Functional and Oncologic Results of Extended Supracricoid Partial Laryngectomy

Jun-Ook Park, MD; Young-Hoon Joo, MD; Kwang-Jae Cho, MD; Nam-Gyun Kim, MD; Min-Sik Kim, MD, PhD

Objective: To evaluate functional and oncologic results in patients who underwent unilateral arytenoidectomy during supracricoid partial laryngectomy.

Design: Retrospective analysis of medical records.

Setting: Tertiary care referral center.

Patients: One hundred sixteen patients who had received supracricoid partial laryngectomy.

Main Outcome Measures: Functional and oncologic results in patients who received supracricoid partial laryngectomy with the extended procedure of unilateral arytenoidectomy.

Results: There was a significantly higher rate of aspiration pneumonia ($P = .002$) and a longer delay of decannulation ($P = .03$) in the extended group. No significant differences were noted between the 2 groups in the scores for “normalcy of diet” ($P = .68$), “eating in public” ($P = .65$), or “understandability of speech” ($P > .99$) on the Performance Status Scale for Head and Neck Cancer Patients at the last follow-up visit. Five-year overall recurrence was 24.5% in the extended group. Five-year overall survival was 66.6%, and 5-year disease-specific survival was 72.1% in the extended group.

Conclusions: Resection of the arytenoids may interrupt physiologic airway protection in the early postoperative period, necessitating special caution to prevent aspiration pneumonia. However, extended supracricoid partial laryngectomy including arytenoidectomy allows for reasonable oncologic safety and avoidance of functional handicaps and social maladjustment.


SUPRACRICOID PARIAL LARYNGECTOMY (SCPL) is an organ-preserving surgical technique used for resection of the entire thyroid cartilage, including the 2 vocal folds, the paraglottic space, and the preepiglottic space, with an oncologic outcome comparable with that of total laryngectomy.1,2 Traditionally, vocal cord fixation has been considered a contraindication to partial laryngectomy. However, this concept has been changed to preserve the cricoarytenoid unit (ie, the arytenoid cartilage, adjacent cricoid cartilage, ipsilateral superior and recurrent laryngeal nerves, interarytenoid musculature, and ipsilateral posterior and lateral cricoarytenoid musculature), which is the basic functional unit that allows for speech and swallowing without permanent tracheostomy.1,3,4 However, the oncologic safety of the extended procedure, including arytenoidectomy for securing a cancer-free margin in advanced laryngeal cancer, has not been well evaluated. In addition, the arytenoids are a component involved in the sphincteric function of the larynx, and they have an important role in protecting the airway. Thus, arytenoid resection may have a negative effect on function until the compensatory action of the residual arytenoids takes effect in time. We designed this study to evaluate the functional and oncologic results in patients who underwent unilateral arytenoidectomy during SCPL.

METHODS

PATIENTS AND TREATMENT MODALITY

We retrospectively reviewed clinical and pathologic data from 122 patients who were diagnosed as having laryngeal carcinoma and underwent SCPL at the Department of Otolaryngology–Head and Neck Surgery, The Catholic University of Korea, Seoul, between January 1, 1993, and December 31, 2009. The institutional review board of Seoul St Mary’s Hospital approved this retrospective review of the medical records and the use of archived tumor specimens. In total, 116 patients were in-
chanced according to the following criteria: (1) patients who had not been treated for the same diagnosis (cancer of the larynx) before hospitalization and (2) patients who had received SCPL as initial surgical treatment with curative intent with a minimum follow-up of 12 months.

Unilateral arytenoid cartilage disarticulation and resection was performed at the time of SCPL in patients with a lesion occupying the mucosa in the region of the arytenoid cartilage or with a fixed true vocal cord and impaired arytenoid motion. In all the patients who underwent resection of 1 arytenoid, the retroarytenoid mucosa was spared to cover the cricoarytenoid joint area on the cricoiids. This spared posterior mucosal flap was elevated and sutured anteriorly and laterally to the transacted posterior subglottic mucosa to create additional mass with the goal of equalizing the heights on both sides.

Prophylactic selective neck dissection was performed for clinically negative necks, and modified radical neck dissection was performed for clinically positive necks. Adjuvant treatment was considered when the cancer involved the resection margin, when extracapsular invasion was found, or when multiple nodal metastases were found. These rules were consistently applied to the patients in both groups. Most patients were followed up every 6 months for the first 2 years and every 12 months thereafter. Follow-up tools included computed tomography, magnetic resonance imaging, liver/bone scanning, and positron emission tomography/computed tomography.

To compare the functional results of arytenoid resection, the study participants were divided into nonextended and extended groups. The following data were recorded from the patient medical records: age, sex, staging, reconstruction method, treatment modality, complications, and clinical outcome. To evaluate the clinical outcome, we analyzed the recurrence rate, site of recurrence, and overall and disease-specific survival rates. Patients were staged according to the 2002 American Joint Committee on Cancer staging system.

**EVALUATION OF EARLY POSTOPERATIVE RECOVERY**

The following data were recorded from the patient medical records: aspiration pneumonia, days to decannulation, days to nasogastric tube removal, and hospital days. We routinely evaluated the swallowing function using the modified barium swallow procedure with videofluoroscopy, and the reviews were not blinded. We removed the nasogastric tube when patients were supposed to be able to eat more than 50% of a regular meal orally without severe aspiration (ie, 7-10 days postoperatively). We usually removed the tracheostomy tube when the patients tolerated plugging of the tracheotomy tube orifice and had no evidence of pulmonary complications on chest radiographs.

**EVALUATION OF VOICE AND SPEECH**

Perceptual Analysis

Perceptual evaluation was performed using the GRBAS scale designed by Hirano and tested and retested by De Bodt et al,3 where G stands for overall hoarseness grade; R, roughness; B, breathiness; A, asthenia; and S, strain. Each subscale was rated as 0 (normal), 1 (slight), 2 (moderate), or 3 (severe). The voices were judged by 2 speech therapists by consensus and were rated using a live voice situation.

**Acoustic Analysis**

We used the Multi-Dimensional Voice Program from the Computerized Speech Lab, model 4150 (version 3.1.7; KayPENTAX, Montvale, New Jersey) to measure the values of jitter and shimmer and the noise to harmonic ratio. The acoustic voice signal was recorded by placing a microphone (model SM48; Shure Inc, Niles, Illinois) 10 cm from the mouth. The 2-second record of the central segment of the /a/ vowel was selected and maintained for approximately 5 seconds at a comfortable pitch and volume for the patient.

**EVALUATION OF RECOVERY OF SOCIAL DIET AND SPEECH**

Swallowing and speech functions in social life were subjectively evaluated at the last follow-up visit using the Performance Status Scale for Head and Neck Cancer Patients, as described by List et al.9 The normalcy-of-diet subscale assessed the degree to which a patient was able to eat a normal diet. The subscale included 10 food categories arranged from “easy to eat” at the low end to “hard to eat” at the high end, and ratings were based on the highest-ranking food the patient was able to eat. The rating-in-public subscale assessed the degree to which the patients ate in the presence of other people. It contained 5 levels ranging from “always eat alone” at the low end to “no restriction of place, food, or companion” at the high end, and ratings were based on the degree to which the interviewer could understand the patient’s speech.

**STATISTICAL ANALYSIS**

Χ², Fisher exact, t tests, and correlation analyses were used as appropriate to identify significant differences in functional variables between the 2 groups. The 5-year recurrence and survival rates were determined using the Kaplan-Meier method. \( P < .05 \) was deemed to indicate statistical significance. All the analyses were performed using a commercially available software program (SPSS version 13.0; SPSS Inc, Chicago, Illinois).

**RESULTS**

**PATIENT DEMOGRAPHICS**

Patient demographics associated with functional results are summarized in Table 1. The nonextended and extended groups consisted of 84 and 32 patients, respectively. No significant differences were noted between the 2 groups in age, sex, reconstruction method, or postoperative adjuvant therapy. The T and N categories were significantly higher in patients in the extended group \( P = .001 \) and \( P = .008 \), respectively.

**COMPARISON OF EARLY POSTOPERATIVE RECOVERY**

The results of functional recovery in the early postoperative period are summarized in Table 2. According to the extended procedure of unilateral arytenoidectomy, there were significant differences in the decannulation time \( (P = .03) \) and the rate of aspiration pneumonia \( (P = .002) \) between the 2 groups. There were significant delays in decannulation \( (P = .03) \) and nasogastric tube re-
The results of swallowing and speech functions are summarized in Table 4. Based on the deglutition function, the mean (SD) score was 89.33 (12.01) for normalcy of diet and 91.67 (13.66) for ability to eat in public. Fifteen patients (50%) had no limitations in their diet, with mean scores of 0 to 60. Twenty-one patients (70%) had no restrictions in place, food, or companions (ate out at any opportunity), with a mean score of 100. Fifteen patients (75%) in the nonextended group and 6 (60%) in the extended group scored 100. Eight patients (27%) had no restrictions of place, but diets were restricted when in public (ate anywhere, but intake was limited to less “messy” foods, eg, liquids), with a score of 75. Only 1 patient (3%) in the nonextended group could eat only “messy” foods, eg, liquids, with a score of 75. Ten patients (50%) in the nonextended group and 5 (50%) in the extended group scored more than 75. 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Oncologic results

The cancer involved the resection margin in 5 cases (4.3%), but no cases involved the posterior margin near the arytenoids. Two cases had positive margins inferiorly, 2 anteriorly, and 1 laterally (paraglottic space). Oncologic results of the patients who underwent SCPL with the extended procedure of unilateral arytenoidectomy are described in the Figure. Five-year overall recurrence was 24.5%, 5-year local recurrence was 11.3%, and 5-year regional recurrence was 15.0%. Five-year overall survival was 66.6%, and 5-year disease-specific survival was 72.1%.

COMMENT

Supracricoid partial laryngectomy is a surgical procedure that removes most of the sphincteric anatomy of the larynx and leaves only 1 cricoarytenoid unit in some advanced cases.1 The cricoarytenoid unit consists of the arytenoid cartilage, adjacent cricoid cartilage, ipsilateral superior and recurrent laryngeal nerves, interarytenoid musculature, ipsilateral posterior and lateral cricoarytenoid musculature, and the basic functional anatomical structure for swallowing and phonation. The understanding how this functional unit works enables laryngeal preservation, even in more advanced cancer cases with vocal cord fixation and impaired arytenoid motion after removing 1 arytenoid.1,3,4 However, the unpaired function of 1 cricoarytenoid unit is not likely to be enough for normal swallowing and speech without any functional deficit. We evaluated functional recovery in the early and late postoperative periods separately.

To evaluate functional rehabilitation of the larynx in the early postoperative period, we compared the decannulation and nasogastric tube removal times. Decannulation is thought to be the most important event for the rehabilitation of voice and swallowing. A delay in dec-
Effect of arytenoid resection in 20 SCPL (CHP) patients and reported that the mean time to decannulation was 20.8 days when both arytenoids were spared and 40.2 days when 1 arytenoid was spared. The mean time to removal of the feeding tube was 8.8 days when both arytenoids were spared and 18.4 days when 1 arytenoid was spared. The differences were statistically significant.

In our study, the decannulation time was significantly delayed in patients with 1 arytenoid, which is consistent with those of the 3 aforementioned studies. Even when considering the compensatory function of the remaining epiglottis (which functions as a laryngeal sphincter) in SCPL (CHEP) patients, the mean decannulation and nasogastric tube removal times were significantly different according to the extended procedure of unilateral arytenoidectomy. In SCPL (CHP) patients, the mean decannulation and nasogastric tube removal times were delayed in the extended group, but the differences were not statistically significant owing to the small number of patients. Because the arytenoids are the only remaining structure of the laryngeal sphincter in SCPL (CHP) patients, it seems to be a natural result that additional resection of 1 arytenoid has a negative effect on function. Even the preserved epiglottis in CHEP patients, another sphincter, the preserved epiglottis may not have a normal airway protective function due to surgical trauma or mucosal swelling. Thus, adequate time for resolution of swelling and compensation of the remaining sphincter is needed.

We also identified the correlation between arytenoid resection and aspiration pneumonia. Although 43.8% of patients in the extended group experienced pneumo-

### Table 2. Functional Recovery in the Early Postoperative Period

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonextended Group (n = 84)</th>
<th>Extended Group (n = 32)</th>
<th>CHEP (n = 83)</th>
<th>CHP (n = 33)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to decannulation, mean (SD), d</td>
<td>16.83 (10.33)</td>
<td>23.27 (19.53)</td>
<td>.03</td>
<td>16.78 (10.26)</td>
<td>.03</td>
</tr>
<tr>
<td>Time to nasogastric tube removal, mean (SD), d</td>
<td>24.19 (16.91)</td>
<td>27.33 (13.39)</td>
<td>.36</td>
<td>22.66 (12.86)</td>
<td>.09</td>
</tr>
<tr>
<td>Hospitalization time, mean (SD), d</td>
<td>40.83 (25.59)</td>
<td>43.74 (16.01)</td>
<td>.56</td>
<td>38.06 (16.45)</td>
<td>.05</td>
</tr>
<tr>
<td>Aspiration pneumonia, No. (%)</td>
<td>No</td>
<td>71 (84.5)</td>
<td>.002</td>
<td>68 (81.9)</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>13 (15.5)</td>
<td></td>
<td>21 (26.1)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonextended Group (n = 20)</th>
<th>Extended Group (n = 10)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRBAS score, mean (SD)</td>
<td>2.85 (0.47)</td>
<td>3.00 (0.00)</td>
<td>.33</td>
</tr>
<tr>
<td>Grade</td>
<td>2.85 (0.47)</td>
<td>3.00 (0.00)</td>
<td>.69</td>
</tr>
<tr>
<td>Roughness</td>
<td>2.19 (0.67)</td>
<td>2.45 (0.68)</td>
<td>.28</td>
</tr>
<tr>
<td>Breathiness</td>
<td>1.23 (1.13)</td>
<td>0.54 (0.93)</td>
<td>.18</td>
</tr>
<tr>
<td>Aesthenia</td>
<td>1.71 (0.54)</td>
<td>1.81 (0.75)</td>
<td>.89</td>
</tr>
<tr>
<td>Strain</td>
<td>6.52 (1.24)</td>
<td>4.98 (1.45)</td>
<td>.57</td>
</tr>
<tr>
<td>Jitter, %</td>
<td>1.75 (0.36)</td>
<td>1.67 (1.12)</td>
<td>.39</td>
</tr>
<tr>
<td>Shimmer, %</td>
<td>0.48 (0.23)</td>
<td>0.56 (0.24)</td>
<td>.58</td>
</tr>
</tbody>
</table>

### Abbreviations:
- CHEP: cricohyoidoepiglottopexy
- CHP: cricohyoidopexy
- Nonextended Group
- Extended Group
- CHEP
- CHP
- PN: Performance Status Scale for Head and Neck Cancer Patients
- PSS-HN: Performance Status Scale for Head and Neck Cancer Patients
- P: P-value

### Table 3. Comparison of Voice Variables According to Arytenoid Resection

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonextended Group (n = 20)</th>
<th>Extended Group (n = 10)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0, Hz</td>
<td>121.14 (42.03)</td>
<td>101.52 (51.67)</td>
<td>.30</td>
</tr>
<tr>
<td>Jitter, %</td>
<td>6.52 (1.24)</td>
<td>4.98 (1.45)</td>
<td>.57</td>
</tr>
<tr>
<td>Shimmer, %</td>
<td>1.75 (0.36)</td>
<td>1.67 (1.12)</td>
<td>.39</td>
</tr>
<tr>
<td>Noise to harmonic ratio</td>
<td>0.48 (0.23)</td>
<td>0.56 (0.24)</td>
<td>.58</td>
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</table>

### Table 4. Recovery of Swallowing and Speech Function in Social Life at the Final Follow-up Visit According to Arytenoid Resection

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nonextended Group (n = 20)</th>
<th>Extended Group (n = 10)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSS-HN score, mean (SD)</td>
<td>90.00 (11.69)</td>
<td>88.00 (13.16)</td>
<td>.68</td>
</tr>
<tr>
<td>Normalcy of diet</td>
<td>92.50 (14.28)</td>
<td>90.00 (12.91)</td>
<td>.65</td>
</tr>
<tr>
<td>Understandability of speech</td>
<td>65.00 (20.52)</td>
<td>65.00 (17.48)</td>
<td>&gt;.99</td>
</tr>
</tbody>
</table>

### Abbreviations:
- F0: fundamental frequency
- GRBAS: G stands for overall hoarseness grade; R, roughness; B, breathiness; A, asthenia; S, stain.
- PSS-HN: Performance Status Scale for Head and Neck Cancer Patients
- P: P-value

Cannulation may lead to inflammatory changes in the larynx, resulting in granulation, and can disturb laryngeal elevation during swallowing, resulting in dysphagia. We evaluated the swallowing function using the modified barium swallow procedure with videofluoroscopy, and we removed the nasogastric tube when patients were supposed to be able to eat a portion of a regular meal orally without severe aspiration. Therefore, the nasogastric tube removal time (approximately at 7 day postoperatively) can be a reliable variable for early postoperative recovery of deglutition. Several studies have used the indication and nasogastric tube removal times as indicators for early postoperative rehabilitation. Bron et al. evaluated the effect of arytenoid resection in SCPL (CHP/CHEP) patients. They reported that the nasogastric tube removal time was not significantly different based on arytenoid resection, and they determined that single-arytenoid resection did not affect swallowing function in the early postoperative period. Akbas and Demirelter evaluated the effect of arytenoid resection in 46 (CHP) patients. The mean time for decannulation was 20 days when both arytenoids were spared and 41 days (range, 13-150 days) when 1 arytenoid was spared. The mean time for removal of the feeding tube was 21 days (range, 9-60 days) when both arytenoids spared and 40 days when 1 arytenoid was spared. Yuce et al. also investigated the effect of arytenoid resection in 20 SCPL (CHP) patients and noted 20.8 days when both arytenoids were spared and 40.2 days when 1 arytenoid was spared. The mean time to removal of the feeding tube was 8.8 days when both arytenoids were spared and 18.4 days when 1 arytenoid was spared. The differences were statistically significant.

In our study, the decannulation time was significantly delayed in patients with 1 arytenoid, which is consistent with those of the 3 aforementioned studies. Even when considering the compensatory function of the remaining epiglottis (which functions as a laryngeal sphincter) in SCPL (CHEP) patients, the mean decannulation and nasogastric tube removal times were significantly different according to the extended procedure of unilateral arytenoidectomy. In SCPL (CHP) patients, the mean decannulation and nasogastric tube removal times were delayed in the extended group, but the differences were not statistically significant owing to the small number of patients. Because the arytenoids are the only remaining structure of the laryngeal sphincter in SCPL (CHP) patients, it seems to be a natural result that additional resection of 1 arytenoid has a negative effect on function. Even the preserved epiglottis in CHEP patients, another sphincter, the preserved epiglottis may not have a normal airway protective function due to surgical trauma or mucosal swelling. Thus, adequate time for resolution of swelling and compensation of the remaining sphincter is needed.

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nia, all improved with antibiotic drug therapy and conservative treatment. We previously investigated and reported the factors that predict postoperative pulmonary complications after SCPL. Age, chronic lung disease, smoking status, CHP, and ipsilateral arytenoidectomy were associated with pulmonary complications.

Luna-Ortiz et al evaluated the deglutition function of patients who underwent SCPL (CHEP) using the Performance Status Scale for Head and Neck Cancer Patients, and most of their patients had only 1 arytenoid. Fifteen of 17 patients had 1 arytenoid removed. Deglutition function was excellent, with a median score of 95 for normalcy of diet and 100 for the ability to eat in public. They explained that 41% of the patients had mild long-term limitations for foods such as peanuts, raw vegetables, and rice. They also concluded that arytenoidectomy had no significant negative effect on the deglutition function. Yuce et al investigated the functional effect of arytenoidectomy in patients who underwent SCPL with CHP. They evaluated the deglutition function 12 months after surgery using Marchese-Ragona’s dysphagia scoring system, which is composed of 5 simple but somewhat equivocal variables. There was no significant difference in deglutition function 1 year after surgery according to the number of remaining arytenoids. In the present study, the deglutition function was generally satisfactory regardless of arytenoidectomy, but understandability of speech was comparatively low in both groups. Approximately 50% of patients stated that face-to-face contact was needed to understand speech, but we could understand their speech without face-to-face contact, even on a telephone call. The understandability of speech results were somewhat subjective and may have been affected by the working environment, fellow workers, family members, and individual personality.

Complete neoglottic closure is an essential factor for phonation and airway protection during swallowing. When sparing only 1 arytenoid, the interarytenoid muscle must be transected so that the posterior and lateral cricoarytenoid muscle takes over the main role as the neoglottic closer. Contraction of the lateral cricoarytenoid muscle induces the adduction and anterior fall of the arytenoid body, which consists primarily of anteroposterior movement against the epiglottis. Yuce et al claimed that the recovery of swallowing and voice function more than 1 year after surgery may be due to the compensatory action of the residual arytenoid. However, because of the limitation of medial movement without the interarytenoid muscle, we believe that the compensatory overaction of the contralateral arytenoid is not sufficient to completely close the glottis gap. Hypertrophy of the mucosa covering the arytenoidectomy side may cover the gap from the contralateral arytenoid. Weinstein and Laccourreye also reported that the mass effect of the preserved arytenoid mucosa on the arytenoidectomy area is important for a functional outcome. We estimated and reported the thickness of neoarytenoid soft tissue (mean [SD], 5.66 [2.61] mm) measured from the superior surface of the cricoid cartilage on neck computed tomography, and it was significantly larger than that of the mucosa covering the spared arytenoid cartilage.

Compensatory overaction of the remnant arytenoid and the mass effect of neoarytenoid soft tissue are essential for complete glottic closure. Thus, swallowing and voice rehabilitation need enough time for formation of hypertrophic tissue at the arytenoidectomy and for adaptation of compensatory posterior and lateral cricoarytenoid muscles. In cases requiring arytenoidectomy, we routinely preserve the retroarytenoid mucosa to cover the cricoarytenoid joint area on the cricoids. This spared re-

Figure. Kaplan-Meier survival curves for patients who underwent supracricoid partial laryngectomy with the extended procedure of unilateral arytenoidectomy. A, Overall survival. B, Disease-specific survival. C, Disease-specific survival according to the T category.
roarytenoid mucosa is sutured anterolaterally to the resected subglottic mucosal margin to equalize the heights of both sides and form a buttress. This hypertrophic soft-tissue mass of repaired retroarytenoid mucosa is thought to promote neoglottic closure, and it helps prevent aspiration during swallowing.

Kirchner and Som16 analyzed 23 total laryngectomy specimens with true vocal cord fixation and reported that tumor invasion was limited to the paraglottic space without invasion of the thyroid or cricoid cartilages. Brasnu et al17 analyzed specimens from 14 patients with glottic cancer with vocal cord fixation and reported thyroarytenoid muscle invasion in all cases except cricoarytenoid joint invasion or lateral cricoarytenoid muscle invasion only in cases in which the arytenoid cartilage was fixed. Laccourreye et al3 reported that arytenoid cartilage fixation is a contraindication for SCPL. However, there are several reports of satisfactory outcomes of SCPL with arytenoidectomy in patients with vocal cord fixation and impaired arytenoid motion, not arytenoid fixation.1,18 Thus, we usually consider arytenoidectomy during SCPL in cases with true fixed vocal cords and impaired arytenoid motion. In the present study, because of the higher regional recurrence, the overall recurrence rate was higher in the extended group. In other hands, the higher recurrence rate was not due to the higher local recurrence. This higher recurrence rate was due to frequent regional recurrence in the extended group, which is a natural result of more advanced T-category and N-category tumors.

In conclusion, arytenoid resection during SCPL may interrupt physiologic airway protection in the early postoperative period, necessitating special precautions to prevent aspiration pneumonia. However, extended SCPL, including arytenoidectomy for patients with advanced laryngeal cancer with arytenoid invasion or fixed cords, allows for reasonable oncologic safety and avoidance of functional handicaps and social maladjustment.

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REFERENCES