

# Evaluation of Surgical and Functional Outcomes of Supracricoid Laryngectomy and Rehabilitation Protocols

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## Abstract

Laryngeal squamous cell carcinoma (LSCC) is the most common malignant neoplasms of the head and neck. Several treatment options exist for LSCC according to cancer location and stage at diagnosis; proposed treatments include surgery alone or in combination with chemotherapy and radiotherapy. In selected LSCC cases in the T2–T4 staging, supracricoid laryngectomy (SCL) is an organ-sparing surgical approach aimed at preserving the main laryngeal functions that has been proposed as an alternative to total laryngectomy. Rehabilitation for swallowing and respiratory functions plays a central role after SCL; functional outcomes after SCL may significantly vary among different centers but they are generally satisfactory when oncological radicality has been obtained and the rehabilitation protocol starts promptly. In this clinical review, we analyzed functional outcomes for swallowing and voice rehabilitation in patients after SCL, as well as the optimal SCL surgical technique, post-operative complications and comparison with total laryngectomy or radio-chemotherapy protocols. *Ter 2021; 172 (4):363-368. doi: 10.7417/CT.2021.2341*

**Key words:** laryngeal squamous cell carcinoma, radiotherapy, chemotherapy, total laryngectomy, supracricoid laryngectomy, swallowing

## Introduction

Head and neck squamous cell carcinoma (HNSCC) include a variety of tumors arising from the lip, oral cavity, hypopharynx, oropharynx, nasopharynx or larynx. HNSCC represents the sixth most common malignancy worldwide, accounting for approximately 6% of all cancer cases, and is responsible for an estimated 1%–2% of all cancer deaths. Oral cavity and laryngeal cancers are the most common head and neck cancers globally and, particularly, laryngeal squamous cell carcinoma (LSCC) accounts for approximately 2% to 5% of all diagnosed cancers, with a peak incidence in men between the ages of 55 and 65 (1). Nearly 55% of LSCC patients are diagnosed with localized disease, and the the-

rapeutic strategies developed in the twentieth century have significantly improved the overall survival rate; however, post-operative laryngeal dysfunction and a poor prognosis still characterize this pathology in advanced stages (2-4).

The proposed treatments for LSCC include surgery alone or in combination with chemotherapy (CHT) and radiotherapy (RT) according to cancer location and stage at diagnosis. Initial stages (I and II) are treated with unimodal treatment that may include surgery and RT, while CHT and radical surgery are considered the best therapeutic approach for cancers in advanced stages (III and IV) (5-10). In selected LSCC cases in the T2–T4 staging, supracricoid laryngectomy (SCL) is a valuable option as an alternative to total laryngectomy (TL); this surgical treatment is considered an organ-sparing surgical approach aimed at preserving the main laryngeal functions (Fig. 1).

Surgical protocols of organ preservation with SCL have been questioned for many years, in particular for patient selection criteria and functional outcomes (12-15). The main functional endpoints after SCL include the swallowing and respiratory recovery. The introduction of a rehabilitation protocol is essential to make effective the preservation of functionality of the "neo-larynx". The aim of this clinical review is to analyze and discuss functional outcomes for swallowing and voice rehabilitation in patients with LSCC treated with SCL.

## Methods

A literature review has been performed on articles retrieved from PubMed and Scopus from the last 30 years on the following topics: head and neck squamous cell carcinoma, laryngeal squamous cell carcinoma, radiotherapy in laryngeal carcinoma, chemotherapy in laryngeal carcinoma, total laryngectomy, supracricoid laryngectomy, swallowing in supracricoid laryngectomy, respiratory function in supracricoid laryngectomy, voice in in supracricoid laryngectomy, supracricoid laryngectomy rehabilitation, supracricoid laryngectomy functional outcomes.

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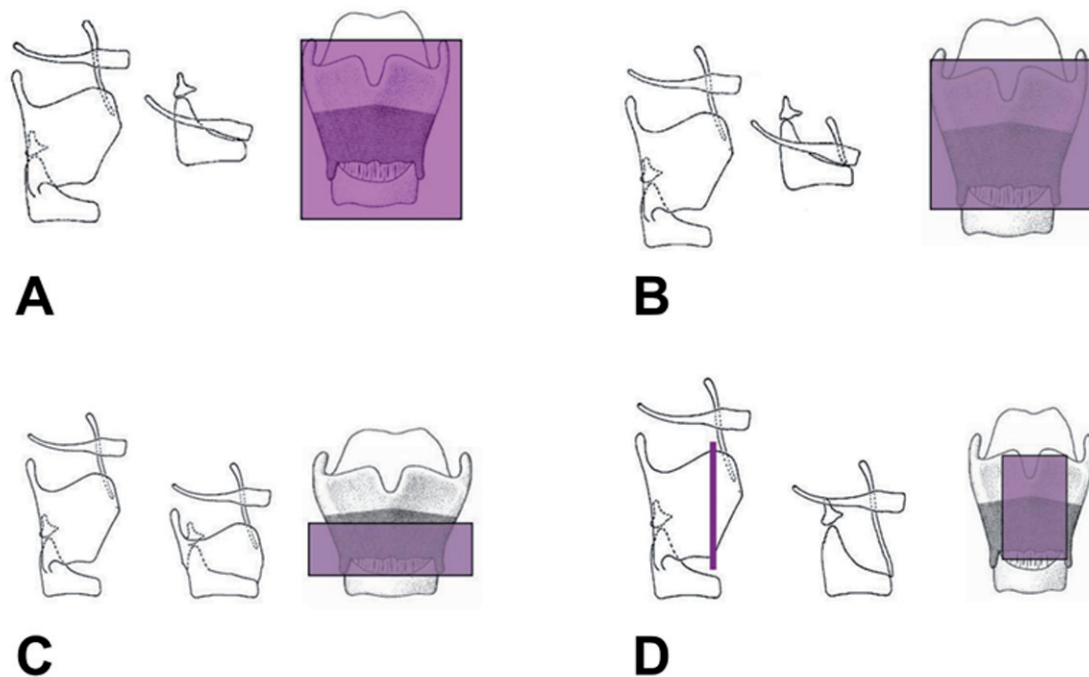


Fig. 1. Different types of supracricoid partial laryngectomy procedures. A) Supracricoid laryngectomy with cricohyoidopexy (CHP); B) Supracricoid laryngectomy with cricohyoidepiglottopexy (CHEP); C) Transglottic laryngectomy according to Calero; D) Transglottic laryngectomy according to Sedláček-Tucker. From Wiskirska-Woźnica et al. (11)

## Results

### *Surgical techniques for supracricoid laryngectomy*

Different types of partial laryngectomies have been described. Recently, the European Laryngological Society (ELS) has included SCL in the “open partial horizontal laryngectomies” (OPHL Type II) system defined as “OPHL Type II”, furtherly differentiated by the suffixes “a” and “b” regarding the sparing or not of the suprahyoid epiglottis (16).

This surgical procedure provides resection of the entire thyroid cartilage, while the inferior limit is the upper edge of the cricoid ring. OPHL Type II surgical techniques are divided into Type IIa and Type IIb. OPHL Type IIa, previously defined as “supracricoid laryngectomy with crico-hyoido-epiglottopexy”, requires a horizontal incision of the thyrohyoid membrane superiorly, then the pre-epiglottic space and epiglottic cartilage are transected so that the suprahyoid part of the epiglottis is spared. The inferior constrictor muscles are incised bilaterally, the piriform sinuses are dissected, the inferior horns of thyroid cartilage are cut, and the ventricular and vocal folds are divided down to the lower limit of resection in the subglottic region. Laryngeal reconstruction is then obtained by performing a crico-hyoido-epiglottopexy. OPHL Type IIa can preserve one arytenoid, while OPHL Type IIb, previously defined as “supracricoid laryngectomy with crico-hyoidopexy”, requires the resection of the thyrohyoid membrane horizontally along the lower border of the hyoid bone. The posterior aspect of the hyoid is the

dissected, and the valleculae and the entire epiglottis are included in the surgical specimen. Laterally and inferiorly, the procedure is carried out as in OPHL Type IIa. The entire supraglottis and the pre-epiglottic space are removed. Larynx reconstruction is achieved by crico-hyoidopexy. Similarly to Type IIa, OPHL Type IIb can be extended to include one arytenoid in the surgical resection.

### *Post-operative complications*

Among post-operative complications, laryngotracheal stenosis negatively impacts on postoperative sequelae, increasing time of tracheostomy and exposing the patient to risk of infections and mucosal damage. Montgomery T-tube is a valid tool in the management of these patients (17). Specifically, this treatment strategy allows the ability to function either by tracheostomy or by stent cannula, with the possibility to close the outer branch in order to breath and have a natural phonation. The main disadvantages are tracheostomy maintenance and potential biofilm colonization.

Chronic aspiration after SCL is a very controversial phenomenon and may be a cause of failure of this surgery. Simonelli et al. evaluated a sample of 164 SCL patients for chronic aspiration (18). The degree of postoperative aspiration was evaluated according to Leipzig's (19) and Pearson's (4) scales. A moderate percentage (17.2%) of patients referred constant cough, worsening during meals. Studies through FEES showed that 68% of patients (79 out of 116) had various swallowing alterations and different degrees of aspiration without developing aspiration pneu-

monia. Moreover, some dysphagic patients may be able to tolerate certain aspiration degree without developing pneumonia, suggesting that the action of the ciliary movement, the strength of the cough reflex and patient conditions may play a significant role. A FEES study in these patients should be performed to detect the presence of premature spillage, pharyngeal pooling, laryngeal penetration and insufficient cough reflex.

#### *Rehabilitation outcomes*

The main functional endpoints after SCL are the recovery of swallowing, evaluated by the removal time of the nasogastric tube (NGT), and of natural respiratory function, assessed by the percentage and time of tracheostomy decannulation. The postoperative assessment includes a fiberoptic endoscopic evaluation of swallowing (FEES) and videofluoroscopic swallowing exam, estimating oral transit time (OTT) and pharyngeal transit time (PTT).

The swallowing is evaluated by clinical or instrumental tools. The most common reported clinical assessment are the presence and severity of tracheal aspiration, presence of cough reflex and diet restrictions (20). The evaluation of postoperative suction degree may be detected according to Leipzig (21) and Pearson scales (4) (1 none, 2 occasional cough but no clinical problem, 3 worsening of coughing constantly with meals or swallowing, 4 pulmonary complications).

The same criteria, still using the Leipzig and Pearson scales, have been adopted to evaluate the discourse (1 good subjective speech, 2 adequate communication, 3 occasional word or syllable produced, 4 reading of the lips necessary to understand the sounds).

Voice preservation and rehabilitation is another important aspect after SCL. Several methods have been used for postoperative voice evaluation, although maximum phonation time (MPT) appears to be the most important aerodynamic parameter; the MPT is the maximum time (in seconds) for which a person can sustain a vowel sound (usually the "ah") when produced on one deep breath at a relatively comfortable pitch and loudness. The GIRBAS scale is one of the most widely used for perceptual voice evaluation. It identifies different parameters of voice quality: grade (G), instability (I), roughness (R), breathiness (B), asthenia (A), and strain (S); the score ranges from 0 (normal voice) to 3 (severe dysphonia).

Self-assessment of patient's condition may be evaluated by several questionnaires to assess nutrition, phonation and social reintegration. Long-term results should be measured at least 6 months after surgery, interviewing each patient.

#### **Discussion**

Laryngeal cancer treatment has been largely debated as regarding surgical and non-surgical treatment protocols and the speech and swallowing impairment, as well as the rehabilitation time, may depend on the implemented strategy.

For initial cancer stages, there is a broad consensus that the oncological and functional results of transoral laser surgery or RT are equivalent in glottic T1 carcinomas (Phase

I) and T2 (Phase II), reaching 80% to 95% of local control of disease (5, 22, 23). In locally advanced stages, the therapeutic choice includes TL, although the problem of vocal preservation and airway recovery persuaded surgeons to select procedures that spared the organ while guaranteeing oncological radicality. Such organ preservation protocols necessarily need to evaluate the effects on organ survival and function.

Functional results after SCL are of great interest. A recent literature review by Schindler regarding functional results of SCL reported a great variability in the mean hospitalization time, feeding-tube removal time and tracheostomy tube decannulation time among different studies (13, 24, 25). With an appropriate rehabilitation protocol, respiration, deglutition and phonation may be restored in most cases: the decannulation rate ranges between 85.7% and 100%, and a safe unrestricted oral diet is achieved by 53% to 100% of patients within the first postoperative year (20). Other studies showed great heterogeneity in mean decannulation times, varying between 8 days, as reported by Laccoureye (24) and 105 days (26). On the contrary, little variability was found in decannulation rates, which ranged between 85.7 and 100% (13) (25, 27, 28) confirming good respiratory outcomes following SCL.

#### *The role of rehabilitation*

A post-operative rehabilitation protocol is essential to achieve satisfactory functional outcomes and should be started early to avoid stiffness of the arytenoid (29). Early mobilization avoids the onset of scarring fibrosis of the crico-arytenoid joint which is associated with the functional failure of the intervention, requiring a TL due to functional incompetence of the neoglottis. The purpose of the rehabilitation protocol is the enhancement of protective reflexes through voluntary cough exercises with forced expiration, setting the patient in the most appropriate and facilitating compensatory posture, and introducing the patient to supra-glottic swallowing maneuver.

Compared to a few years ago, rehabilitation techniques recommend early decannulation to improve the sensitivity of the new glottis during air flow and laryngeal vibratory arrangement. In fact, the presence of the tracheostomy tube protects against airway aspirations but limits the motility of neolarynx and reduces its sensitivity. Moreover, a long permanence of tracheostomy tube is a risk factor for the formation of tracheo-cutaneous fistulas requiring local closure surgery in nearly 30% of cases. In these cases, the closure may be problematic for increased subglottic pressure during expiration and during cough related to chronic aspiration (30).

Several factors may cause a delay in the restoring of swallowing. Woisard et al. studied the pharyngeal phase of swallowing in patients treated with OPHL Type IIa, and showed defects consisting of a reduced movement of the back of the tongue, faulty backward tilting of the epiglottis, reduced anterior laryngeal movement and reduced laryngeal elevation. In patient treated with a OPHL Type IIb, a reduced movement of the back of the tongue may be also present with a reduced posterior motion of the tongue base, a reduced anterior laryngeal movement and a reduced laryngeal elevation (31).

Concerning phonation recovery, correct and timely logopedic therapy is necessary. Reconstructive surgery dramatically changes the anatomy of the larynx and the phonation mechanism. Phonation function recovery is almost equivalent in both surgical techniques; slightly better voice quality is achieved in OPHL Type IIa. SCL voice is characterized by moderate to severe alterations in roughness and grade, slight to moderate alterations in breathiness, slight or practically absent alterations in asthenicity and slight or moderate alterations in strain (20).

Assessing voice in SCL patients with MPT appears to be the most widely used aerodynamic parameter. Moreover, most authors reported similar data of a highly reduced MPT, with values ranging between 8 (13) and 11 seconds (28).

#### *Comparison with other treatment options*

Given the reported clinical and functional outcomes, SCL can be considered as extremely competitive not only in prognostic terms but also in terms of functional results such as a reduction in the number of TL, especially for intermediate stages and some advanced stages (T3 and selected T4a) (15). The theoretical advantage of SCL versus TL is the maintenance of the main laryngeal functions (respiration, phonation and swallowing) since at least one functioning cricoarytenoid unit is maintained facilitating neoglottic competence without a permanent tracheostoma (13, 32).

The evaluation of results after RT and CHT for advanced stage LSCC has been questioned by several studies as the Veteran Affairs and RTOG 91-11, regarding organ preservation and patient survival (5, 7). A severe speech and swallowing impairments are often associated with these aggressive protocols, suggesting that fibrosis and oedema with a poorly functioning larynx could be a possible reason for negative functional outcomes in organ-preservation therapy (33) (34). Moreover, mortality rates for LSCC in the 1990s and in the 1980s in United States showed decreased survival rate; this result has been attributed to an increased number of patients treated with RT/CHT (35). In several countries of Latin Europe, SCL has been considered an important alternative to RT/CHT for LSCC and have been performed for many years since the first sub-total laryngectomy proposed by Labayle (36) in 1972 (OPHL Type IIb). SCL surgery was not habitually performed in several Northern European countries as well as in the United States, while conservatory RT/CHT treatments have been preferred for many years. The explanation of this different behavior lies on the post-operative management of SCL that requires a longer hospitalization time and the different functional results among centers (37). In the recent years, SCL gained an increasing agreement around the world including the United States.

*The experience of our unit* In our clinical practice, SCL surgery has been performed for several decades with different surgical approaches. The best results from an oncologic and functional point of view have been obtained with SCL according to Labayle and Bismuth (OPHL Type IIb) (38) and SCL according to Mayer-Piquet (OPHL Type IIa) (39). As confirmed by various studies, the reconstructive techniques of "OPHL Type IIa" and "OPHL Type IIb" are valid in such a way as to equal the TL in terms of survival and oncological radicality (13, 32, 40). Moreover, the effectiveness of

SCL has been evaluated in residual or recurrent cancer after radiotherapy (41-45).

Surgical preoperative selection is critical in the achievement of a successful therapeutic outcome in terms of functional and oncological results. Thus, surgical feasibility is not the most important factor in determining whether SCL is the best treatment for an individual patient. Furthermore, the choice between SCL and TL must be balanced, considering both technical and non-technical aspects of treatment such as patient preferences and mental status. In fact, even when the extension of the cancer would allow a SCL, many LSCC patients are treated with TL for individual characteristics (32); oppositely, SCL can be intraoperatively converted into a OPHL type III (supratracheal laryngectomy) or a TL by the surgeon in order to assure a complete excision of the tumor.

For early stage disease, the extensive use of SCL should be re-considered as there are valid and proven less-invasive surgical and non-surgical alternatives with good functional results. In these cases, the use of SCL is only justifiable for cases at risk such as T1b glottic tumors with significant involvement of the anterior commissure and/or with difficulties in exposition in direct microlaryngoscopy and/or with suspect involvement of the prelaryngeal lymph nodes, T2 glottic tumors that involve the paraglottic space superiorly and/or inferiorly and that tend to behave biologically as authentic T3 cancers (46).

In patients treated with SCL, we always follow a specific rehabilitation protocol to obtain the preservation of functionality of the "neo-larynx". The rehabilitation protocol consists of three different phases. The first phase starts from the second postoperative day and includes costodiaphragmatic breathing and pneumophonic coordination exercises performed with strengthening exercises of preserved structures. The second phase starts from the second to fourth postoperative day, and includes pneumophonic coordination exercises, head and neck mobilization, protective reflex activity enhancement, and exercises of swallow function in compensating posture. The third phase starts from the eighth postoperative day and provides swallowing tests with semi-solid foods. The protocol allows to remove the tracheostomy tube between the second and the fourth post-operative day in most cases avoiding experiencing dyspnea and it allows to restore the function of swallowing solids and liquids without pulmonary aspiration leading to nasogastric-tube safety removal.

#### **Conclusion**

To date, SCL represents a well-accepted technique for selected cases of laryngeal cancer because of the maintaining of the main laryngeal functions (respiration, phonation and swallowing) since at least one functioning cricoarytenoid unit is maintained. The functional results are strictly related to the post-operative rehabilitation protocol which should be started early to avoid stiffness of the arytenoid and fibrosis of the crico-arytenoid joint which is associated with functional failure. Several protocols on postoperative care have been reported but standardized clinical recommendations should be drawn up on early post-surgical management. Voice and



swallowing functional outcomes after SCL may significantly vary among different centers but they are generally satisfactory when oncological radicality has been obtained and the rehabilitation protocols start promptly.

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