

Renesans of supracricoid partial laryngectomy with crico-epiglottohyoidopexy or with crico-hyoidopexy – is it possible? Literature review

Renesans laryngektomii nadpierzścieniowej z rekonstrukcją zespoleniem pierścienno-nagłośniowo – gnykowym lub pierścienno-gnykowym – czy jest możliwy? Przegląd piśmiennictwa

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ABSTRACT: Supracricoid Partial Laryngectomy (SCPL) with Crico - Epiglottohyoidopexy (CHEP) or Crico - Hyoidopexy (CHP) is a surgical technique, which is difficult and demanding for the surgeon. However it yields oncologic efficacy, successful functional outcomes require postoperative rehabilitation of speech and swallowing. The aim of the review is to highlight importance of this surgical method with strict respect to the oncological contraindications and precise qualification of patients to the surgical treatment.

KEYWORDS: Supracricoid partial laryngectomy, Crico-epiglottohyoidopexy, crico-hyoidopexy, larynx cancer, aspiration

STRESZCZENIE: Laryngektomia nadpierzścieniowa rekonstrukcyjna z zespoleniem pierścienno-nagłośniowo -gnykowym oraz pierścienno-gnykowym jest techniką operacyjną trudną i wymagającą dobrych umiejętności od chirurga. Mimo skuteczności leczenia onkologicznego, zadowalające wyniki funkcjonalne wymagają pooperacyjnej rehabilitacji głosu i aktu połykania. Celem pracy jest podkreślenie skuteczności metody chirurgicznej – laryngektomii nadpierzścieniowej rekonstrukcyjnej, zachowując respekt wobec onkologicznych przeciwwskazań i precyzyjnej kwalifikacji pacjenta przy wyborze tej metody leczenia.

SŁOWA KLUCZOWE: Laryngektomia nadpierzścieniowa z rekonstrukcją, zespolenie pierścienno-nagłośniowo-gnykowe, zespolenie pierścienno-gnykowe, rak krtani, aspiracja

Supracricoid partial laryngectomy (SCPL) with crico-epiglott-to-hyoidopexy (CHEP) or crico- hyoidopexy (CHP) is technically difficult. Although SCPL is effective in patients with laryngeal cancer, postoperative rehabilitation of speech and swallowing is needed for good functional outcomes. We discuss what patients can benefit from SCPL, with CHEP or CHP, and when these procedures are contraindicated.

LIST OF ABBREVIATIONS USED WITH AN EXPLANATION:

RLN-Recurrent Laryngeal Nerve
ILN-Inferior Laryngeal Nerve (anterior branch and posterior)
SLN-Superior Laryngeal Nerve
LCA-Lateral Cricoaarytenoid Muscle
PCA- Posterior Cricoaarytenoid Muscle
CTJ-Cricothyroid Joint
CAJ-Cricoaarytenoid Joint
SCPL-CHP - Supracricoid Laryngectomy, crico-hyoidopexy
SCPL-CHEP - Supracricoid Laryngectomy, crico-epiglott-to-hyoidopexy
VPL-Vertical Partial Laryngectomy
FESST-Fiberoptic Endoscopic Evaluation of Swallowing with Sensory Testing
NFT-Nasogastric Feeding Tube
MV-Mucosal Wave
F0-Fundamental Frequency
MPT-Maximum Phonation Time
SR-Speech Rate (number of words read per minute)
PG-Phrase Grouping (number of words per each breath)
Botox-botulinum toxin type A

INTRODUCTION:

Supracricoid partial laryngectomy with crico-hyoidopexy (SCPL-CHP) was developed to reduce the postoperative disability of patients with laryngeal cancer, which was seen after total laryngectomy and other surgeries. At the same time, it was intended that patients treated with SCPL-CHP should have similar outcomes as those who undergo more radical surgeries. Majer and Rieder, two Austrian physicians working in Vienna [19], first described SCPL in 1959. In 1974, Piquet et al. [31] performed crico-epiglott-to-hyoidopexy (CHEP) in patients with glottic cancer, who, at that time, would be treated with vertical partial laryngectomy. Currently, SCPL is a recognized technique in Europe and other parts of the world, and it is used as voice conservation surgery in some patients with stage 3 glottic cancers (SCP-CHEP) and stage 2 supraglottic cancers originating from the laryngeal ventricle or vestibular folds (SCPL-CHP).

OUTCOMES OF SCP IN PATIENTS WITH LARYNGEAL CANCER:

According to Marioni et al. [21], in some patients with advanced laryngeal cancer (T2-T3 supraglottic cancer, squamous cell carcinoma of the glottis), both local control and 5-year survival are similar after SCPL and after total laryngectomy. However, SCPL is technically more difficult than other surgical techniques used in patients with laryngeal cancer. For patients who undergo surgery due to laryngeal cancer, it is crucial to have functional breathing, speech, and swallowing. By creating the neoglottis, a T-shaped structure formed with the cricoarytenoid unit, functional swallowing and speech can be restored. Moreover, the T-shaped neoglottis reduces airflow turbulences in the rima glottidis and increases the subglottic pressure, which is the key to functional speech. In the 1990s, Laccoureye [14, 16] found that SCPL-CHEP was associated with a better local control than vertical partial laryngectomy or radiation therapy. At the same time, in some patients with stage 3 or 4 glottic cancer, Piquet [30] and Laccoureye [12] found that SCPL-CHEP could be used instead of total laryngectomy because of a similar local control. At the beginning of the 21st century, Dufour et al. [7] suggested that SCPL, with or without induction chemotherapy, was an effective type of larynx preservation surgery. After 5 years of follow-up among 118 patients with stage 3 cancer, SCPL significantly increased the local control and preserved the voice organs in more patients compared to radiotherapy alone. **The above-described studies confirmed that SCPL could be used in some patients with stage 3 laryngeal cancers instead of total laryngectomy or radiation therapy.** According to Weinstein et al. [44], the quality of life in patients after SCPL was better than in those after total laryngectomy with tracheoesophageal fistulas. Based on histological assessments, including the assessment of tissue margins of laryngeal tissue removed after total laryngectomy, many patients treated with total laryngectomy could potentially be candidates for SCPL. Thus, the following question arose: what are the limitations of SCPL?

The main contraindications to SCPL are as follows: permanent immobilization (fixation) or limited mobility of the arytenoid cartilage on the tumor side, subglottic tumor infiltration, tumor infiltration of the upper surface of the cricoid cartilage, tumor infiltration of the posterior commissure, and extralaryngeal tumor spread [7].

Dufour et al. [7] suggested a role for induction chemotherapy in qualifying patients for SCPL. Of 118 patients who underwent SCPL in that study, 100 received prior induction chemotherapy with cisplatin and fluorouracil. After the induction therapy, 18 patients, who were initially qualified for total laryngectomy, could be qualified for SCPL instead. The induction therapy reduced

the restricted mobility and fixation of the arytenoid cartilage on the side of surgery, which allowed the patients to be qualified for SCPL. The local control was achieved in 97.3% of patients, after 1 year, in 93.5%, after 3 years, and in 91.4%, after 5 years. Many authors suggest that the response to induction chemotherapy should be taken into account when planning treatment, and SCPL should be used much more frequently in patients with advanced stage 3 squamous cell laryngeal cancer [7].

Laccourreye et al. [11] compared treatment outcomes in 204 patients with squamous cell carcinoma of the glottis (T2N0) who underwent either vertical laryngectomy (85 patients) or SCPL (119 patients). In that study, a 10-year survival was lower in patients who underwent vertical partial laryngectomy (46.2%) than in those who underwent SCPL (66.4%), and the 10-year local control was lower (69.3%) after vertical partial laryngectomy than after SCPL (94.6%). The better local control after SCPL could be due to a wider exposure of the subglottic space, which enables wider resections. However, the risk of aspiration pneumonia was greater after SCPL-CHEP than after vertical partial laryngectomy. In both treatment groups, Laccourreye et al. [11] assessed the need for subsequent total laryngectomy due to functional disorders, such as choking or dysphagia, that were not due to tumor recurrence after the initial surgery. Among patients who underwent vertical partial laryngectomy, total laryngectomy was performed in 1.2%, and among those after SCPL, in 0.8%. These results indicated that partial laryngectomies are technically difficult, and therefore adequate qualification of patients for partial laryngectomy is essential. According to Leeper et al. [17], after vertical hemilaryngectomy, the voice is rough, puffing, and suffocating, whereas after SCPL it is mainly puffing.

INDICATIONS:

According to Laccourreye et al. [11, 24, 40], SCPL-CHEP is indicated in patients with stage 2 or stage 3 glottic cancers, which include glottic cancer with bilateral vocal fold involvement (horseshoe lesions), unilateral cancer of the vocal folds infiltrating the anterior commissure, cancer of the vocal folds with limited mobility of the vocal folds and limited infiltration of the subglottis or the laryngeal vestibule (<1 cm), stage 3 glottic cancer with slightly restricted mobility [without immobilization] of the arytenoid cartilages. SCPL-CHEP is also indicated in some patients with stage 4 glottic cancer with limited thyroid cartilage infiltration (no infiltration beyond the outer surface of the thyroid cartilage plate).

SCPL-CHP is indicated in patients with the following tumors: epiglottic tumors with preserved or limited mobility of vocal folds and stage 2 or stage 3 glottic cancer originating from the

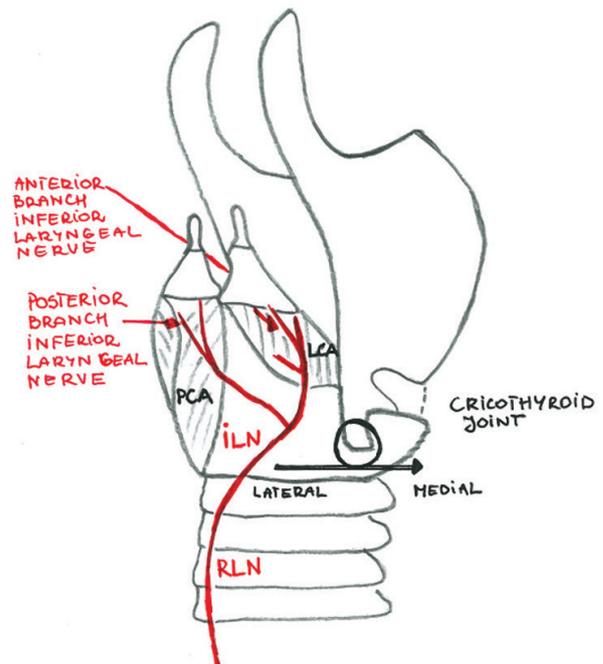


Fig 1. Disarticulation of the cricothyroid joint – the key to protect the recurrent laryngeal nerve (RLN). Dissection should be made laterally to medially. LCA (lateral cricoarytenoid muscle)

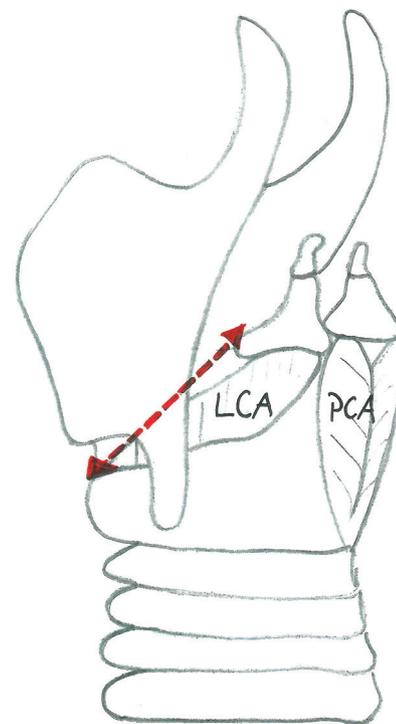


Fig. 2. Resection of the paraglottic space. Vertical pre-arytenoid incision is made at the level of the vocal process of the arytenoid cartilage.

laryngeal ventricle or the laryngeal vestibular fold [24]. It is worth mentioning that immobilization of the arytenoid cartilage on the tumor side is one of the cardinal contraindications to SCPL [7] because it indicates neoplastic invasion of the cricoarytenoid muscle (anterior or posterior), cricoarytenoid joint, and cricoid cartilage, which have to be removed. Resection of unilateral cancer of the vocal folds that infiltrates the anterior commissure includes the resection of the submucosal Broyles ligament, which lies in the infrapetiolar region. Through this ligament, cancer cells can infiltrate the thyroid cartilage due to numerous dehiscences in the perichondrium. Involvement of the anterior commissure in early glottic cancer is a risk factor for recurrence after CO₂ laser chordectomy or radiation therapy. Thus, in this case, SCPL-CHP can be considered, and when the Broyles ligament is not infiltrated, SCLP-CHEP can be used instead.

Although SCPL is indicated for the treatment of laryngeal cancer, it impairs the laryngeal sphincter, which is associated with an increased risk of aspiration. „Patients who cannot climb two steps without losing their breath should not undergo such procedures” [19, 40].

RULES OF SURGERY:

The postoperative structure of the neoglottis affects functional outcomes.

The „cricoarytenoid unit” is the basic functional unit of the larynx. It consists of the arytenoid cartilages, cricoid cartilages, cricoarytenoid joint, lateral cricoarytenoid muscle, posterior cricoarytenoid muscle, recurrent laryngeal nerve, and superior laryngeal nerve. These structures are responsible for speech and swallowing, and after SCLP, there is no need for permanent tracheostomy [19].

Surgical steps and possible difficulties and pitfalls:

- 1) Dissect the thyrohyoid muscle and the omohyoid muscle from the hyoid bone. Do not dissect laterally because you can damage the superior laryngeal nerve (SLN).
- 2) Dissect the lower pharyngeal sphincter from the upper cornus of the thyroid cartilage. SLN lies rostrally and laterally to the upper cornus of the thyroid cartilage. Ossification of the thyrohyoid membrane increases the risk of SLN damage.
- 3) Dissect and release the lateral pharyngeal wall and the mucous membrane of the piriform recesses on both sides, from the glottis and thyroid cartilage.
- 4) Disarticulate the cricothyroid joint to prevent damage to the recurrent laryngeal nerve (RLN). Always dissect from the side to the middle [19]. Fig. I.

- 5) Open the larynx and resect the glottal space. A vertical incision above the arytenoid cartilages is made further above the vocal processes of the arytenoid cartilages. Take care not to damage the lateral cricoarytenoid muscle (LCA) or the cricoarytenoid joint. If the LCA muscle is traumatized or the cricoarytenoid joint is damaged, adduction of the arytenoid cartilages will be limited despite preserved RLN function [19]. Fig. II.
- 6) Position the arytenoid cartilages in a correct way.

If the RLN is preserved and the cricoarytenoid joint is normal, correct reposition of the cartilage is necessary to form a symmetrical, T-shaped neoglottis.

The thyroarytenoid muscles move the arytenoid cartilages in front of the anterior pharyngeal wall. Because during SCPL the thyroarytenoid muscles are removed, the arytenoid cartilages move posteriorly. It is therefore necessary to stitch the arytenoid cartilages in front of the posterior pharyngeal wall, taking care to preserve the mobility in the cricoarytenoid joints. If both arytenoid cartilages are preserved, the sutures are placed bilaterally between the arytenoid cartilages and the cricoid cartilages in an anterolateral direction. If only one arytenoid cartilage is preserved, the corniculate cartilage (small elastic cartilage) and the mucous membrane from the site of the removed arytenoid cartilage are used to make a convex fold, which will cover the cricoid cartilage at the level of the cricoarytenoid joint.

- 7) Mobilize the trachea (bluntly, without scissors) to increase the mobility of the tissue defect and to better close the tissue defect after SCLP (the defect is about 4 cm long).
- 8) Connect the cricoid cartilage to the epiglottis and the hyoid bone. The first suture (Vicryl 1 - 0) is placed in the midline, runs submucosally, covers the cricoid cartilage, part of the epiglottis, and the hyoid bone, and runs further in the base of the tongue. The next two sutures (1 - 0 vicryl) should run parallel to the midline (5 mm to 10 mm from it) [19].

Potential problems

- 1) Subluxation of the hyoid bone below the cricoid cartilage; it will cause an incomplete closure of the glottis and problems with swallowing and articulation. Do not use too much force when stitching.
- 2) Damage to the hypoglossal nerve and the lingual artery; it will flatten the base of the tongue and disturb the swallowing. During CHEP and CHP, do not use more than three sutures; place the sutures no further than 1 cm apart. [9]
- 3) Fracture of the cricoid cartilage; it can happen when the sutures are placed closer than 0.5 cm apart with too great

a force. When the cricoid cartilage is fractured, the sutures should be placed around the two tracheal rings immediately below the larynx.

- 4) Anterior dislocation of the hyoid bone; it will increase the risk of aspiration.
- 5) Posterior dislocation of the hyoid bone; it will narrow the diameter of the neoglottis and increase the risk of breathing disorders.
- 6) Upward dislocation of the cricoid cartilage; it will cause cricopharyngeal hypertonicity, which requires myotomy [15].
- 7) Medial dislocation, due to traction of sutures, of the lower pharyngeal sphincter and of the mucous membrane of both piriform recesses. The piriform recesses are important for the pharyngeal phase of swallowing [19].

Postoperative complications:

Naudo et al. [26] analyzed complications among 190 patients who underwent SCPL-CHEP. The serious complications included aspiration pneumonia (8.5%), infection of the postoperative wound (4.2%), laryngocele (3.1%), rupture of CHEP (1%), chondroradionecrosis (0.5%), and stenosis of the larynx (0.5%). Chondroradionecrosis occurred in one patient, who had undergone radiation therapy before SCPL. The patient improved after treatment with antibiotics and hyperbaric oxygen. One year after SCPL, normal swallowing without gastrostomy and normal breathing without tracheostomy were achieved in 98.4% of patients (187/190). Such promising results indicate that SCPL-CHEP does not frequently cause postoperative complications. Cervical fistula is a rare complication of SCPL-CHEP because CHEP is covered with a well-vascularized layer of subhyoid muscles.

Decannulation:

Early decannulation promotes the return of the coughing reflex and mobilization of the arytenoid cartilages, which lead to a better glottal closure. In patients with tracheostomies, Sasaki et al. [35] showed that reduced airflow through the larynx weakens the breathing reflex and reduces the mobility of the arytenoid cartilages. Early decannulation improves both the mobility of the arytenoids and the upward laryngeal motion, which are key to swallowing and good phonation in patients after SCPL. Tracheostomy tubes lower the larynx and reduce or even block the coughing reflex. Pikus et al. [27] pointed out that a lack of the coughing reflex can lead to complications in the lower respiratory tract, such as aspiration pneumonia. In patients who had evidence of aspiration on videofluoroscopy with barium, the depth of barium penetration in the bronchial tree did not predict pneumonia; however, patients who lacked the coughing reflex during videofluoroscopy were more likely

to develop pneumonia. The best time for decannulation should be assessed for each patient. Holsinger et al. [19] recommends that the cuff of the tracheostomy tube be deflated as early as 6 hours and no later than one day after surgery to prevent hypo-sensitization of subglottic receptors; thus, the deflation of tracheostomy cuffs should speed up the decannulation. Bron et al. [4, 5] suggested that an early closure of the tracheostomy enables early swallowing and prevents cricoarytenoid joint ankylosis. These investigators suggested that early decannulation should be performed despite some residual aspiration because it will stimulate coughing and normal glottal closure. Delayed decannulation may be due to swelling of the arytenoid cartilage in the postoperative period, which can be successfully treated with vaporization by a carbon dioxide laser. Naudo et al. [26] used a carbon dioxide laser in 26 patients with postoperative swelling of the arytenoid cartilage; in 49 patients, they used steroids instead. Holsinger et al. [19] used antibiotics to treat patients with symptoms of aspiration and „silent pneumonia”, and they continued antibiotics until the tracheostomy wound healed. Anti-reflux therapy is also indicated to enhance healing. According to Naudo et al. [25], the average time of early decannulation is about 8 days, and according to Bron et al. [5], it is about 27 days. In a multicenter study from Italy, performed by Botazzi et al. [6], over 95% of 323 patients who underwent SCPL had an early decannulation.

Aspiration

The trigeminal (V), glossopharyngeal (IX), and vagus (X) nerves provide sensory innervation to the vocal apparatus. These cranial nerves also take part in the defense mechanisms of the airways. [42]. The defense mechanisms can be impaired in patients after radiation therapy, which is recommended after surgery in patients with extracapsular lymph node involvement. Radiation therapy damages the salivary glands and thus causes dryness of the mucous membranes, which results in atrophy of the pharyngeal and laryngeal muscles and in decreased sensation in that region. In addition, during SCPL, many structures that protect the airways are removed. Patients who undergo SCPL have an increased risk of aspiration because SCPL moves the pharynx and the airways closer together. The factors that increase the risk of aspiration include older age, lack of middle reposition of the lower pharyngeal sphincter and the mucous membrane of the piriform recesses, cricoarytenoid joint damage, resection of the arytenoid cartilage, and prolonged use of tracheostomy. The scale used by the Leipzig [18] and Pearson [28] classifies the degree of postoperative aspiration as follows: 0, no aspiration; 1, periodic aspiration; 2, coughing with meals or swallowing; 3, pulmonological complications. In a study by Naudo et al. [26], 8.5% of 190 patients with aspiration developed pneumonia, which was the most com-

mon complication of aspiration. Simonelli et al. [36] assessed swallowing in 116 patients who underwent SCPL. Overall, 76 patients had aspiration confirmed on fiberoptic endoscopic evaluation of swallowing (FEES). Of those 76 patients, 45 had aspiration of videofluoroscopy, which is the best method for diagnosing swallowing disorders. Simonelli [36] found that patients who undergo SCPL have aspiration episodes, which are quite well tolerated by the patients; thus, no dietary changes are necessary. Pulmonological complications are the greatest problem of SCPL. Cough, which is an indicator of aspiration, is important for preventing tracheal-bronchial complications. Moreover, by coughing, patients can clear the lower airways if aspiration takes place. Persistent aspiration of foods differing in texture leads to persistent, productive cough.

Fig. III: MICROSCOPIC IMAGES - INFLAMMATORY CHANGES IN THE AIRWAY EPITHELIUM DUE TO ASPIRATION

Swallowing:

Swallowing disorders are the most frequent complications of SCPL; typically, they are short-term [14]. Although SCPL is a method of organ conservation surgery, it may cause problems with swallowing, breathing, and speaking.

In 1816, Francois Magendie divided the process of swallowing into three phases: oral phase, pharyngeal phase, and esophageal phase. [19]. After SCLP, rehabilitation of swallowing concentrates mainly on the rehabilitation of the pharyngeal phase of swallowing. The hypoglossal and superior laryngeal nerves coordinate normal swallowing. Holsinger et al. [19] suggest that the following factors impair swallowing: age > 75 years, pre-operative radiation therapy, transection of the hypoglossal or superior laryngeal nerves, resection of the arytenoid cartilage, and damage to the cricoarytenoid joint. Rehabilitation of swallowing should concentrate on enabling normal closure of the glottis, which can be achieved by mobilization of the arytenoid cartilages and by moving the neoglottis upwards. Active voice therapy and regular breathing exercises may also be helpful. Partial preservation of the glottis can make normal swallowing more likely. Patients with glottic cancer who underwent SCPL-CHEP achieved normal swallowing faster than the patients with glottic cancer who underwent SCPL-CHP. In patients who can swallow saliva, nasogastric feeding tubes are removed once the tracheostomy has closed and healed. Nasogastric feeding tubes are used for long periods in patients with chronic obstructive pulmonary disease or diabetes, in patients after resection of the arytenoid cartilage, and in patients who have tracheostomies for a long time. In patients after SCPL, nasogastric tubes, if used for long, can cause ulcerations of the mucous membrane in the retro-cricoid space. According to

Naudo et al. [26], on average, nasogastric tubes are removed 16 days after SCLP, and according to Bron et al. [4, 5], in the first month after SCPL. Currently, it is not clear when it is best to remove nasogastric tubes and tracheostomies after SCPL. Some investigators suggest to remove nasogastric tubes and to start oral nutrition even when tracheostomy is not closed [30, 31].

Diet: After removing the nasogastric tube, the so-called „sliding diet” should be used (soft foods such as pasta and other soft meals) [24]. Subsequently, carbonated drinks and finally clean water are given. Fluids can be condensed to increase their sensation by the patient. Patients have the greatest difficulties in re-learning how to swallow fluids. When swallowing, the patient should have her or his head extended forwards and downwards, and her or his arms should be lifted [19]. This position enables safe swallowing because it keeps the neoglottis under the tongue. Patients can return to a normal diet after 6 to 12 months. Marioni et al. [21], who observed dysphagia in 2 of 16 patients after SCPL, proposed a good method for treating dysphagia. To assess the severity of dysphagia, they used the Marchese - Ragon scales [22]. The two patients, who did not improve after rehabilitation of swallowing, were treated with botulinum toxin. Single, bilateral injections of botulinum toxin (8 IU, Botulinum toxin A - Botox, Allergan, Inc. Irvine, CA) were injected into the cricopharyngeal muscle under electromyographic guidance. In both cases, swallowing improved [21]. Fiberoptic endoscopic evaluation of swallowing with sensory testing (FESST) and videofluoroscopy are recognized methods for the diagnosis of swallowing disorders, for the measurement of the sensory threshold of the larynx, and for the evaluation of the laryngeal adductor reflex. Pulses of pressurized air are delivered through the canal to the mucosa of the arytenoid cartilages. The average pressure necessary to induce the laryngeal reflex is about 4 mmHg, but higher values are needed in older people. Schindler et al. [37] used FESST to plan rehabilitation in patients with swallowing disorders after SCPL.

Voice

On psychoacoustic evaluation, the voice of patients after SCPL is harsh and puffy, but their speech is intelligible. Rehabilitation of voice may be hindered by hearing problems, which increase with age. The “puffing” voice is of a high frequency, and patients with presbycusis or other types of sensorineural hearing loss lose their ability to perceive high-frequency sounds. In these patients, hearing one’s own „puffing” voice, which is quiet, is difficult; thus, patients need to force additional airflow to make the voice louder. However, this maneuver may lead to progressive voice failure when used often [32]. Other factors can also influence voice rehabilitation. Inflammation caused by gastroesophageal reflux (GERD) contributes to persistent

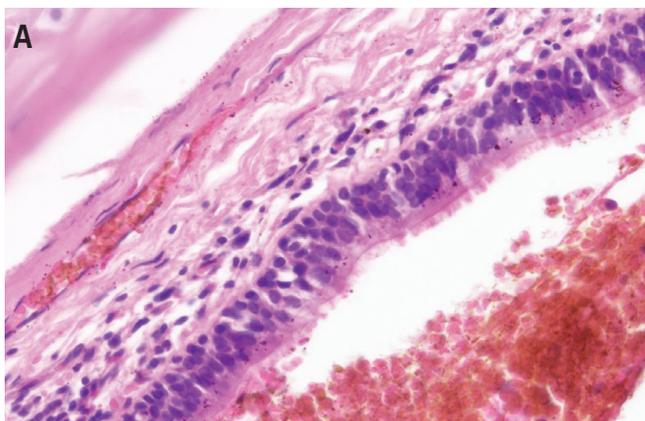


Fig. 3a. A Multilayer ciliary epithelium; below the epithelium, stromal inflammatory cell infiltration (x400).

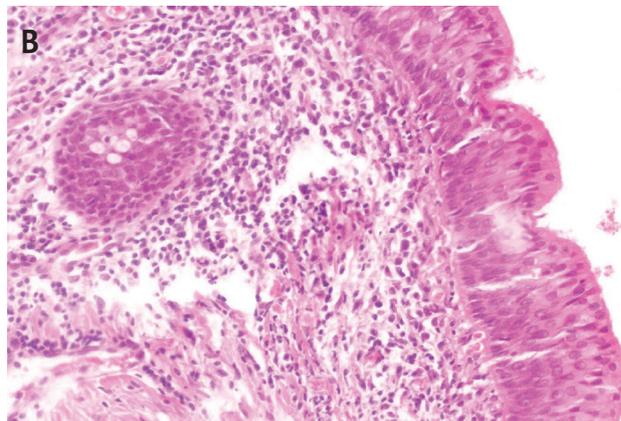


Fig. 3b. Tracheal wall, preserved mucosa, multilayer cylindrical epithelium without cilia, stromal infiltration of inflammatory cells (x200).

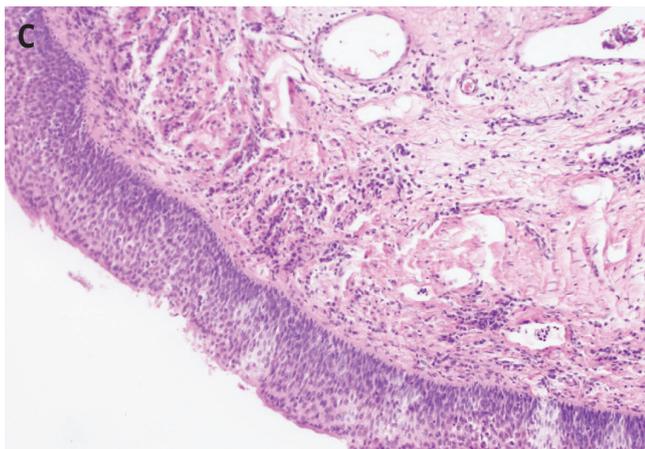


Fig. 3c. Tracheal mucosa, early stage of squamous metaplasia (parbasal cell proliferation in the upper part, preserved cylindrical epithelium with ciliary loss; x100).

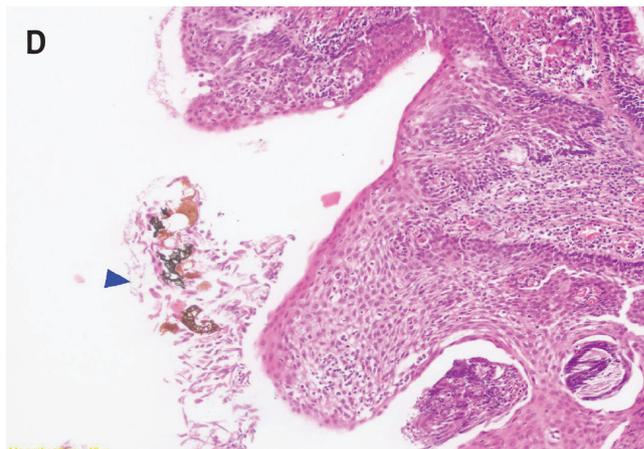


Fig. 3d. Tracheal mucosa with features of mature squamous metaplasia, abundant stromal infiltration of inflammatory cells. Blue arrow - exfoliated squamous epithelial cells mixed with food debris.

post-operative dysphonia by delaying the healing of the surgically formed sphincter, which is necessary for proper phonation. Chronic obstructive pulmonary disease (COPD) also hinders voice rehabilitation. Radiation therapy, by causing xerostomy, swelling, and hardening of tissues, reduces the vibrational abilities of the neoglottis; thus, the resulting voice is „muffled”. Also the scope of surgical resection and the newly created laryngeal architecture affect voice quality. The SCPL-SCP technique includes the removal of the thyroid cartilage, epiglottis, entire paraglottic space, entire supraglottic space, and true and pseudo vocal folds on both sides of the larynx; however, at least one arytenoid cartilage is preserved during SCPL. The cricoid cartilage and the hyoid bone are always preserved to make the anastomosis. The voice after SCPL-CHP arises because one or both arytenoid cartilages vibrate at the base of the tongue [40]. The sphincter of the neoglottis func-

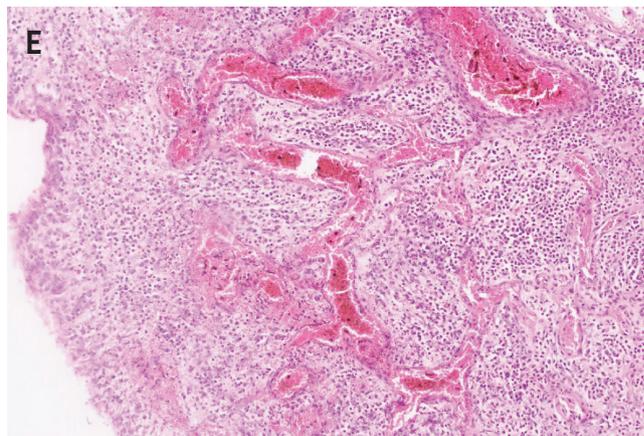


Fig. 3e. Trachea wall without mucosa (necrotic), non-specific granuloma in the stroma (x 200).

tions because the arytenoid cartilages move forwards with simultaneous retraction of the base of the tongue. SCPL-CHP and SCPL-CHEP enable similar mobility of the arytenoid cartilages. After SCPI-CHP, the preserved arytenoid cartilage(s) vibrate towards the base of the tongue, whereas after SCPL-CHEP they vibrate towards the rigid epiglottis. Makieff et al. [20] found that the function of the preserved arytenoid cartilage(s) did not significantly affect the quality of voice, but preservation of both arytenoid cartilages significantly shortened rehabilitation of swallowing. Preservation of both arytenoid cartilages means preservation of the oblique and transverse arytenoid muscles, which move the arytenoids closer together and prevent the arytenoids from moving forwards. After SCP-CHEP, good contact during vibrations between the epiglottis and the arytenoid cartilages enables satisfactory voice quality. On the other hand, Laccourreye et al. [13] emphasized that preservation of both arytenoid cartilages does not significantly improve closure of the neoglottis on phonation. The preserved arytenoid cartilages move horizontally and medially, which creates a gap before the epiglottis. Because of this configuration, the voice is puffy and the fundamental frequency (F0) and the maximum phonation time (MPT) are reduced. In this situation, during voice rehabilitation, the patient should be taught to retract the tongue backwards. Moving the tongue posteriorly causes the epiglottis to invert and touch the arytenoid cartilages, which increases the tone of voice. Also, exercising the adduction of arytenoid cartilages through forced breath-holding will also strengthen the anterior movement of the cartilages. Patients may initially report breathing difficulties due to air leakage through the gap in the neoglottis, but long-term exercises help with this problem. In most cases, patients after partial surgery have problems with full closure of the neoglottis on phonation due to tissue loss after surgical resection. Schneider et al. [38] stresses that when the gap in the glottis on phonation is greater than 1 mm, a puffing voice is produced. After SCPL, the voice is puffy and has low fundamental frequency (F0). The purpose of early rehabilitation is to increase the strength, endurance, and elasticity of the remaining parts of the larynx and to create a vibration zone in the neoglottis.

According to Sparano et al. [39], preservation of at least one arytenoid cartilage with normal mobility in the cricoarytenoid joint allows a good recovery of swallowing and speech after SCPL-CHEP. Laccourreye et al. [13] pointed out that an adult with a properly functioning voice apparatus speaks, on average, 10 words more, in one breath, than a patient after SCPL, which after a minute results in a difference of 28 words. Pindzola et al. [29] found that MPT is twice as long in a person with a functional voice apparatus than in a patient after SCPL (16 s versus 8.7 s). Laccourreye et al. [13] studied voice in 28 patients after SCPL-CHEP. They assessed the following vari-

ables: maximum phonation time (the maximum time of pronouncing the vowel „a” at a comfortable intensity), speech rate (the number of words read per minute), and phrase grouping (the number of words for each breath). MPTs and speech rates were lowered, and phrase grouping were shortened in patients after SCPL-CHEP. Their F0 values were also lowered (124 Hz in patients after SCPL, compared with 150 Hz in people with normal voice apparatus). The variables indicating voice disorders, i.e., jitter, shimmer, noise-to-harmonic ratio (NRH) were increased in patients after SCPL. Laccourreye et al. [13] suggests that the reduction of F0 after SCPL is due to altered laryngeal construction and thickening of vibrating tissues in the neoglottis (tongue base, the mucous membrane of the arytenoids, and epiglottis). Increased jitter, shimmer, and noise-to-harmonic ratios are due to an incomplete closure of the neoglottis and uncoordinated vibrations on phonation. Weinstein et al. [43] evaluated vibration by videostroboscopy in patients after SCPL-CHEP. He found a mucosal wave between the front of the arytenoid cartilage(s) and the base of the tongue or the epiglottis. According to Weinstein, when one arytenoid cartilage was preserved, the mucosal wave was typically observed between the mucous membrane of the cartilage and the epiglottis. When both arytenoid cartilages were preserved, the mucosal wave was observed between the two cartilages and between the cartilages and the epiglottis. In another study, Weinstein et al. [44] evaluated the voice quality in patients undergoing SCPL. They found that the voice was more similar to the normal voice compared to patients after total laryngectomy and with tracheoesophageal fistulas. Therefore, SCPL-CHP and SCPL-CHEP can preserve intelligible voice (by forming the neoglottis without decreasing the scope of resection). Botazzi et al. [6] performed a multicenter study in Italy, which involved 323 patients after SCPL. In 183 patients (56%), the voice was hoarse, and in 140 patients (43%), the voice was puffing. Bron et al. [4] performed a subjective evaluation of voice in patients after SCPL with the GRBAS scale (grade, roughness, breathiness, asthenicity, strain). The voice was classified as rough, puffing and tense, or as heavy dysphonia. According to Ruiz et al. [32], the puffing voice can be due to mucosal edema. As the swelling decreases, the mobility of the cartilage returns and the voice becomes less puffing.

SUMMARY:

In principle, supracricoid partial laryngectomy (with crico-epiglottis-hyoidopexy or with crico-hyoidopexy) is an extension of supraglottic surgery of the larynx [19]. In the supraglottic surgery of the larynx, vocal folds are preserved, whereas the entire supraglottic part of the larynx is removed. In SCPL, the vocal folds are removed, and the neoglottis is formed from the

„cricoaerytenoid unit”. Thus, post-operative outcomes in terms of intelligible speech and functional swallowing are satisfactory. Partial laryngectomies are technically difficult and should

be offered to carefully qualified patients. Reconstructive supracricoid laryngectomy should be used more frequently in patients with advanced laryngeal cancer.

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