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Review

Endoscopic Transoral Surgery for Skull Base Tumors

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ABSTRACT

Endoscopic transoral surgery constitutes a significant advancement in the management of complexpathologies involving the nasopharynx, parapharyngeal space, and ventral skull base. This minimally invasive approachutilizes natural orifices to access regions traditionally requiring extensive external dissection, thereby reducing morbiditywhile maintaining oncologic efficacy. Technological integration—including high-definition endoscopy, robotic assist-rhhzhyphen↲ance, and augmented navigation—has expanded the applications of endoscopic transoral surgery from initial diagnosticprocedures to sophisticated multiportal resections. Future advancements in flexible robotics and bioengineered-reconstruction promise to overcome current spatial constraints. This review synthesizes anatomical principles, technicalinnovations, clinical outcomes, and evolving paradigms, establishing endoscopic transoral surgery as the standard of carefor selected ventral skull base pathologies.

KEYWORDS

endoscopic transoral surgery, skull base tumor, nasopharyngeal carcinoma, craniovertebral junction, parapharyngeal space

1 Introduction

The nasopharynx and ventral skull base present one of anatomy's most formidable surgical challenges—a confined space sheltering the internal carotid artery (ICA), lower cranial nerves, and critical aerodigestive pathways. Historically, accessing this region required destructive open approaches such as the maxillary swing or mandibulotomy, which carried substantial morbidity, such as facial scar, cranial nerve injury, chronic trismus, and velopharyngeal insufficiency due to extensive osteotomies and soft tissue disruption[1]. While endoscopic endonasal techniques offered minimally invasive alternatives, their utility remained constrained above the nasopalatine line[2].

The transoral approach provides a direct, midline corridor to the ventral skull base, craniovertebral junction (CVJ), nasopharynx, and parapharyngeal spaces, avoiding external incisions and significant neurovascular displacement[2]. Its evolution, particularly with endoscopic and robotic assistance, has transformed the management of complex pathologies in this anatomically challenging region. This review examines its evolution, technical foundations, and expanding role in modern skull base oncology—where anatomic constraints are transformed into surgical opportunities.

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2 Clinical Applications

2.1 Nasopharyngeal tumors

The nasopharynx presents significant surgical challenges due to its deep central location and proximity to critical neurovascular structures like the ICA, cranial nerves, and the skull base. Traditional open approaches provide wide exposure but carry substantial morbidity. With the rapid advancement of endoscopic skull base surgery techniques and instruments, a novel classification of transnasal endoscopic nasopharyngectomy (TEN) was proposed in 2021[3]. In this study, type I TEN referred to the resection of nasopharyngnx, sphenoid sinus, ethmoid sinus, nasal cavity, and/or oropharynx; type II TEN referred to the resection lateral extended to parapharyngeal space and pterygoid structures; type III TEN referred to resction of the lateral petroclival region, infratemporal fossa, middle cranial fossa (epidural), orbit and superior orbital fissure, cavernous sinus, and cranial nerves outside the cranium; and the type IV referred to exposure/resection of the extracranial ICA, and/or intracranial structures. The 2-year overall survival for type I, type II, type III, and type IV was 79.8%, 100%, 68.0%, and 100%, respectively[3].

Despite its notable benefits, the TEN still presents certain limitations, particularly when a nasopharyngeal lesion extends inferior to the palatal plane into the parapharyngeal space, laterally into the infratemporal fossa (ITF) or posteriorly to involve the ICA, optimal visualization and control of key surrounding structures surrounding the tumor are limited with an endoscopic transnasal (ETN) surgery[4].

In contrast, the endoscopic transoral (ETO) approach exploits the natural oropharyngeal corridor, providing direct axial access to the tumor-ICA interface. Anatomical cadaveric studies established the feasibility of minimally invasive transoral routes, primarily via the PPS to access the nasopharynx, ITF, and skull base[5]. Crucially, they demonstrated that endoscopic transoral nasopharyngectomy allows early identification and proximal control of the parapharyngeal ICA, a vital step for safe resection of tumors extending inferolaterally below the palatal plane or involving the ICA. Surgical freedom and angles of attack were found to be greatest at the anterior genu of the ICA, facilitating instrument maneuverability[5].

The da Vinci system's 3D magnification, tremor filtration, and EndoWrist articulation enhance precision in the deep nasopharynx. Described initially by Wei et.al.[6] in 2010 and refined by Kang et al.[7] in 2020, transoral robotic surgery (TORS) typically employs a lateral palatal flap (avoiding central split fistulas) to expose the tumor. It was suggested that TORS is suitable for small, centrally or laterally located recurrences not abutting the ICA or bone with minimal blood loss and acceptable functional outcome[7]. Combining TORS with endonasal endoscopy proved effective for complex benign conditions like nasopharyngeal stenosis, offering unparalleled access and precision[8]. Similarly, the transnasal-transoral double endoscopic approach uses simultaneous nasal and oral endoscopes for 360° visualization, facilitating en-bloc resection of nasopharyngeal tumors while preserving turbinates and palate[9,10].

Transoral approaches, underpinned by detailed anatomical studies and powered by endoscopic and robotic technology, represent a paradigm shift in managing select nasopharyngeal pathologies. They offer a critical balance between adequate oncologic resection and minimized morbidity, particularly valuable in the salvage setting after radiotherapy. While promising, long-term oncologic outcomes and wider applicability for larger tumors or those involving critical vessels need further validation. Continued refinement of techniques, instrumentation, and reconstruction will likely expand their role in skull base surgery.

2.2 Tumors in retropharyngeal space

Retropharyngeal lymph node (RPLN) metastasis represents a critical prognostic determinant in nasopharyngeal carcinoma (NPC), with MRI-documented incidence rates of 63.4%–88.6%[11]. Its anatomical position—medial to the ICA and adjacent to cranial nerves IX–XII—complicates management. RPLN metastasis independently reduces 5-year overall survival (72.2% vs 58.7%) and distant metastasis-free survival (84.6% vs 75.0%) compared to non-RPLN-involved NPC[12].

The traditional maxillary swing approach achieves 59% 5-year disease control but causes disfiguring morbidity, such as 40.8% middle ear effusion, 11.2% trismus, 10.9% palatal fistula, and 7.1% facial numbness[13]. Transcervical endoscopic approach reduces external trauma and achieves 63.9% 2-year locoregional relapse-free survival in NPC patients with RPLN recurrence, but it is associated with 19.4% dysphagia and 9.7% shoulder dysfunction[14]. TORS is another less invasive and safer option, but it lacks tactile feedback and struggles with RPLN localization in confined spaces[15]. These constraints necessitated minimally invasive alternatives enabling precise ICA visualization and RPLN targeting.

The ETO approaches, specifically the transoropharyngeal[16] and transoral medial pterygomandibular fold[17] approaches, address these limitations by leveraging natural anatomical corridors. The transoropharyngeal approach prioritizes minimal access trauma but is restricted to smaller nodes (< 1.5 cm) without ICA encasement[16]. In contrast, the transoral medial pterygomandibular fold approach demonstrates broader applicability. To identify retropharyngeal lymph nodes by transoral medial pterygomandibular fold approach, dissect posteriorly along the lateral surface of the superior pharyngeal constrictor to expose the longus capitis muscle; the nodes lie anterolateral to this muscle (defining their medial margin) and are bordered laterally by the ICA, which marks their lateral boundary[17]. It could resect nodes up to 26.4 mm with ICA encasement through meticulous landmark dissection and intracapsular resection when adhesions precluded en-bloc removal[17]. The transoropharyngeal cohort (n = 25) achieved 100% R0 resection and outstanding 2-year outcomes (relapse-free survival: 100%, overall survival: 91.5%) with minimal morbidity (12% grade 1)[16]. The transoral medial pterygomandibular fold series (n = 6) confirmed complete resection via postoperative MRI, managing complications conservatively (one transient Horner's syndrome)[17]. Critically, zero ICA ruptures occurred in both studies, underscoring the safety of their respective ICA management protocols[16,17].

These advantages of endoscopic transoral approach for retropharyngeal lymph node dissection include a shorter surgical path, quick exposure of the carotid sheath and pharyngeal lymph nodes, full exposure of the cervical internal carotid artery while protecting it, minimal trauma, preservation of normal tissue structures and physiological function, no need for bone grinding, reduced bleeding, faster recovery, and clear visualization of anatomical structures through good nasal endoscopic lighting conditions. Remaining challenges of the endoscopic transoral approach include technical expertise demands, long-term survival validation, and optimizing adjuvant therapies for systemic control.

2.3 Tumors at craniovertebral junction

The surgical management of craniovertebral junction (CVJ) pathologies has evolved significantly, with approaches categorized into ventral, lateral, and dorsal routes[18]. Chordomas exemplify the formidable challenges inherent to this region due to their ventral midline location, proximity to critical neurovascular structures (vertebral arteries, brainstem, spinal cord), and aggressive local behavior[18]. While en-bloc resection is ideal, as gross total resection is the strongest predictor of progression-free and overall survival, anatomical constraints typically necessitate maximal safe intralesional resection followed by high-dose adjuvant radiotherapy to optimize outcomes given high recurrence risks[19].

There is considerable overlap at the pharyngeal level in the structures that can be viewed by the transoral and transnasal routes[20,21]. However, the cadaveric study showed the working corridor of ETO (41.6 mm wide) is significantly broader than the ETN route (18.7 mm), enhancing instrument maneuverability[21].

For strictly midline chordomas involving the clivus and upper CVJ down to the C2 body (above the nasoaxial line), the ETN approach provides a direct anatomical corridor with superior visualization[20,22,23]. However, ETN exposure faces significant anatomical constraints. Inferiorly, access is restricted anteriorly by the nasal cartilages, limiting downward angulation of the endoscope below the level of the hard and soft palates, and posteriorly by the hard palate (typically situated at the level of the C1 anterior arch). While a straight endoscope reaches the anterior arch of C1 and adjacent C2 body, angled endoscopes can extend this inferior limit to the lower edge of the C2 body. Superiorly, the exposure extends to the cribriform plate. Laterally, access is constrained beyond the parapharyngeal space/ICA.

The traditional transoral approach serves as a direct anatomical corridor to the anterior CVJ, accessing structures from the lower clivus to the C3 vertebral body. For lesions extending below the nasoaxial line (C1-C3), the ETO approach represents a significant advancement. The ETO approach integrates the established transoral surgical corridor with endoscopic visualization, specifically targeting midline, extradural CVJ and upper cervical spine pathologies ventral to the spinal cord where pure ETN is limited. Its fundamental advantage is vastly improved visualization compared to the standard microscopic transoral approach. Angled endoscopes provide a wider, magnified, and panoramic view deep within the operative field, illuminating critical recesses and angles (e.g., superior dens, lateral C1-C2 joints) difficult to visualize microscopically[3].

The ETN and ETO offer significant advantages for the management of clival chordomas. While the ETN tends to displace fewer structures, the ETO provides adequate exposure to the lower third of the clivus. Selection between ETN and ETO hinges on careful assessment of patient anatomy, lesion extent, and the balance of risks and benefits. Importantly, combining ETN and ETO provides significantly better access to the midline anterior CVJ than either approach alone[21,24,25]. This combined strategy allows endoscopes to be advanced in one cavity (e.g., nasal) and surgical instruments in the other (e.g., oral), synergistically enhancing visualization and working space while reducing or eliminating the need for palate splitting, glossotomy, or mandibulotomy. Complex tumors spanning multiple anatomical compartments (e.g., extensive clivus-C2 lesions with lateral spread) often require staged or simultaneous combined approaches (e.g., ETN + ETO) to achieve the goal of maximal safe resection.

2.4 Tumors in parapharyngeal space

The parapharyngeal space is an inverted pyramid extending from the skull base to the hyoid bone, anatomically divided into prestyloid (containing fat, salivary rests, lymphatics) and poststyloid (containing the neurovascular bundle and lower cranial nerves) compartments by the styloid diaphragm[26]. Pathology within this deep space is rare (0.5% of head and neck tumors) and predominantly benign (80%–90%)[26,27]. Common pathologies include salivary gland tumors (pleomorphic adenomas are most frequent), neurogenic tumors (schwannomas from cranial nerves IX-XII or sympathetic chain, paragangliomas), vascular malformations, and rare entities like glial heterotopia[26,27]. The most common symptoms are external or intraoral masses, and complete surgical resection is the mainstay of treatment[26,27].

Management of the ICA within the parapharyngeal space presents a significant challenge. Conventional approaches, including cervical, transparotid, and cervical-parotid, are associated with substantial surgical scar and suboptimal visualization[28]. The endoscopic transnasal transpterygoid and ETO approach provides detailed exposure of the parapharyngeal space with distinct advantages and limitations. The endoscopic transnasal transpterygoid approach offers direct access to the upper parapharyngeal space but is constrained inferiorly by the hard palate and laterally by the medial and lateral pterygoid muscles[2]. The ETO approach optimally targets the lower parapharyngeal space but struggles to expose the region around the Eustachian tube[2]. Critically, during the ETO approach, the styloglossus and stylopharyngeus muscles serve as the safe anterior boundary of the parapharyngeal ICA. Direct access to the ICA is achieved by dissecting between the stylopharyngeus muscle and the superior pharyngeal constrictor muscle[2]. Furthermore, a combined endoscopic transnasal transpterygoid and ETO approach effectively eliminates the anatomical barrier posed by the hard palate, enabling exposure of the entire parapharyngeal space contents without disturbing critical neurovascular structures[2].

Comprehensive mastery of parapharyngeal space anatomy is paramount to avoiding ICA injury. While structures like the Eustachian tube, longus capitis muscle, and levator veli palatini muscle can partially identify segments of the parapharyngeal ICA, the "ICA window" provides a critical, reliable surgical landmark[29]. This window is defined by muscular and fascial structures, with the parapharyngeal ICA lying posterior to the ICA window (directly behind the stylopharyngeal fascia), with the stylopharyngeal muscle anterolateral, the levator veli palatini muscles anterosuperior, and the longus capitis posteromedial to it (Figure 1)[29]. Image guidance and intraoperative Doppler ultrasound are essential adjuncts for navigating complex anatomy and positively identifying the ICA during dissection.

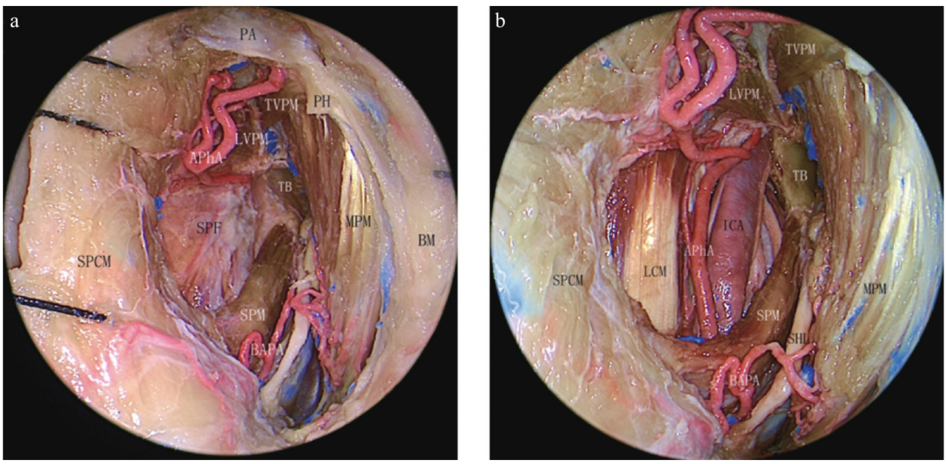

Fig. 1 Anatomical landmarks of the ICA window in ETO surgery. (a) ICA window directly behind the stylopharyngeal fascia (SPF). (b) Key landmarks of ICA window, including the stylopharyngeal muscle (SPM), the levator veli palatini muscles (LVPM), and the longus capitis muscle (LCM). APhA, ascending pharyngeal artery; BAPA, branch of ascending palatine artery; BM, buccal mucosa; LVPM, levator veli palatini muscle; MPM, medial pterygoid muscle; PA, palatine aponeurosi; PH, pterygoid h amulus; SHL, stylohyoid ligament; SPCM, superior pharyngeal constrictor muscle; SPF, stylopharyngeal fascia; SPM, stylopharyngeus muscle; TB, tympanic bone; TVPM, tensor veli palatini muscle; IX, glossopharyngeal nerve.

Careful patient selection is critical for ETO approach success. Based on clinical practice, inclusion criteria typically include[30]: main body (> 50%) of the PPS tumor located below the level of the hard palate; lateral tumor boundary not exceeding the mandibular ramus; intact tumor capsule without adhesion to vital neurovascular structures; benign pathology (excluding paragangliomas due to high vascularity); no general contraindications to surgery.

The ETO approach is generally contraindicated for paragangliomas, malignant tumors requiring wide margins, or lesions with significant lateral extension or skull base invasion[30]. For extensive tumors or high skull base extension, a combined endoscopic transnasal transpterygoid and transoral approach creates a multiportal corridor, overcoming the hard palate limitation, enabling comprehensive exposure from the jugular foramen to the hypopharynx[2]. Angled endoscopes (30°/45°/70°) improve visualization of superior recesses. The integration of careful patient selection, surgeon expertise, and technological adjuncts (endoscopy, navigation, Doppler) ensures the ETO approach is a safe and effective primary strategy for managing appropriate parapharyngeal space pathology, balancing oncologic efficacy with minimized morbidity.

3 Conclusion

Endoscopic transoral surgery has redefined the management paradigm for tumors or lesions located in the parapharyngeal space, retropharyngeal space, nasopharynx, and craniovertebral junction. By leveraging the natural oral corridor enhanced by technological synergy—robotic dexterity, augmented navigation, and advanced energy devices —the ETO approach achieves oncologic outcomes comparable to open approaches while reducing morbidity through tissue preservation. Next-generation systems like the SP Da Vinci platform address spatial constraints through single-port access and flexible instruments, while experimental haptic feedback systems restore tactile sensation during dissection.

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Ethical statement

Not applicable.

Conflicts of interest

Professor Hongmeng Yu, Editor-in-Chief of *ENT Discovery*, and Xicai Sun, Associate Editor-in-Chief of *ENT Discovery*, were not involved in the peer-review process or in any editorial decisions regarding this manuscript. The peer-review process was handled independently by other qualified editors to minimize potential bias. All other authors declare that they have no conflicts of interest.

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Data availability statement

Not applicable.

Author contributions

Shixing Zheng, Quan Liu, and Huankang Zhang contributed to the writing of the manuscript and the preparation of anatomical images. Ziping Huang annotated the anatomical images. Kai Xue, Wanpeng Li, Ye Gu, and Xiaole Song participated in the discussion of the manuscript and provided valuable suggestions. Xicai Sun conceived the study. Xicai Sun and Hongmeng Yu supervised the manuscript writing.

References

1. Wei WI, Lam KH, Sham JS. New approach to the nasopharynx: the maxillary swing approach. *Head Neck*. 1991, 13(3): 200–207.
2. Sun X, Yan B, Truong HQ, Borghei-Razavi H, Snyderman CH, Fernandez-Miranda JC. A comparative analysis of endoscopic-assisted transoral and transnasal approaches to parapharyngeal space: a cadaveric study. *J Neurol Surg B Skull Base*. 2018, 79(3): 229–240.
3. Liu Q, Sun X, Li H, et al. Types of transnasal endoscopic nasopharyngectomy for recurrent nasopharyngeal carcinoma: Shanghai EENT Hospital experience. *Front Oncol*. 2020, 10: 555862.
4. Roger V, Patron V, Moreau S, Kanagalingam J, Babin E, Hitier M. Extended endonasal approach versus maxillary swing approach to the parapharyngeal space. *Head Neck*. 2018, 40(6): 1120–1130.
5. Soriano RM, Rindler RS, Helman SN, Pradilla G, Solares CA. Endoscopic transoral nasopharyngectomy. *Head Neck*. 2021, 43(1): 278–287.
6. Wei WI, Ho WK. Transoral robotic resection of recurrent nasopharyngeal carcinoma. *Laryngoscope*. 2010, 120(10): 2011–2014.
7. Kang HJ, Park HJ, Lee DW, Tae K. Feasibility of transoral robotic nasopharyngectomy for recurrent nasopharyngeal carcinoma: how we do it. *Minim Invasive Ther Allied Technol*. 2020, 29(5): 310–315.
8. Wagner RT, Khalili S, Henning B, Mundi NS. A novel technique for nasopharyngeal stenosis repair: combined transoral robotic and endonasal approaches for enhanced visualization and surgical precision. *J Neurol Surg Rep*. 2025, 86(1): e14–e18.
9. Tan Q, Yang Q, Li H, et al. Short-term efficacy of the transnasal-transoral approach to endoscopic nasopharyngectomy for nasopharyngeal adenocarcinoma. *Ann Otol Rhinol Laryngol*. 2023, 132(8): 905–911.
10. Sreenath SB, Rawal RB, Zanation AM. The combined endonasal and transoral approach for the management of skull base and nasopharyngeal pathology: a case series. *Neurosurg Focus*. 2014, 37(4): E2.
11. Coskun HH, Ferlito A, Medina JE, et al. Retropharyngeal lymph

node metastases in head and neck malignancies. *Head Neck*. 2011, 33(10): 1520–1529.
12. Ma J, Liu L, Tang L, et al. Retropharyngeal lymph node metastasis in nasopharyngeal carcinoma: prognostic value and staging categories. *Clin Cancer Res*. 2007, 13(5): 1445–1452.
13. Chan JY, Chow VL, Wong ST, Wei WI. Surgical salvage for recurrent retropharyngeal lymph node metastasis in nasopharyngeal carcinoma. *Head Neck*. 2013, 35(12): 1726–1731.
14. Liu YP, Wang SL, Zou X, et al. Transcervical endoscopic retropharyngeal lymph node (RPLN) dissection in nasopharyngeal carcinoma with RPLN recurrence. *Head Neck*. 2021, 43(1): 98–107.
15. Ding X, Lin QG, Zou X, et al. Transoral robotic retropharyngeal lymph node dissection in nasopharyngeal carcinoma with retropharyngeal lymph node recurrence. *Laryngoscope*. 2021, 131(6): E1895–E1902.
16. Liu YP, Wu HB, Feng ZK, et al. Endoscopic transoropharyngeal retropharyngeal lymph node (RPLN) dissection for RPLN recurrence nasopharyngeal carcinoma. *Ann Surg Oncol*. 2025:1-9.
17. Xue K, Liu J, Liu Q, et al. Anatomical studies and early results on endoscopic transoral medial pterygomandibular fold approach to salvage retropharyngeal lymphadenectomy in nasopharyngeal carcinoma. *J Laryngol Otol*. 2024, 138(5): 540–547.
18. Baldassarre BM, Di Perna G, Portonero I, et al. Craniovertebral junction chordomas: case series and strategies to overcome the surgical challenge. *J Craniovertebr Junction Spine*. 2021, 12(4): 420–431.
19. Zou Y, Neale N, Sun J, et al. Prognostic factors in clival chordomas: an integrated analysis of 347 patients. *World Neurosurg*. 2018, 118: e375–e387.
20. Visocchi M, Iacopino DG, Signorelli F, Olivi A, Maugeri R. Walk the line. *The surgical highways to the craniovertebral junction in endoscopic approaches: a historical perspective. World Neurosurg*. 2018, 110: 544–557.
21. Seker A, Inoue K, Osawa S, Akakin A, Kilic T, Rhoton AL Jr. Comparison of endoscopic transnasal and transoral approaches to the craniovertebral junction. *World Neurosurg*. 2010, 74(6): 583–602.
22. Mangussi-Gomes J, Beer-Furlan A, Balsalobre L, Vellutini EA, Stamm AC. Endoscopic endonasal management of skull base chordomas: surgical technique, nuances, and pitfalls. *Otolaryngol Clin North Am*. 2016, 49(1): 167–182.
23. Chibbaro S, Cornelius JF, Froelich S, et al. Endoscopic endonasal approach in the management of skull base chordomas: clinical experience on a large series, technique, outcome, and pitfalls. *Neurosurg Rev*. 2014;37(2):217–224; discussion 224–225.
24. Tan SH, Ganesan D, Rusydi WZ, Chandran H, Prepageran N, Waran V. Combined endoscopic transnasal and transoral approach for extensive upper cervical osteoradionecrosis. *Eur Spine J*. 2015, 24(12): 2776–2780.
25. El-Sayed IH, Wu JC, Ames CP, Balamurali G, Mummaneni PV. Combined transnasal and transoral endoscopic approaches to the craniovertebral junction. *J Craniovertebr Junction Spine*. 2010, 1(1): 44–48.
26. Riffat F, Dwivedi RC, Palme C, Fish B, Jani P. A systematic review of 1143 parapharyngeal space tumors reported over 20 years. *Oral Oncol*. 2014, 50(5): 421–430.
27. Jiang C, Wang W, Chen S, Liu Y. Management of parapharyngeal space tumors: clinical experience with a large sample and review of the literature. *Curr Oncol*. 2023, 30(1): 1020–1031.
28. Guo D, Sun C, Yin X, et al. A retrospective analysis on the effects and complications of endoscope-assisted transoral approach and lateral cervical approach in the resection of parapharyngeal space tumors. *Comput Intell Neurosci*. 2022, 2022: 7536330.
29. Wang L, Zhang HK, Liu Q, et al. ICA window: a reliable landmark for locating parapharyngeal ICA via endoscopic transoral medial pterygomandibular fold approach. *Laryngoscope*. 2025, 135(8): 2748–2755.
30. Liu J, Liu Q, Sun XC, Yu HM, Wang DH. Endoscopic transoral approach to the parapharyngeal space: technical nuances and preliminary results. *J Laryngol Otol*. 2023, 137(6): 678–684.