Review

Advances in the Application of Transoral Robotic Surgery

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ABSTRACT Transoral robotic surgery (TORS) has progressed from cadaveric feasibility work to an established minimally invasive option for selected lesions of the oropharynx, larynx, hypopharynx, and tongue base. This review examines technical development, currently available platforms, clinical indications, outcomes, and the multidisciplinary conditions required for safe clinical implementation. It draws on landmark and recent studies published through June 21 2026. Multiport da Vinci systems account for most clinical experience. Single-port, modular, flexible, and emerging Chinese platforms are intended to improve access to the upper aerodigestive tract. The most mature evidence concerns carefully selected human papillomavirus (HPV)-associated oropharyngeal squamous cell carcinoma, in which resection provides pathological risk information that may support protocol-based treatment deintensification. Randomized data do not show surgery to be inherently safer or superior to contemporary radiotherapy. TORS can also identify occult primary tumors in the neck; its roles in laryngeal, hypopharyngeal, salvage, and sleep surgery remain less certain. Across indications, value depends on exposure, margin feasibility, vascular planning, rehabilitation, and multidisciplinary case selection rather than on the robot alone.

KEYWORDS
transoral robotic surgery, oropharyngeal neoplasms, head and neck neoplasms, robotics, squamous cell carcinoma, laryngeal neoplasms, hypopharyngeal neoplasms, obstructive sleep apnea

1 Introduction

Natural-orifice approaches seek to reduce morbidity caused by surgical access. In head and neck surgery, the oral route provides direct access but creates a restricted workspace shared by the camera, retractors, instruments, suction, and hemostatic devices[1,2]. Transoral laser microsurgery and transoral videolaryngoscopic surgery showed that selected pharyngeal and laryngeal tumors could be treated without mandibulotomy or pharyngotomy. Their reach, however, is limited by line-of-sight visualization and rigid instrumentation[2].

Transoral robotic surgery (TORS) emerged from pharyngeal and laryngeal cadaveric studies in 2005, followed by early procedures at the tongue base and tonsil and then prospective oncologic feasibility studies[3–6]. A later multicenter series established an important benchmark for selected oropharyngeal cancer[7]. Three-dimensional visualization, tremor filtration, motion scaling, and wristed instruments improve precision after the target has been exposed. They cannot compensate for inadequate access or for a deep margin that cannot be obtained safely.

Exposure remains the limiting step in many cases. Dentition, tongue bulk, mandibular shape, cervical extension, trismus, previous reconstruction, and tumor volume all affect the operative field. The magnified image may make the anatomy appear more spacious than it is; the endoscope, instrument shafts, bedside assistant, smoke, and bleeding still compete within a narrow corridor. Loss of tactile feedback, thermal spread, and restricted access to proximal vascular control remain practical constraints.

Exposure should be regarded as a reproducible precondition rather than a binary finding recorded after anesthesia. A lesion may appear small on imaging yet still be poorly suited to transoral resection because the working angle is unfavorable, the deep plane cannot be defined, or a vessel cannot be controlled promptly. Conversely, a technically accessible lesion may not be a good oncologic or functional candidate. Preoperative assessment should therefore test the whole operative

Article history: Received Aug 9, 2026; Accepted Oct 14, 2026

pathway: exposure, resection, specimen retrieval and orientation, hemostasis, and the feasibility of a rapid rescue maneuver. This distinction helps explain why experience from carefully selected high-volume series may not transfer directly to a new program[7–9].

2 Scope and Literature Update

A concise Chinese-language overview by members of this author group summarized TORS applications through 2025. The present review was written anew in English as a substantively updated and expanded narrative review. It includes a broader platform comparison and new tables on clinical applications and program implementation, while integrating current guidelines, prospective studies, systematic reviews, and informative cohorts. Literature was searched through June 21 2026 using terms related to TORS, single-port and flexible robotics, oropharyngeal cancer, carcinoma of unknown primary, laryngeal and hypopharyngeal disease, hemorrhage, swallowing, obstructive sleep apnea, training, and cost. The search was targeted rather than systematic; pooled estimates from published meta-analyses were presented descriptively and were not recalculated.

3 Robotic Platforms and Access

3.1 Multiport and single-port systems

The da Vinci Si and Xi remain the most widely used multiport TORS platforms. The Si retains useful 5-mm instruments, whereas the Xi provides longer arms and flexible boom positioning; its standard 8-mm instruments can, however, be crowded in the larynx and hypopharynx[8,9]. The da Vinci Single Port (SP) system delivers a flexible camera and three 6-mm instruments through a single 2.5-cm cannula. Comparative reports and pooled evidence suggest more efficient access and fewer collisions in selected cases, but long-term comparative oncologic data remain limited[10–12]. Only early TORS experience has been reported with da Vinci 5, which should not yet be considered a head-and-neck-specific advance[13].

The articulating SP camera can visualize beyond the initial entry axis and leaves room for a dedicated retraction arm. A 2026 synthesis of 479 patients reported low blood loss and no conversion to multiport or open surgery, although operative and hospital outcomes were heterogeneous and follow-up was limited[10]. The available data support technical feasibility and favorable ergonomics. They do not establish equivalence across disease sites, stages, or treatment pathways.

3.2 Modular, flexible, and Chinese systems

Versius uses independently positioned modular arms and an open console. Early IDEAL (Idea, Development, Exploration, Assessment, Long-term study) stage 1/2a studies have shown transoral feasibility, while also identifying limitations in the available instruments and access to the distal tongue base[14,15]. The now-discontinued Flex Robotic System demonstrated the potential value of flexible access to curved upper-airway anatomy[16]. Chinese groups have described flexible-arm systems designed for the laryngopharynx and preliminary domestic single-port experience[17,18]. These systems may broaden access or reduce cost, but the TORS-specific evidence base remains early and should be judged by indication, safety, rescue options, and lifecycle cost rather than docking time alone.

The TORSS flexible-arm robot was developed for laryngopharyngeal anatomy and has been reported in domestic Chinese-language case series of laryngeal and hypopharyngeal lesions[17]. The Jingfeng SP1000 report included only four transoral cases[18]. A Chinese-language domestic narrative review has also summarized early TORS development in China[19]. These reports are useful early descriptions, but their small patient numbers and limited follow-up preclude conclusions about equivalence with established platforms. Local manufacture may improve availability and cost control; it does not replace indication-specific evidence on instrumentation, hemostasis, assistant access, or a reliable conversion strategy.

Platform choice also requires a distinction between a mechanical advantage and a clinically meaningful advantage. Greater articulation, a flexible camera, or a smaller external footprint may improve access in a particular anatomy, but these features do not by themselves improve local control, swallowing, or treatment value. The relevant comparison is the complete operating environment: the quality of visualization, instrument reach, bedside-assistant access, suction and smoke evacuation, retraction, hemostatic options, docking reliability, and the ability to convert safely when exposure deteriorates. Comparative studies should consequently report the indication and anatomical target, not simply operative time or blood loss[8–19]. The main platform features, strengths, limitations, and maturity of the supporting TORS evidence are summarized in Table 1.

4 Clinical Applications

4.1 Oropharyngeal squamous cell carcinoma

The strongest evidence for TORS is in selected, resectable oropharyngeal squamous cell carcinoma, particularly HPV-associated disease. Resection yields pathological information on margins, nodal disease, lymphovascular invasion, perineural invasion, and extranodal extension that can guide adjuvant treatment. In

Table 1 Comparison of robotic platforms used or reported for transoral robotic surgery.

Platform	System/access	TORS strengths	Limitations	TORS evidence
da Vinci Si/Xi	Multiport rigid 3D endoscope	Largest clinical experience; mature workflow; 5-mm Si instruments	External/internal collision; 8-mm Xi instruments can crowd caudal targets	Established[8,9]
da Vinci SP	One 2.5-cm cannula, flexible camera, three 6-mm instruments	Access beyond entry axis; fewer collisions; retraction arm	Long-term comparative data limited; evidence depends on site and indication	Growing[8,10–12]
da Vinci 5	New multiport generation	Early TORS feasibility	Not head-and-neck-specific; no comparative effectiveness data	Very early[13]
Versius	Modular arms; open console	Configurable setup; smaller footprint	Instruments and access limit some distal tongue-base work	Early[14,15]
Flex Robotic system	Flexible endoscope and instruments	Access to curved anatomy	Discontinued; limited current scalability	Historical[16]
TORSS and Jingfeng SP1000	Domestic flexible-arm and single-port systems	Laryngopharyngeal access; potential local availability	Few patients; Chinese-language reports; short follow-up	Early[17–19]

Note: 3D, three-dimensional; SP, Single Port; TORS, transoral robotic surgery.

ECOG-ACRIN E3311, a carefully defined intermediate-risk group had excellent outcomes after risk-adapted treatment, including reduced-dose postoperative radiotherapy[20,21]. ORATOR2, in contrast, closed early after two treatment-related deaths in the surgical arm. Its results make clear that TORS is not automatically safer or demonstrably superior to reduced-dose radiotherapy[22]. Both approaches are reasonable for appropriate patients, and the possibility of trimodality treatment should be discussed before treatment is chosen[23].

At 54 months of follow-up in E3311, progression-free survival and overall survival were 90.6% and 95.3%, respectively, among evaluable participants. Progression-free survival was 94.9% in the 50-Gy intermediate-risk group[21]. Swallowing declined early after treatment and subsequently improved. Lower-dose radiotherapy reduced acute aspiration, although this difference was not sustained at 24 months[24]. These findings support protocol-based deintensification in carefully selected patients treated within quality-assured programs; they do not justify unplanned omission of adjuvant therapy.

Margin terminology is a major source of heterogeneity in published TORS oncologic results. In this review, a positive margin refers to tumor at the inked resection edge, whereas a close margin refers to a tumor-free but narrowly clear margin. The distance used to define a close margin varies across publications, which limits direct comparison of local control and adjuvant-treatment rates[25]. The intended oncologic plane, specimen orientation, inking, and surgeon-pathologist communication should be established before resection. In selected lateralized tonsillar tumors, routine contralateral surgery may increase morbidity without a clear oncologic benefit[26].

The choice between TORS and nonoperative treatment is therefore best framed as a pathway decision rather than a contest between technologies. The surgeon should estimate the probability of a negative margin, the likely nodal and pathological risk profile, the chance that adjuvant radiotherapy or chemoradiotherapy will be recommended, and the anticipated effects of each pathway on swallowing, speech, shoulder function, dental health, and quality of life. Patients differ in their tolerance of uncertainty, their travel and support circumstances, and the value they attach to pathology-directed treatment. A candid discussion of the possibility of trimodality therapy is essential. When that possibility is high, the apparent appeal of a minimally invasive resection may diminish; when it is low, pathological staging and risk-adapted adjuvant treatment may offer a meaningful advantage[20–26].

4.2 Carcinoma of unknown primary

TORS-assisted palatine and lingual tonsillectomy can identify small HPV-associated primary tumors after imaging and directed biopsies have been unrevealing. A meta-analysis estimated an overall detection rate of 66.2%, rising to 81.5% in HPV-positive disease[27]. National and institutional series also report useful yields in selected HPV-mediated disease[28,29]. The clinical value of diagnostic TORS lies in using the diagnosis to focus radiotherapy or avoid unnecessary treatment. Fluorescence-guided TORS remains investigational[30].

In a Danish national cohort, the detection rate was 49% overall and 58% in HPV-associated disease after a standardized work-up[28]. In a 157-patient HPV-mediated series, TORS identified the primary tumor in 88% of cases, and two-thirds of patients avoided chemoradiotherapy[29]. Yield is lower in HPV-negative disease, whereas bilateral mucosectomy increases pain and bleeding risk. HPV testing, imaging, laterality, and the likely radiation field should therefore inform the diagnostic plan from the outset.

Diagnostic TORS should not be judged solely by the frequency with which a primary tumor is found. Its usefulness rests on whether the information changes management in a way that matters to the patient—for example, by narrowing the target volume, clarifying laterality, avoiding unnecessary chemotherapy, or strengthening the rationale for surveillance. This requires close coordination among surgeons, radiologists, pathologists, radiation oncologists, and the patient before mucosectomy is undertaken. In some cases, a negative procedure may still be informative; in others, the morbidity of bilateral sampling may outweigh a modest incremental diagnostic yield. The work-up should therefore be individualized rather than treated as an

automatic sequence of transoral procedures[27–30].

4.3 Laryngeal and hypopharyngeal tumors

Articulated robotic instruments can facilitate selected supraglottic and hypopharyngeal resections, but any access advantage must be weighed against aspiration, edema, airway protection, stenosis, reconstruction, and swallowing function. Available series and meta-analyses suggest a role in organ preservation, yet are strongly affected by selection bias and treatment-era effects[31,32]. Salvage TORS may spare selected patients an open operation after radiotherapy, but bleeding and functional morbidity are higher and require an experienced multidisciplinary service[33].

A recent review of early supraglottic cancer identified only six TORS studies among 59 eligible reports. Functional outcomes were heterogeneous, and comparisons with modern radiotherapy are still needed[31]. In a 48-patient hypopharyngeal series, 60% of patients avoided radiotherapy to the primary site, but extranodal extension was strongly associated with outcome[32]. These findings support organ preservation in selected patients; they do not establish superiority over laser, videolaryngoscopic, or nonsurgical treatment.

4.4 Selected benign and salvage indications

Selected, well-circumscribed parapharyngeal or retropharyngeal lesions, ectopic lingual thyroid, schwannoma, salivary lesions, and other benign disease may be treated through a transoral route without a neck scar. The decisive issue is anatomical control: the lesion must be separable from the carotid sheath, skull base, and lower cranial nerves, with a credible rescue route. Previous radiotherapy adds fibrosis, impaired healing, and occult vascular risk. In a French multicenter series, postoperative bleeding occurred in 15.2% of salvage cases[33].

Across non-oropharyngeal and salvage indications, the purpose of TORS should be stated with particular care. It may be to obtain diagnosis, preserve an organ, avoid a morbid external approach, reduce a radiation field, or provide local control when nonsurgical options are limited. Those goals are not interchangeable. Reports should therefore describe the intended benefit, the alternatives considered, the planned rescue strategy, and the functional trade-off that was accepted. This is especially important after prior radiation, where access may be technically feasible but wound healing, vascular risk, and long-term swallowing reserve can be substantially less forgiving[31–33].

4.5 Obstructive sleep apnea

TORS tongue-base reduction may be considered for selected patients with obstructive sleep apnea who cannot tolerate positive airway pressure (PAP) and have retrolingual collapse. Prospective studies and meta-analyses report improvement in the apnea-hypopnea index and quality of life, but multilevel procedures, selection bias, and bleeding risk limit causal inference[34–36]. TORS should complement established first-line therapy rather than replace it.

Sleep-surgery evidence presents a different clinical problem from oncologic TORS. A reduction in the apnea-hypopnea index is important, but it should be interpreted alongside symptoms, cardiovascular and metabolic risk, adherence to PAP, weight trajectory, and the patient's experience of daytime function. Multilevel surgery also makes it difficult to isolate the contribution of tongue-base reduction. Careful phenotyping, including assessment of the pattern of upper-airway collapse, is therefore more useful than applying a single numerical threshold to all patients. Shared decision-making should address the expected benefit, the durability of response, alternative treatments, and the nontrivial possibility of postoperative bleeding[34–36].

In the first prospective study of SP tongue-base surgery, 76% of patients met Sher success criteria and the apnea-hypopnea index fell from 58.6 to 18.2 events per hour; two patients had major hemorrhage[34]. Dynamic collapse assessment, body mass index, competing therapies, patient preferences, and the contribution of any multilevel procedure should all be considered before surgery is offered. Table 2 summarizes the indication-specific roles, evidence base, and principal clinical considerations across the current applications of TORS.

5 Outcomes, Safety, and Patient Selection

5.1 Oncologic and functional outcomes

Favorable survival figures in TORS series partly reflect favorable anatomy, lower disease burden, and treatment at experienced centers. Once clinical heterogeneity and adjuvant treatment are considered, reviews have not shown a consistent advantage over transoral laser microsurgery or radiotherapy[37,38]. Comparative studies should report stage, HPV status, smoking exposure, margin definitions, nodal risk, adjuvant and salvage treatment, and center volume.

The most important source of confounding is often the treatment pathway rather than the robot itself. Surgical cohorts tend to include patients with more favorable exposure, smaller primary tumors, lower smoking exposure, limited nodal burden, and access to high-volume services. A favorable surgical outcome is less meaningful if full-dose chemoradiotherapy follows without a compensating diagnostic or functional benefit.

Early return to oral intake is an important objective, but

Table 2 Clinical applications of transoral robotic surgery and the current evidence base.

Indication	Current role	Evidence appraisal	Key clinical consideration
Oropharyngeal squamous cell carcinoma	Primary treatment for selected resectable disease, often HPV-associated	Largest evidence base; risk-adapted adjuvant pathways after TORS. Comparative trials do not establish inherent superiority of surgery[20–26]	Assess the likelihood of trimodality treatment and discuss nonsurgical alternatives
Carcinoma of unknown primary	Diagnostic palatine and lingual tonsillectomy after an appropriate work-up	Pooled detection rate 66.2%; higher yield in HPV-positive disease[27–29]	Value depends on enabling a more focused radiation field or avoiding unnecessary treatment
Laryngeal and hypopharyngeal tumors	Selected organ-preserving resection	Small heterogeneous studies; observed outcomes are strongly influenced by selection[31,32]	Consider airway protection, swallowing, margin feasibility, and reconstruction
Benign and salvage indications	Selected well-circumscribed lesions and limited recurrences	Predominantly cohort evidence; salvage surgery carries greater functional and vascular risk[33]	Require a credible vascular-control and rescue pathway
Obstructive sleep apnea	Tongue-base reduction in selected patients with retrolingual collapse and PAP intolerance	Prospective and meta-analytic data show improvement, but multilevel treatment and selection limit causal inference[34–36]	TORS does not replace first-line PAP therapy

Note: HPV, human papillomavirus; PAP, positive airway pressure; TORS, transoral robotic surgery.

it does not capture the full recovery of swallowing. In a contemporary cohort, most patients resumed an oral diet promptly, while patient-reported swallowing symptoms could still worsen early after surgery[39]. Resection volume, baseline function, and radiation dose to swallowing structures are important determinants. Preoperative assessment and early speech-language and nutritional support should therefore be routine components of care.

In that cohort, 97.6% of patients tolerated an oral diet at discharge, and 95.3% of those with documented status at 6 weeks were taking a soft or regular diet. Nevertheless, 63.6% of patients with paired patient-reported measures described worse swallowing at 6 weeks[39]. Patient experience and physiological testing answer different questions and should both be reported with feeding-tube and tracheostomy outcomes.

Functional recovery deserves the same analytical discipline as oncologic outcomes. Oral intake at discharge is a useful early milestone, but it does not establish normal swallowing, durable diet quality, or freedom from aspiration. Outcomes should be anchored to a defined baseline and reported at clinically meaningful intervals with complementary measures: patient-reported symptoms, clinician-rated swallowing, instrumental assessment when indicated, feeding-tube and tracheostomy status, unplanned readmission, and the dose of adjuvant radiotherapy received. This approach makes it less likely that a short-term technical success will be mistaken for a durable functional benefit, particularly when postoperative treatment differs between cohorts[24,37–39].

5.2 Hemorrhage and airway risk

Postoperative hemorrhage is the characteristic acute complication of TORS because even a modest bleed can rapidly compromise the airway. Prior radiotherapy, larger tumors, anticoagulant or antiplatelet exposure, and other patient-level factors are associated with risk[40,41]. Preoperative risk scores may improve counseling but require external validation[42]. Delayed hemorrhage may occur after discharge and beyond the immediate postoperative period. Patients and caregivers therefore need explicit written and verbal instructions on warning signs, urgent access to emergency care, and a defined follow-up arrangement.

A meta-analysis estimated overall and major hemorrhage rates at approximately 5.8% and 2.9%, respectively[40]. In a 2025 cohort of 414 oncologic and sleep-surgery procedures, bleeding occurred in 11.3% and severe bleeding in 4.3%; antiplatelet exposure increased risk, whereas arterial ligation during neck dissection was associated with less severe bleeding[41]. Airway, nutrition, discharge, and follow-up plans should be individualized before the operation and reviewed again before the patient leaves hospital.

Hemorrhage prevention is likewise a system responsibility, not only an intraoperative technical task. Before discharge, the team should reconcile antithrombotic medication, confirm that the patient and caregiver understand the significance of fresh oral bleeding, document how emergency care will be accessed, and ensure that the receiving service understands the recent operation. The threshold for reassessment should remain low because a seemingly minor sentinel bleed can precede airway compromise. Center-specific pathways should also specify who reviews delayed events and how lessons are fed back into case selection, vascular planning, and patient education[40–42].

5.3 Patient selection and training

Suitable candidates have reproducibly adequate exposure, a lesion that can be removed with a definable deep plane, acceptable baseline swallowing and medical reserve, and a credible prospect of avoiding unnecessary treatment intensification. Inadequate exposure, carotid involvement, extensive prevertebral or skull-base disease, uncontrolled coagulopathy, or a near-certain need for full-dose chemoradiotherapy usually weigh against TORS. European guidance similarly emphasizes indication-specific selection, an experienced multidisciplinary team, and an established rescue pathway[43].

Assessment should include mouth opening, mandibular anatomy, cervical extension, tumor laterality, the deep plane, threatened vessels, and the expected defect. It should also consider pulmonary reserve, baseline aspiration and swallowing, frailty, antithrombotic treatment, social support, and the ability to return promptly if delayed bleeding occurs. Neck dissection, vascular control, reconstruction, pathology orientation, radiation planning, speech-language therapy, nutrition, and emergency rescue must function as one coordinated pathway.

Credentialing should be based on more than case numbers. Programs should audit margins, hemorrhage, airway events, feeding-tube use, swallowing, adjuvant treatment, and recurrence. Published learning-curve estimates usually range from 20 to 50 cases, but vary substantially with the chosen endpoint and the operator's previous experience[44]. Future studies should use common definitions and compare complete treatment pathways, including cost and patient-centered outcomes, rather than isolated technical measures.

A mature TORS program should make its learning process visible. Supervision needs to extend beyond docking and console performance to case selection, judgment at the deep margin, management of unexpected bleeding, coordination with anesthesia and nursing, and review of postoperative function. Early case series can be valuable when they describe this context honestly, including exclusions, conversions, adverse events, and changes made to the pathway. Programmatic audit is particularly important when a new platform is introduced, since familiarity with one robotic system does not guarantee equivalent performance with another[43,44].

Docking and console time improve relatively early, whereas judgment about exposure, deep margins, specimen handling, vascular control, and postoperative rescue develops more slowly. Simulation, cadaveric training, dual-console mentoring, video review, and staged case complexity are more defensible than unstructured case accumulation. Enhanced-recovery pathways can also standardize analgesia, swallowing assessment, nutrition, airway management, and discharge without changing the robotic platform. Table 3 summarizes practical elements that should be established before a TORS program is expanded.

6 Future Directions

Future progress is likely to depend on smaller distal instruments, flexible or shape-controllable endoscopes, reliable suction and smoke evacuation, fine bipolar energy, and rapid conversion to manual hemostasis. Near-infrared fluorescence may assist occult-primary localization, perfusion assessment, or vessel identification, but early indocyanine-green experience has shown limited specificity[30]. Augmented reality and intraoperative ultrasound will need to demonstrate improvements in deep margins or complication rates in deformable pharyngeal tissue.

Postoperative circulating tumor HPV DNA may eventually refine surveillance and risk-adapted treatment. In a prospective kinetics study, most detectable results on postoperative days 1–2 cleared by week 2, so very early positivity should be interpreted cautiously[45]. The next priority is prospective multicenter comparison of complete treatment pathways—not only docking time—using shared definitions of exposure, conversion, margins, hemorrhage, swallowing, voice, recurrence, cost, and patient-reported outcomes.

Future comparative research should be designed around decisions that patients and multidisciplinary teams actually face. Useful studies will compare complete, risk-adapted treatment pathways and prospectively capture baseline function, patient-reported outcomes, treatment burden, complications after discharge, salvage treatment, and cost. Agreement on definitions for exposure, conversion, close and positive margins, hemorrhage severity, and functional recovery would make observational data more interpretable and permit meaningful meta-analysis. Technical innovations should be evaluated against these outcomes, rather than being adopted on the basis of feasibility alone. Such work is likely to be more informative than additional small single-platform case series[37–45].

Table 3 Practical elements of a safe transoral robotic surgery program.

Domain	Essential planning or program element	Reason for inclusion
Candidate selection	Confirm reproducible exposure, a definable deep plane, anticipated functional defect, and the probability of avoiding unnecessary treatment intensification	An accessible tumor may still be a poor TORS candidate if margins, function, or the likely adjuvant pathway are unfavorable[25,43]
Multidisciplinary planning	Plan neck management, specimen orientation, pathology communication, radiation contingencies, reconstruction, and rehabilitation before resection	The benefit of surgery depends on the complete treatment pathway, not resection alone[20–24]
Hemorrhage and airway preparedness	Review antithrombotic therapy, vascular risk, postoperative airway needs, emergency access, and written instructions for delayed bleeding	Hemorrhage can occur after discharge; rescue arrangements must be explicit[40–42]
Functional recovery	Document baseline swallowing, involve speech-language and nutrition services early, and define diet and follow-up plans	Early oral intake does not capture all patient-reported swallowing morbidity[39]
Training and quality assurance	Use staged case complexity, mentoring, simulation or cadaveric training, video review, and audit margins, complications, function, and adjuvant treatment	Case count alone does not establish safe independent practice[44]

Note: TORS, transoral robotic surgery.

7 Conclusion

TORS is an important option in contemporary head and neck surgery when a safe transoral route can achieve complete treatment at an acceptable functional cost. Its clearest roles are in selected oropharyngeal cancer and in localizing occult HPV-associated primary tumors. The evidence for laryngeal, hypopharyngeal, salvage, and sleep-surgery indications is encouraging but less mature. TORS should always be considered through shared decision-making alongside definitive radiotherapy, chemoradiotherapy, and open-surgical alternatives when appropriate. Platform development will matter clinically only if it improves specialty-specific access, safety, value, and patient-centered outcomes within a quality-assured multidisciplinary pathway.

Acknowledgements

Not applicable.

Conflicts of interest

The authors declare no conflicts of interest.

Ethical statement

Not applicable. This narrative review involved no human participants, animals, or identifiable patient information.

Funding information

No funding.

Data availability statement

No datasets were generated or analyzed for this review.

AI statement

The authors used Codex (Version 26.930.61225) as a language-editing tool to improve grammar, clarity, and readability. The AI tool was not used for data analysis, data generation, image processing, or scientific content creation. All outputs were carefully reviewed and verified by the authors, who take full responsibility for the final content.

Author contributions

Jian Zhou conceived this manuscript. Qiang Huang, Jian Zhou, Chiyao Hsueh, and Chengzhi Xu collected the related references. Lei Tao supervised and revised the manuscript. All authors read and approved the final manuscript.

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