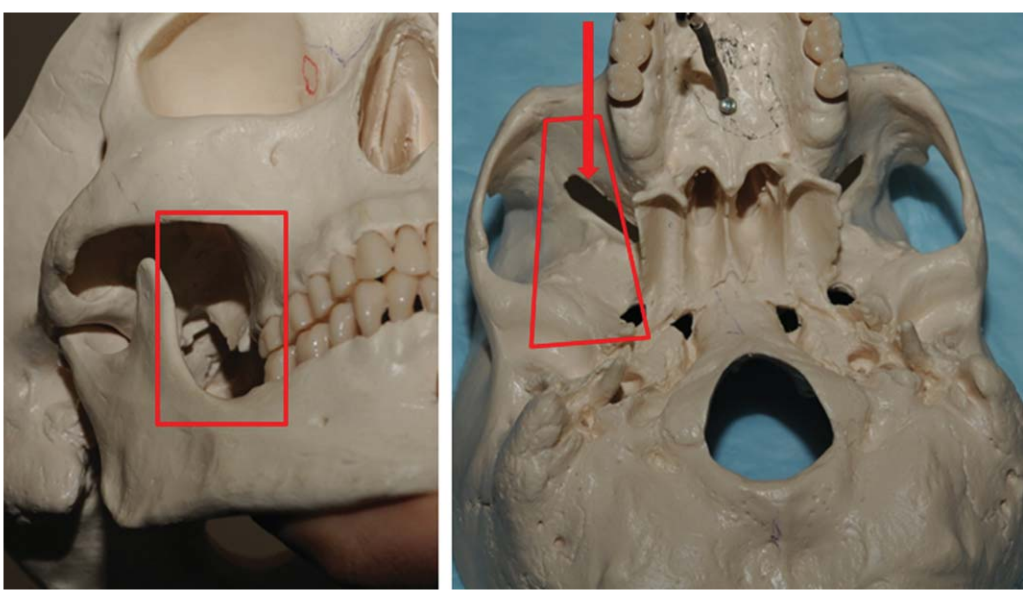

Fig. 2. The figure on the left demonstrates the trajectory of the transvestibular approach that is bounded laterally by the ramus of the mandible. In the figure on the right, the infratemporal fossa is identified by the trapezium; seen also are the pterygoid plates medially and the foramen ovale posterior to the arrow. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

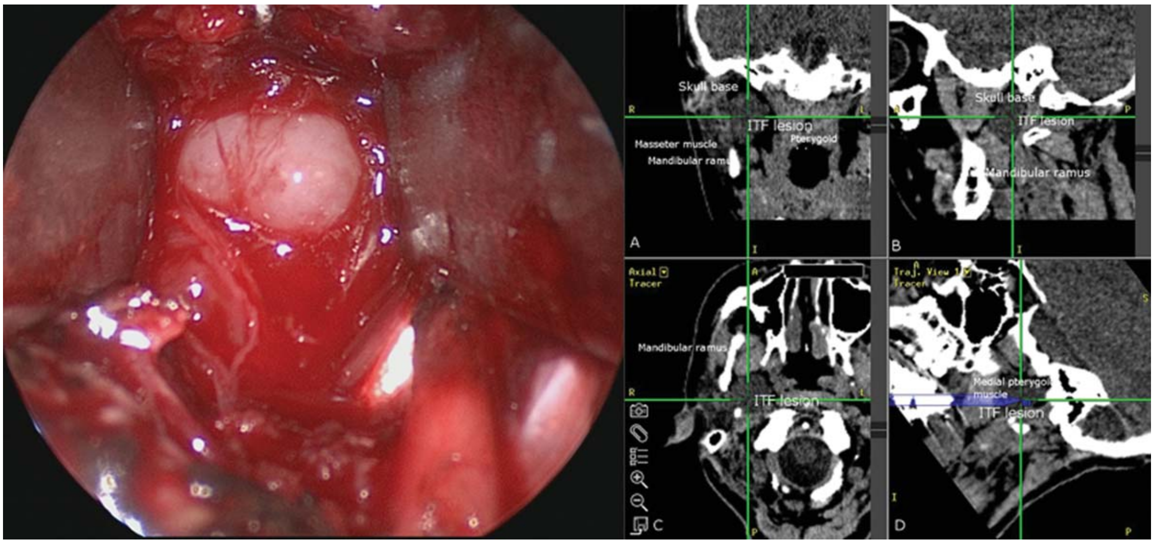

Fig. 3. Intraoperative computed tomography–guided navigation for tumor localization. The left image demonstrates the infratemporal fossa lesion (ITF), and the right image demonstrates the corresponding navigation probe crosshairs centered on the right ITF lesion, with adjacent anatomic structures labeled. (A) coronal view; (B) parasagittal view; (C) axial view; (D) view along the trajectory of the straight probe. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

present between the foramen ovale and eustachian tube, deep to a generous fat pad. To visualize the foramen rotundum or vidian canal, removal of the pterygoid muscles and drilling of the lateral pterygoid plate with the aid of angled endoscopes and instruments is necessary.

The PPS lies behind the ITF and is bounded anteriorly by pterygomandibular raphe. Consequently, to expose the PPS from the ITF, it is necessary to traverse the MPM and the medial pterygoid fascial layer.

Endoscopic assisted tumor dissection within the ITF and PPS can be achieved in various ways depending on the goals of surgery and consistency of the lesion, as illustrated with Figures 5C and 5D. Large tumors in the IFT tend to be intimately involved with the LPM and extend into the PPS through the

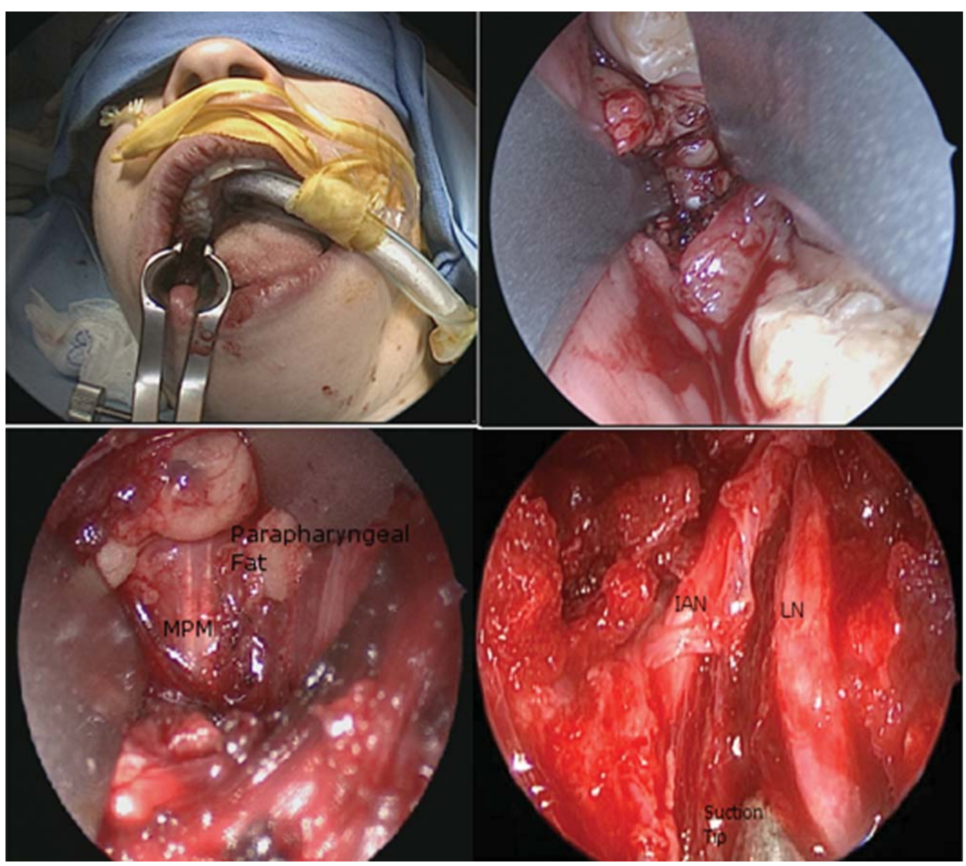

Fig. 4. (A) The left upper image showing initial patient setup with endotracheal tube taped away from operative side and retractor in place following initial incision onto the mandibular ramus. (B) Right upper image with view following initial incision onto mandible ramus through the transvestibular approach. (C) Left lower image showing endoscopic corridor to the infratemporal fossa through the masticator space. The medial pterygoid muscle (MPM) and parapharyngeal fat are illustrated. (D) Right lower image showing that after medialization of the MPM, the right inferior alveolar nerve (IAN) is seen traveling anterolaterally to enter the mandibular foramen. The lingual nerve (LN) is seen more medially. A blunt suction tip gently dissects between the two nerves. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

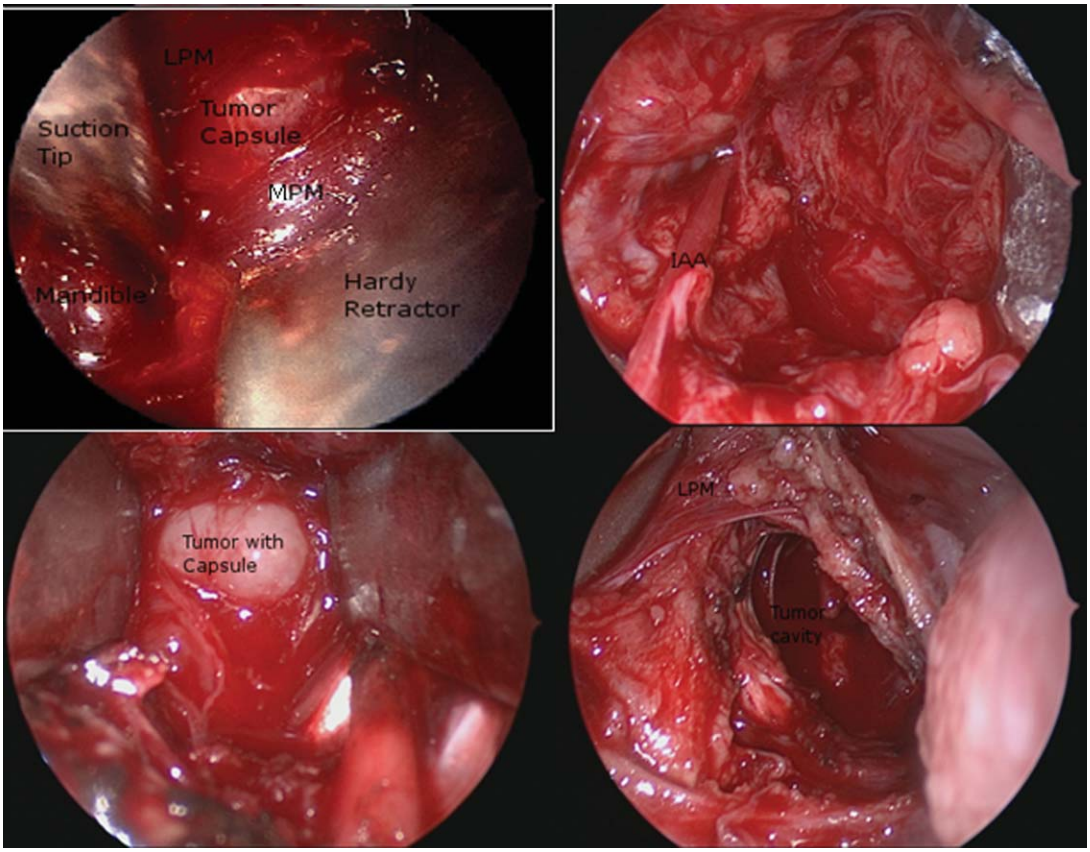

Fig. 5. (A) Left upper image with endoscopic view of right masticator space leading to the right infratemporal fossa; right medial pterygoid muscle (MPM) traveling obliquely to insert in right angle of mandible. Also seen is the lateral pterygoid muscle (LPM) traveling posterolaterally to insert into the mandibular condyle and displaced by tumor. (B) Right upper image showing the inferior alveolar artery (IAA) branch of the internal maxillary artery is shown, as it courses toward the mandibular ramus. (C) Left lower image showing tumor with capsule intact. (D) Right lower image following resection of tumor with resultant cavity and LPM visible. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

MPM, as seen in Figure 6. Fibers of the pterygoid muscles are often stretched and thinned out by the tumor, which facilitates their endoscopic dissection. In well-defined and encapsulated lesions, blunt dissection around the capsule or pseudocapsule frees up the tumor for removal in one piece. In less-defined lesions, sharp dissection from the surrounding muscle may be necessary. In our cases, we found the Sonopet (Stryker, Kalamazoo, MI) useful, with piecemeal removal of large tumors, starting from the core of the tumor creating a larger space to facilitate peripheral dissection.

RESULTS

Excellent access and exposure of tumors involving the PPS and ITF in four patients was achieved using this approach. The craniocaudal endoscopic range extended from the mid-PPS, at a level below the mandibular angle inferiorly to the greater wing of the sphenoid bone superiorly, with safe dissection and functional preservation of major neurovascular structures. The four patients in the series are presented in Table I.

DISCUSSION

Our early experience with the transvestibular endoscopic approach to the ITF and PPS shows that it is

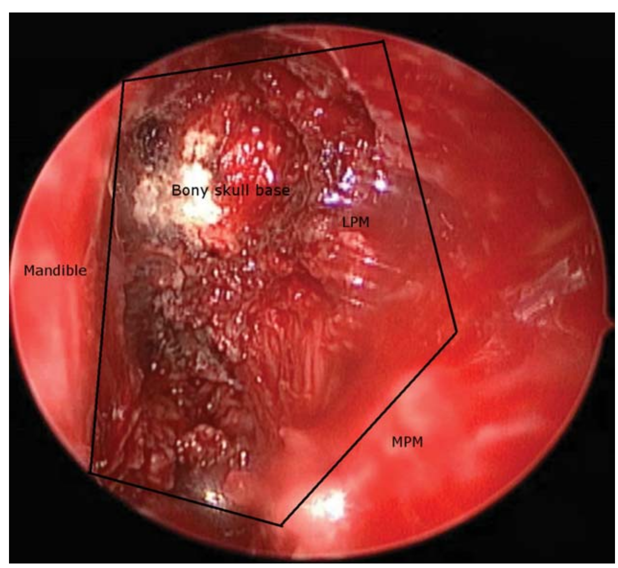

Fig. 6. Surgical corridor outlined by black lines. This figure demonstrates the exposed bone of the infratemporal skull base after tumor ablation. LPM = lateral pterygoid muscle; MPM = medial pterygoid muscle. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

TABLE I.
Patient Demographics, Presentation, Diagnosis, and Complication.

Patient No.	Age (yr)/Sex	Presentation	Pathology	Preoperative Diagnosis	Complication
1	20/F	Incidental finding on MRI	Pleomorphic adenoma	Enlarging mass on MRI	None
2	59/M	Right-sided facial pain	Synovial chondromatosis	Possible neuroma on biopsy	Transient numbness of lower lip
3	74/F	Right lower lip numbness	Mucoepidermoid carcinoma	Recurrent mucoepidermoid carcinoma	Transient dysphagia
4	54/M	Recurrent parapharyngeal mass on MRI	Pleomorphic adenoma	Recurrent pleomorphic adenoma	None

F = female; MRI = magnetic resonance imaging; M = male.

feasible and facile in exploring a difficult-to-reach anatomic region. The approach is minimally invasive and provides excellent endoscopic visualization, with less morbidity when compared to traditional open approaches to the ITF and PPS. The approach, as presently described, appears ideal for lesions that are benign and have defined capsules or pseudocapsules, biopsy of malignant lesions, trigeminal nerve exploration for rhizotomy or biopsy. As we gain more experience with this approach, it may be possible to expand the extent of dissection to include the entire ITF and a large portion of the PPS. Endoscopic exposure, manipulation, and control of major vessels in this area are important. Although the pterygoid plexus of veins are easily controlled with hemostatic agents, major arteries should be retracted out of the field or clipped with the long endoscopic clip applicator. Potential limitations of the procedure include en bloc resection of tumors, when oncologically desired, particularly when tumor is engulfing a displaced carotid artery.

The feasibility of endoscopic exploration and resection of PPS and ITF lesions have been demonstrated with endoscopic and robotic surgery.[3–9] Although all dissections performed in the four cases presented here were performed with the 0-degree 4-mm endoscope (Karl Storz, Tuttlingen, Germany), angled and three-dimensional endoscopes can aid further exploration of the ITF and PPS. Maintaining a wide open optical cavity in the ITF and PPS is paramount, and we have adapted the Killian and Hardy retractors commonly used in transnasal surgery for this purpose. The ease of inserting and repositioning the endoscope via the transvestibular route helps provide some degree of depth perception and allows tactile feedback.

The safe endoscopic exploration of the IFT and PPS requires a three-dimensional understanding of the anatomy of this area. Exposing the MPM first directs subsequent dissection, with the inferior alveolar nerve the next key structure to be exposed that can be followed to the skull base. Although the lingual nerve can similarly be traced back to the foramen ovale, one should be wary of the chorda tympani branch of the facial nerve joining the lingual nerve underneath the LPM. Blunt dissection of the LPM, where possible, should be used to preserve the muscle fibers and minimize postoperative trismus. Some degree of early postoperative trismus should be expected, and patients should be advised to start early postoperative jaw stretching exercises.

Recently, Abuzayed et al. described an endoscopic dissection to the ITF through a lateral sublabial incision in three cadaver specimens.[2] They presented this as a potential approach to the foramen ovale for accessing the Gasserian ganglion during rhizotomy for trigeminal neuralgia. The access incision in the lateral sublabial approach is limited to the zygomatico- maxillary junction and provides direct entry to the IFT at a much higher level than we have described. In this case, the LPM and branches of the maxillary artery are the first structures encountered. Extending the exposure inferiorly as we have described provides and even wider range with access to the PPS.

A detailed endoscopic anatomic review of the PPS was recently published by Dallan et al.,[10] showing the spatial relationship between the neurovascular structures in the parapharyngeal space. The cadaveric study by Dallan et al. approached the PPS from its medial aspect through a palatal and a glossopharyngeal arch incision. As in our approach, these authors recognized the pterygoid muscles as key surgical landmarks in further exploring the parapharyngeal space.

The endoscopic transvestibular approach described here takes advantage of a natural bony window and corridor to the ITF and parapharyngeal spaces without the need for bone removal. The opening to this surgical corridor is limited medially and laterally by the maxilla and mandibular ramus but is adequate for simultaneous introduction of an endoscope and additional instruments. Similar to other endoscopic keyhole approaches, the optical cone of light from the endoscope provides a broad and excellent visualization along the surgical corridor beyond the relative limited bony window. Access to PPS below the level of the mandibular angle is limited. In large lesions extending below the mandibular angle, the advantages of the transvestibular approach may be used as an adjunct to the traditional transcervical approach to limit more extensive surgery. Compared to the more open lateral approaches to the IFT and parapharyngeal space, the transvestibular endoscopic approach is limited in its ability to control the C1 segment of the ICA. Therefore, the use of neuronavigation is advisable as one dissects beyond the pterygoid muscles to allow accurate identification of the ICA. Hemostatic agents and tissue sealants used in standard endoscopic transnasal skull base surgery such as thrombin and microfibrillar collagen hemostats should also be available.

CONCLUSION

The transvestibular endoscopic approach to the ITF and PPS is a minimally invasive option for exploring this difficult to access area. For selected lesions, this approach may offer the clear advantage of a shorter less morbid surgery with quicker recovery compared to traditional lateral and anterior approaches.

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