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CONTEMPORARY THERAPEUTIC STRATEGIES IN LARYNGEAL CANCER: FROM ORGAN PRESERVATION TO PRECISION ONCOLOGY

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ABSTRACT

Laryngeal cancer remains a clinically significant malignancy because effective treatment must achieve adequate oncological control while preserving vital functions such as respiration, swallowing, airway protection, and phonation. Conventional approaches, including surgery, radiotherapy, chemotherapy, and combined-modality treatment, remain fundamental; however, their potential impact on speech, swallowing, respiratory function, and long-term quality of life has stimulated the development of more selective and function-preserving strategies. **Objective.** The aim of this review was to summarize contemporary therapeutic approaches to laryngeal cancer, with particular emphasis on organ preservation, minimally invasive surgery, advanced radiotherapy, immunotherapy, targeted treatment, molecular diagnostics, personalized treatment planning, multidisciplinary care, and rehabilitation. **Materials and Methods.** A narrative analytical review was conducted using the scientific and clinical sources included in the original manuscript, including contemporary head and neck cancer guidelines, established evidence on organ-preservation chemoradiotherapy, oncological reference literature, and tumor-classification resources. Therapeutic approaches were assessed according to their role in local tumor control, preservation of laryngeal anatomy and function, treatment-related toxicity, patient selection, and integration into individualized multidisciplinary care. **Results.** Modern management of laryngeal cancer has evolved from a predominantly anatomy-based model toward a more individualized therapeutic strategy. Early-stage disease may be treated with organ-preserving surgery or radiotherapy, whereas locally advanced tumors frequently require multimodal treatment. Transoral laser microsurgery and other minimally invasive approaches may reduce surgical morbidity in appropriately selected patients. Modern radiation techniques allow increasingly precise dose delivery and improved protection of surrounding normal tissues. Immune checkpoint inhibition has expanded systemic treatment options in recurrent or metastatic head and neck squamous cell carcinoma, while targeted therapy and molecular profiling provide additional opportunities for biologically oriented treatment selection. Contemporary organ-preservation strategies increasingly emphasize functional rather than purely anatomical preservation. **Conclusion.** Effective management of laryngeal cancer requires a balance between tumor control and preservation of speech, swallowing, respiratory function, and quality of life. Integration of surgery, radiotherapy, systemic treatment, immunotherapy, molecular diagnostics, rehabilitation, and patient-centered decision-making within a multidisciplinary framework may improve

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individualized care. Further clinical research is required to identify predictive biomarkers, optimize treatment sequencing, and determine which emerging approaches provide meaningful improvements in survival and functional outcomes.

Keywords: laryngeal cancer, organ preservation, immunotherapy, targeted therapy, transoral surgery, radiotherapy, personalized medicine, molecular diagnostics, rehabilitation, precision oncology.

INTRODUCTION

Laryngeal cancer is an important malignancy of the upper aerodigestive tract and represents a particularly complex therapeutic problem because the larynx performs several essential physiological functions, including phonation, respiration, swallowing, and protection of the lower airway. Consequently, treatment outcomes should not be evaluated exclusively in terms of tumor eradication or survival; preservation of voice, swallowing capacity, respiratory independence, nutritional status, social functioning, and overall quality of life are equally important components of modern oncological care. Treatment selection depends on numerous tumor-related and patient-related factors, including anatomical site, tumor stage, histological characteristics, regional lymph-node involvement, distant metastases, baseline laryngeal function, age, nutritional status, smoking history, comorbidities, performance status, psychosocial circumstances, and individual treatment preferences. Historically, total laryngectomy represented a major therapeutic option for advanced disease and remains necessary in selected clinical situations. Although it can provide effective local control, the procedure permanently separates the airway from the upper digestive tract and results in the loss of natural laryngeal voice, necessitating adaptation to a permanent tracheostoma and specialized rehabilitation. These considerable functional consequences stimulated the development of organ-preserving approaches. Advances in radiotherapy, systemic treatment, endoscopic surgery, imaging, reconstruction, and supportive care have progressively expanded treatment options. Transoral laser microsurgery, concurrent chemoradiotherapy, intensity-modulated radiotherapy, immune-based systemic therapy, molecular diagnostics, and personalized treatment planning have contributed to a transition from radical anatomy-oriented management toward a more individualized, function-preserving model. The contemporary objective of laryngeal cancer treatment is therefore not limited to removal or destruction of the tumor but includes preservation or restoration of clinically meaningful speech, swallowing, airway function, and social participation whenever this is oncologically safe. The aim of the present review was to analyze the principal developments in modern laryngeal cancer therapy and to assess how conventional and emerging therapeutic approaches can be integrated into organ-preserving and individualized treatment strategies.

MATERIALS AND METHODS

The present study was designed as a narrative review of contemporary therapeutic strategies in laryngeal cancer. The analysis was based on the scientific and clinical sources contained in the original manuscript, including National Comprehensive Cancer Network recommendations for head and neck cancers, established evidence regarding concurrent chemoradiotherapy for laryngeal preservation, comprehensive oncological reference

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literature, and World Health Organization classifications of head and neck tumors. The reviewed therapeutic approaches included conventional surgical treatment, definitive and adjuvant radiotherapy, chemoradiotherapy, organ-preservation strategies, targeted therapy, immune checkpoint inhibition, minimally invasive transoral surgery, advanced radiation technologies, molecular diagnostics, personalized medicine, rehabilitation, and multidisciplinary care. These approaches were analyzed according to their oncological role, potential for preservation of laryngeal anatomy and function, treatment-associated morbidity, suitability for different stages of disease, requirements for patient selection, and possibilities for integration with other treatment modalities. Because the source manuscript represents a narrative clinical review rather than a prospectively registered systematic review, no pooled quantitative analysis, formal meta-analysis, or statistical assessment of heterogeneity was performed. The findings therefore represent a qualitative synthesis of established therapeutic principles and emerging directions in laryngeal cancer management.

RESULTS

The contemporary treatment of laryngeal cancer is characterized by increasing therapeutic diversification and greater emphasis on functional preservation. Surgery remains a fundamental treatment modality, ranging from limited organ-preserving procedures to total laryngectomy. In selected early-stage tumors, conservative surgery can provide adequate local control while preserving sufficient laryngeal structure to maintain useful speech and swallowing. Total laryngectomy continues to play an essential role in selected patients with extensive disease, severe baseline dysfunction, or tumors unsuitable for organ-preserving strategies, although its permanent functional consequences require comprehensive preoperative counseling and rehabilitation. Radiotherapy represents another established modality and may be used as definitive treatment in selected early-stage disease, postoperatively in patients with adverse pathological features, or in combination with systemic therapy for locally advanced tumors. Concurrent chemoradiotherapy has become an important organ-preservation strategy for selected patients with advanced disease and has demonstrated that tumor control can be achieved in some patients without immediate total laryngectomy. However, anatomical preservation does not necessarily guarantee preservation of function, since combined treatment may be associated with substantial acute and late toxicity, including dysphagia, aspiration, mucosal injury, nutritional impairment, fibrosis, and long-term deterioration of laryngeal function. Minimally invasive surgical techniques have also expanded treatment possibilities. Transoral laser microsurgery permits removal of selected lesions through the natural oral route under magnified visualization and may reduce external surgical trauma while preserving uninvolved laryngeal structures. Its potential benefits include shorter hospitalization, lower surgical morbidity, and favorable functional outcomes in appropriately selected patients, although tumor size, depth of invasion, accessibility, involvement of adjacent structures, and surgeon experience remain critical determinants of suitability. Transoral robotic surgery represents an additional technological development in minimally invasive head and neck surgery, but its role varies according to tumor location, anatomy, and institutional expertise and should therefore be considered selectively rather than universally. Radiation therapy has simultaneously undergone major technological refinement. Intensity-modulated radiation therapy allows more precise shaping of dose

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distribution and improved sparing of normal tissues, which is particularly important in the head and neck region where structures responsible for swallowing, salivary function, hearing, airway protection, and other physiological processes lie close to the treatment field. Image-guided radiotherapy can further improve treatment accuracy by verifying patient positioning and anatomical changes during therapy, while adaptive planning may provide additional benefit in selected cases. Proton therapy has attracted interest because of its physical potential to reduce radiation exposure beyond the target volume, although its specific role in laryngeal cancer remains selective and continues to require comparative clinical evaluation. Systemic treatment has also evolved considerably. Targeted therapy reflects a shift from nonspecific cytotoxic treatment toward interventions directed at molecular pathways involved in tumor proliferation and survival. Epidermal growth factor receptor signaling represents one clinically relevant pathway in head and neck squamous cell carcinoma, although targeted treatment is limited by tumor heterogeneity and the development of resistance through alternative signaling mechanisms. For this reason, biomarker-based selection is likely to become increasingly important. Immunotherapy has produced one of the most substantial changes in the management of recurrent and metastatic head and neck cancer. Immune checkpoint inhibitors can restore antitumor immune activity in selected patients and may provide durable disease control in a subset of cases. Nevertheless, treatment response remains variable and immune-related adverse events can involve the skin, thyroid gland, liver, lungs, gastrointestinal tract, and other organs, emphasizing the importance of careful patient selection and monitoring. Biomarkers such as PD-L1 expression and characteristics of the tumor microenvironment may assist treatment selection, although their interpretation remains an evolving area. Personalized medicine has further broadened the concept of individualized treatment. Molecular diagnostics may identify genetic alterations, protein-expression patterns, immune characteristics, and other tumor-associated biomarkers that can contribute to therapeutic stratification. However, personalized oncology should not be interpreted exclusively in molecular terms. Age, nutritional condition, smoking history, comorbid disease, baseline speech and swallowing function, psychosocial circumstances, occupational needs, and patient preferences may substantially influence the choice of therapy. Modern organ-preservation strategies therefore increasingly distinguish between anatomical and functional preservation. Maintaining the anatomical larynx is clinically meaningful only when acceptable swallowing, voice, airway protection, and respiratory function are preserved. Rehabilitation should accordingly be regarded as an integral component of treatment rather than a secondary intervention. Speech-language specialists can contribute before, during, and after treatment by evaluating baseline function, reducing avoidable deterioration, and supporting adaptation. For patients requiring total laryngectomy, tracheoesophageal speech, electrolaryngeal devices, and other assistive methods can restore effective communication. Multidisciplinary management has become essential because the increasing complexity of treatment requires coordinated participation of head and neck surgeons, radiation oncologists, medical oncologists, radiologists, pathologists, speech-language therapists, nutrition specialists, dentists, nurses, psychologists, and rehabilitation professionals. Multidisciplinary tumor boards provide an opportunity to compare alternative strategies and coordinate treatment sequencing, particularly when several oncologically acceptable options are available. Early detection

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and prevention remain equally important. Persistent hoarseness, progressive dysphagia, unexplained throat discomfort, chronic cough, respiratory symptoms, referred otalgia, or a neck mass require appropriate specialist evaluation. Early-stage disease can often be treated with less extensive interventions than advanced tumors, while tobacco cessation and reduction of harmful alcohol exposure remain important preventive and survivorship strategies. Emerging technologies such as artificial intelligence, advanced imaging analysis, liquid biopsy, circulating tumor DNA assessment, and biomarker-guided treatment may further influence diagnosis, risk stratification, treatment planning, and response monitoring, although these approaches remain under investigation and require rigorous clinical validation before routine implementation.

DISCUSSION

The evolution of laryngeal cancer therapy reflects a broader transformation in oncology from maximal anatomical intervention toward function-preserving, biologically informed, and patient-centered treatment. Survival and local tumor control remain the primary therapeutic objectives, but the ability to preserve communication, swallowing, respiratory function, and quality of life has become increasingly important in evaluating therapeutic success. This change is especially relevant in laryngeal cancer because treatment-related impairment can profoundly affect social interaction, nutrition, employment, psychological well-being, and long-term independence. Total laryngectomy remains an effective and sometimes indispensable procedure, yet its permanent functional consequences justify consideration of less destructive options when oncologically appropriate. Organ-preservation chemoradiotherapy represented an important advance in this regard, but anatomical preservation should not automatically be interpreted as therapeutic superiority. A larynx that remains structurally intact but is associated with severe dysphagia, aspiration, airway compromise, or loss of useful voice may not constitute successful functional preservation. For this reason, future clinical studies should distinguish clearly between anatomical laryngeal preservation and preservation of effective function. Minimally invasive surgery offers an additional strategy for reducing treatment morbidity, particularly in carefully selected early or limited tumors, but appropriate case selection remains essential because expanding such techniques beyond their oncological limits may compromise disease control. Modern radiotherapy similarly provides improved precision and greater potential for normal-tissue sparing, yet advanced technology does not eliminate toxicity, particularly when radiation is combined with systemic therapy. The emergence of immunotherapy has substantially expanded systemic treatment options for recurrent and metastatic disease and introduced the possibility of prolonged disease control in a subset of patients; however, variable response and immune-related adverse events underline the need for more accurate predictive biomarkers. Targeted therapy and molecular diagnostics support the broader development of precision oncology, but tumor heterogeneity means that detection of a molecular abnormality does not necessarily translate into therapeutic benefit. Biomarkers must therefore demonstrate clinically meaningful predictive value rather than merely biological association. The concept of personalized medicine should also remain multidimensional. In laryngeal cancer, baseline voice quality, swallowing ability, pulmonary function, nutritional status, psychosocial circumstances, occupational communication needs, and individual preferences may be as

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important as molecular characteristics when determining the optimal treatment strategy. Rehabilitation should therefore be integrated into the entire therapeutic pathway. Early involvement of speech and swallowing specialists can improve functional assessment, set realistic expectations, and support post-treatment adaptation. Multidisciplinary decision-making is particularly valuable when several treatment options are technically feasible because no single modality can be considered optimal without simultaneously assessing oncological efficacy, anticipated functional outcome, treatment toxicity, and patient preference. The present review has several limitations. It represents a narrative synthesis rather than a systematic review, and the source bibliography is limited. Consequently, the manuscript does not provide pooled comparative estimates of overall survival, progression-free survival, laryngeal preservation, treatment toxicity, or quality-of-life outcomes. In addition, several emerging strategies, including proton therapy, artificial intelligence, liquid biopsy, and biomarker-guided treatment, remain under active investigation and should not be interpreted as established replacements for current standards of care. Future research should prioritize prospective comparisons of therapeutic strategies using not only survival endpoints but also swallowing function, voice quality, long-term toxicity, patient-reported outcomes, and health-related quality of life. Identification and validation of predictive biomarkers may further improve selection of systemic, radiation-based, and organ-preserving treatments.

CONCLUSION

Laryngeal cancer treatment is undergoing a progressive transition toward individualized, function-preserving, and multidisciplinary care. Surgery, radiotherapy, and systemic therapy remain the principal therapeutic modalities, while transoral surgery, advanced radiation techniques, immunotherapy, targeted treatment, and molecular diagnostics provide additional opportunities for carefully selected patients. The central objective of modern management is no longer limited to tumor eradication alone but includes preservation of speech, swallowing, airway protection, respiratory function, reduction of treatment-related toxicity, and maintenance of long-term quality of life. Organ preservation should therefore be assessed functionally rather than anatomically. An anatomically preserved but severely dysfunctional larynx cannot be regarded as equivalent to successful functional preservation. Integration of tumor stage, pathological findings, imaging, molecular characteristics, baseline functional status, comorbidities, rehabilitation needs, and patient preferences within a multidisciplinary framework represents the most rational basis for individualized treatment planning. Future advances in immunotherapy, precision oncology, minimally invasive surgery, adaptive radiation therapy, artificial intelligence, liquid biopsy, and biomarker-guided treatment may further improve clinical outcomes, but these innovations require rigorous validation and should be incorporated into routine practice only when they demonstrate meaningful improvements in survival, functional outcomes, safety, or quality of life.

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