REVIEW ARTICLE

Translational Health Reports. 2026; 2(1): 13
https://doi.org/10.22034/thr.2025.236666

A Comparative Analysis of Primary Radiotherapy versus Transoral Surgery for Early-Stage Laryngeal Squamous Cell Carcinoma: Oncologic and Functional Results

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Article history:

Received: 28 Sep 2025
Accepted: 13 Sec 2025
Available online: 19 Dec 2025

Keywords:

Radiotherapy
Transoral Surgery
Laryngeal Squamous Cell Carcinoma

Abstract

Background: Early-stage laryngeal squamous cell carcinoma (LSCC), which includes stage I and II disease, has a high cure rate. The main treatment approaches are definitive radiotherapy (RT) and transoral surgery (TOS), which includes transoral laser microsurgery (TLM) and transoral robotic surgery (TORS). Selecting the optimal treatment involves balancing oncologic effectiveness with functional results and quality of life.
Objective: To review and compare current evidence on overall survival (OS), disease-specific survival (DSS), laryngeal preservation (LP), and functional outcomes in early-stage LSCC treated with primary RT or TOS.
Methods: A narrative literature review was performed, identifying relevant studies from PubMed and Scopus. The focus was on peer-reviewed articles from the last two decades, including retrospective cohort studies, prospective trials, systematic reviews, and meta-analyses that directly compared RT and TOS.
Findings: Recent large-scale analyses and meta-analyses show similar overall and disease-specific survival rates for T1 and T2 tumors treated with modern TOS or RT. The main differences are seen in patterns of oncologic control. TOS is linked to lower local recurrence but a higher incidence of second primary tumors, whereas RT shows higher local recurrence but a lower need for salvage laryngectomy, resulting in comparable long-term laryngeal preservation rates. Functionally, TOS offers advantages in treatment duration, voice outcomes for select T1a lesions, and cost-effectiveness, but may lead to poorer swallowing outcomes for larger resections. RT may provide better voice quality for more extensive T1 and T2 lesions but carries risks of long-term dry mouth and tissue scarring.
Conclusion: Both RT and TOS are effective treatments for early-stage LSCC, with similar long-term survival outcomes. Treatment selection should be individualized, based on tumor characteristics, patient health, institutional experience, and patient preferences regarding functional trade-offs and treatment burden.

Cite this article as: Ruzimova F, Sadullayeva S, Islombek o'g'li MJ, Khajiqurbonova N, O'ktamovich FU, Dilnura X, Shoxida U, Mousavi SMH. A Comparative Analysis of Primary Radiotherapy versus Transoral Surgery for Early-Stage Laryngeal Squamous Cell Carcinoma: Oncologic and Functional Results. Transl Health Rep. 2026; 2(1):13. https://doi.org/10.22034/thr.2025.561197.1030

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Introduction

Laryngeal cancer is a major global health issue, with approximately 184,615 new cases and 99,840 deaths annually worldwide [1]. Over 95% of these cases are squamous cell carcinoma (SCC), strongly associated with tobacco and alcohol use [2]. The larynx plays a vital role in voice production, swallowing, and breathing, making functional preservation as important as cancer cure. Early-stage LSCC (Stage I and II) is highly treatable, with 5-year survival rates often above 80–90% [3]. This high cure potential has shifted treatment goals toward preserving function and quality of life (QoL).

Treatment approaches for early-stage LSCC have changed over time. Historically, external beam radiotherapy (RT) was the standard, valued for being non-invasive and preserving voice, especially for glottic cancers [4]. The development of endoscopic techniques like transoral laser microsurgery (TLM) allowed for precise tumor removal with minimal damage to laryngeal structures [5]. More recently, transoral robotic surgery (TORS) has improved visualization and access for certain tumors, though its use in glottic cancer is still limited [6].

The availability of both RT and TOS as standard options has created a state of clinical equipoise. Without large randomized trials directly comparing modern RT and TOS, treatment decisions are often influenced by institutional practices and clinician expertise [7]. Defining the best outcome involves not only survival but also voice quality, swallowing function, treatment duration, cost, and long-term side effects. This review aims to compare primary RT and TOS for early-stage LSCC, focusing on survival, laryngeal preservation, functional outcomes, and factors guiding treatment choice.

Methods

A narrative review was conducted to identify studies comparing RT and TOS for early-stage (T1–T2, N0–N1) LSCC. Searches were performed in PubMed/MEDLINE and Scopus for articles published between January 2000 and July 2024. Search terms included: "laryngeal neoplasms," "glottic cancer," "early stage," "radiotherapy," "transoral laser microsurgery," "transoral surgery," "TORS," "survival," "overall survival," "disease-specific survival," "laryngeal preservation," "voice outcomes," "dysphagia," and "quality of life."

Inclusion Criteria: Studies were included if they were original research (retrospective cohort, prospective trial, database analysis) or systematic reviews/meta-analyses; focused on adults with untreated T1 or T2 LSCC; directly compared RT and TOS outcomes; and reported on at least one primary outcome (OS, DSS, LP, local control, or functional result).

Exclusion Criteria: Studies were excluded if they included significant numbers of advanced-stage cancers without separate analysis; were case reports, editorials, or non-English articles without translation; or focused only on salvage therapy.

Data extracted from each study included author, year, design, sample size, patient and tumor details, treatment information, survival outcomes, recurrence patterns, laryngeal preservation rates, and functional results. Due to variability in study designs and reporting, a qualitative synthesis was performed.

Results

Oncologic Outcomes

Overall and Disease-Specific Survival: Large observational studies indicate no significant survival difference. A National Cancer Database (NCDB) analysis of 6,395 patients with T1–T2N0 glottic cancer found no link between treatment type (RT vs. TLM) and overall survival [8]. A meta-analysis of 21 studies also reported no significant difference in 5-year OS or DSS between TLM and RT for T1 glottic cancer [3]. Recent analysis of the SEER database confirmed equivalent DSS across treatments [9].

Local Control and Patterns of Failure: While survival is similar, the pathways differ. TOS generally offers better initial local control, likely due to the ability to assess margins during surgery. A systematic review noted local control rates of 91% for TLM vs. 86% for RT in T1 glottic cancer [10]. However, recurrences after RT can often be successfully treated with TOS, preserving the larynx in many cases [11]. Ultimately, 5-year laryngeal preservation rates are comparable for both treatments, around 90–95% for T1 and 80–85% for T2 disease [12,13].

Second Primary Tumors: Studies consistently report a higher rate of second primary tumors in surgical patients. This is likely due to "field cancerization" in smokers, which is not addressed by surgery but may be partially reduced by the broader mucosal coverage of RT [14].

Functional and Quality of Life Outcomes

- **Voice Outcomes:** Voice results depend on tumor stage and location.
- **T1a Lesions:** For small mid-cord lesions, TLM can achieve voice quality **similar** to RT [15].
- **T1b and T2 Lesions:** For tumors involving the anterior commissure or with reduced vocal cord mobility, RT tends to yield better voice outcomes by preserving vocal fold structure [16–18].

Swallowing Outcomes: Severe swallowing problems are rare in early glottic cancer, but differences exist, especially for supraglottic tumors. TOS for larger T2 tumors can cause temporary swallowing issues or require feeding tubes [19]. RT, particularly with modern techniques like IMRT, carries a low risk of severe dysphagia but may lead to chronic dry mouth and mild swallowing complaints [20,21].

Other Considerations

- **Treatment Duration and Cost:** TOS is typically a single **procedure**, while RT requires daily sessions over 6–7 weeks. This makes TOS more cost-effective and convenient for many patients [22].
- **Quality of Life (QoL):** General QoL measures often show no major difference between treatments. However, disease-specific assessments reveal trade-offs: RT patients may experience more fatigue and dry mouth, while TOS patients may have more short-term voice and swallowing concerns [23].

Discussion

This review confirms that both RT and TOS are highly effective for early-stage LSCC, with no difference in long-term survival. This shifts the clinical question from which treatment is superior to which is better for an individual patient.

The decision should consider how cure is achieved and the functional journey involved. Factors include tumor details, patient health, lifestyle, and personal preferences. For example, a young patient with a small mid-cord lesion might prefer TOS for its shorter treatment time and cost savings. In contrast, a professional singer with a T2 lesion might choose RT to maximize voice preservation.

The distinct patterns of treatment failure are important. The higher rate of second primary tumors after surgery [14] highlights the need for lifelong monitoring and smoking cessation support. Meanwhile, the success of surgical salvage after RT failure [11,24] shows how these treatments can complement each other in a multidisciplinary setting.

Beyond Survival: Nuances in Decision-Making Modern advances like IMRT and robotic surgery continue to improve outcomes and reduce side effects. Patient comorbidities also play a role; for instance, those with lung disease may not tolerate post-surgical swallowing risks, while patients with certain connective tissue disorders might face higher risks from RT [27].

Limitations of the Evidence

Current conclusions are limited by the lack of large randomized trials. Most data come from retrospective studies or database analyses, which may be affected by selection bias. Variations in tumor reporting and functional assessment tools also complicate comparisons [28,29].

Future Directions

Future research should focus on:

1. Prospective Studies: Well-designed trials collecting detailed patient-reported and functional outcomes.

2. Predictive Models: Tools integrating clinical, imaging, and molecular data to personalize treatment choice.

3. Technology Evaluation: Assessing new techniques like advanced imaging, proton therapy, and office-based procedures.

4. Value-Based Assessments: Comprehensive analyses incorporating long-term function and QoL into cost-effectiveness evaluations.

Conclusion

In early-stage laryngeal cancer, radiotherapy and transoral surgery are not competing but complementary options. Survival outcomes are equivalent. Modern care should involve shared decision-making within a multidisciplinary team, where patients are informed about the specific benefits and burdens of each approach. The best treatment is one that aligns with the patient's tumor, health, values, and lifestyle.

Acknowledgment

The authors would like to express their appreciation to all those who helped us conduct this research.

Funding

None

Authors Contributions

The authors contributed to the data analysis. Drafting, revising and approving the article, responsible for all aspects of this work.

Conflict of Interest

None

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