Factors That Predict Postoperative Pulmonary Complications After Supracricoid Partial Laryngectomy

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Objective: To determine the risk factors related to postoperative pulmonary complications in patients who undergo supracricoid partial laryngectomy.

Design: Retrospective analysis of medical records.

Setting: Tertiary care referral center.

Patients: One hundred eleven patients who underwent supracricoid partial laryngectomy from January 1, 1993, through December 31, 2008.

Main Outcome Measures: Relationship between postoperative pulmonary complications and perioperative risk factors, such as age, sex, chronic lung disease, smoking status, tumor site, tumor stage, preoperative irradiation, extent of surgery, reconstruction method, and pulmonary function tests.

Results: Thirty-six patients (32.4%) developed postoperative pulmonary complications. Significant correlations were found among age (P = .002), chronic lung disease (P = .005), smoking status (P = .02), and postoperative pulmonary complications. Cricohyoidopexy (P = .008) and ipsilateral arytenoidectomy (P = .03) were associated with postoperative pulmonary complications. The multivariate analysis showed a significant association of the postoperative pulmonary complications with age (odds ratio [OR], 3.8; 95% confidence interval [CI], 1.2-11.7 in patients 60 to 69 years old; and OR, 7.1; 95% CI, 1.3-37.6 in patients 70 to 79 years old) and cricothyroidopexy (OR, 4.4; 95% CI, 1.1-18.1).

Conclusion: Patients 60 years or older and patients with cricothyroidopexy are at high risk of having postoperative pulmonary complications after supracricoid partial laryngectomy.


SUPRACRICOID PARTIAL LARYNGECTOMY (SCPL) is a surgical technique used for en bloc resection of the thyroid cartilage, paraglottic space, and pre-epiglottic space with an oncologic outcome comparable to a total laryngectomy.1,2 Supracricoid partial laryngectomy allows for the cricoarytenoid unit to be spared and enables physiologic phonation and deglutination without a permanent tracheostomy. However, because of the occurrence of aspiration in virtually all patients who undergo this procedure, preoperative assessment of the pulmonary status and prevention of postoperative pulmonary complications are necessary. Postoperative pulmonary complications contribute significantly to the morbidity, mortality, and length of hospitalization after this procedure. The most important and morbidi postoperative pulmonary complications are atelectasis, pneumonia, respiratory failure, and exacerbation of underlying chronic lung disease.3 However, there has been no report with regard to the frequency of postoperative pulmonary complications associated with perioperative risk factors in patients who undergo SCPL. The aims of this study were to retrospectively evaluate the pulmonary complication rates and the clinical and laboratory predictors of postoperative pulmonary complications in patients who undergo SCPL and to provide guidance to reduce the postoperative pulmonary complications.

METHODS

PATIENTS

The clinical and pathologic data of 111 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, from January 1, 1993, through December 31, 2008, were reviewed. The decision to perform SCPL depended on strict oncologic selection criteria. For patients with stage T1 disease that was suspected to involve anterior commissure or...
thyroid cartilage, impaired vocal cord mobility, or paraglottic space invasion in accordance with preoperative imaging. SCPL was considered first. We examined the relationship between postoperative pulmonary complications and preoperative risk factors, such as age, sex, chronic lung disease, smoking status, tumor site, tumor stage, preoperative irradiation, extent of surgery, reconstruction method, and pulmonary function tests (PFTs).

Preoperative evaluations included a complete medical history and physical examination. Forced expiratory volume in 1 second (FEV$_1$), forced vital capacity (FVC), and FEV$_1$/FVC were the specific PFTs examined in each patient included in this study. Each result was placed into 1 of 3 categories based on the FEV$_1$, FVC, and FEV$_1$/FVC (≤50%, 60%-79%, and ≥80%, respectively). The postoperative period was defined as the period that extends from the end of the surgical procedure until hospital discharge. Diagnosis of postoperative pulmonary complications was always supported by chest radiograph and sputum culture data. Disease was staged according to the 2002 edition of the TNM classification of the American Joint Committee on Cancer. The institutional review board of Bandong Seochou Kangnam St. Mary’s Hospital (Seoul, Korea) approved this retrospective review of the medical records and the use of archived tumor specimens.

### STATISTICAL ANALYSIS

To analyze statistically significant relationships among the distribution of categorical values, the χ$^2$ test, Fisher exact test, multiple logistic regression analysis, multiple linear regression analysis, and correlation analysis were used, as appropriate. $P < .05$ was considered statistically significant. All calculations were performed by means of SPSS statistical software, version 13.0 (SPSS Inc, Chicago, Illinois).

### RESULTS

#### PATIENT DEMOGRAPHICS

The mean age of the patients was 60.9 years (range, 40-79 years), and the male-to-female ratio was 105:6. As seen in the Table, we identified 11 patients who had a history of chronic obstructive pulmonary disease (eg, asthma, emphysema, chronic bronchitis). Smoking habits were recorded in all patients: 14 never smoked, 10 had stopped at least 6 months before surgery, and 87 patients currently smoked. With regard to their pathologic stages, there were 19, 46, 28, and 18 patients with stage T1 through T4 disease, respectively. Concerning the disease stage of the cervical lymph nodes, there were 93, 8, 9, and 1 patients with N0 through N3 disease, respectively. The tumor originated from the glottis, supraglottis, and transglottis in 84, 14, and 13 patients, respectively. Preoperative radiosurgery was performed in 8 patients, and PFTs were performed preoperatively in 90 patients. Ipsilateral arytenoidectomy was performed in 28 patients. For reconstruction, cricothyroidopiglottopexy and cricothyroidopexy were performed in 78 and 33 patients, respectively.

#### RISK FACTORS RELATED TO POSTOPERATIVE PULMONARY COMPLICATIONS

Among the 111 patients who underwent SCPL, 36 (32.4%) developed postoperative pulmonary complications. Postoperative pneumonia was identified in 24 patients, pleural effusion in 5 patients, atelectasis in 4 patients, and pulmonary edema in 3 patients. A significant positive correlation was found between age ($P = .002$), chronic lung disease ($P = .005$), and smoking status ($P = .02$) and postoperative pulmonary complications. However, there was no relationship between sex ($P = .39$), preoperative irradiation ($P = .27$), tumor sites ($P = .19$), and primary tumor stage ($P = .84$) and postoperative pulmonary complications. For the SCPL procedure-related risk factors, cricothyroidopexy ($P = .008$) and ipsilateral arytenoidectomy ($P = .03$) were strongly associated with postoperative pulmonary complications. Among the PFTs, the FEV$_1$/FVC...
Pulmonary complications are common, with significant morbidity, after partial laryngectomy procedures and sometimes result in the need for a completion total laryngectomy. The incidence of pulmonary complications has been reported to be 6% to 47% after supraglottic laryngectomy and 0% to 13% after vertical hemilaryngectomy.\(^4\)\(^7\) Supracricoid partial laryngectomy results in complete and bilateral resection of the paraglottic space including, when required, 1 arytenoid cartilage on the tumor-bearing side. When compared with the conventional vertical partial and supraglottic laryngectomies, SCPL is considered to be a conservative laryngeal procedure that interferes mostly with the sphincteric function of the larynx.\(^8\) Lewin et al\(^a\) reported that the postoperative complication rate, including pneumonia and subcutaneous emphysema, was 26% after SCPL. The overall complication rate was 32.4% in our study, slightly higher than with the conventional supraglottic and vertical partial laryngectomies reported in the literature.

The present study showed a statistically significant relationship between the incidence of postoperative pulmonary complications and the risk factors of old age (\(P = .02\)) and cricohyoidoepipexy (\(P = .04\)) after multivariate analysis. Age was a significant risk predictor and was the second most commonly identified risk factor.\(^9\) Aging is associated with impaired oropharyngeal motor commands and laryngopharyngeal sensitivity. Modifications of the pulmonary physiologic processes related to aging also greatly increase the risk of atelectasis and pneumonia during the postoperative period.\(^11\) Some authors have strict age criteria for the performance of partial laryngeal surgery. Alajmo et al\(^12\) studied 3 elderly patients treated with SCPL and cricohyoidoepipexy and found that 1 presented with bronchopneumonia from aspiration and 1 required completion total laryngectomy; the author concluded that SCPL and cricohyoidoepipexy were not advisable in elderly patients. However, others have stated that it is the biological age and overall constitution of the patient that are more important than the chronologic age.\(^3\)\(^8\) Laccourreye et al\(^a\) reported that age by itself should not be considered as a deterrent to SCPL completion. In this study, the postoperative pulmonary complication rate for patients 60 to 69 years of age was 39.6%, and for patients older than 70 years the complication rate was 57.1%; however, the postoperative pulmonary complication rate for patients younger than 59 years was 18.4%. Care should be taken to carefully control the perioperative comorbid conditions and provide the appropriate medical care needed in elderly patients who have undergone SCPL.

Classically, SCPL provides 2 types of interventions: cricohyoidoepiglottopexy and cricohyoidoepipexy. Although similar in surgical concept, they differ in their effects on aspiration and postoperative pulmonary complications.\(^13\) For cricohyoidoepiglottopexy, aspiration uniquely occurs in patients whose epiglottic dynamics do not return to a satisfactory level during the recuperation period. For cricohyoidoepipexy, aspiration more frequently occurs because of the absence of the epiglottis and faulty neoglottic closure, most often secondary to the poor adaptation of lingual dynamics. Woisard et al\(^13\) reported that aspiration was not common after cricohyoidoepiglottopexy but was more frequent with cricohyoidoepipexy. They found that even if neoglottic closure was maintained during the pharyngeal swallow, the persistent stasis between the arytenoids and the lingual base might be aspirated after swallowing in cricohyoidoepipexy. Yüceturk et al\(^14\) however, recently reported excellent functional results after SCPL and cricohyoidoepipexy in 10 patients evaluated by the use of videofluoroscopy. They noted that the preventive precautions for aspiration were preserving of the superior laryngeal nerves, suturing and positioning of the cricoarytenoid unit as anterosuperiorly as possible, early decannulation, and early onset of swallowing rehabilitation. In our series, postoperative pulmonary complications developed in 51.5% of the cricohyoidoepipexy patients and in 24.4% of patients after cricohyoidoepiglottopexy. Therefore, our findings suggest that patients who undergo SCPL and cricohyoidoepipexy are at increased risk for postoperative pulmonary complications.

According to this study, the following risk factors were significant predictors of postoperative pulmonary complications on univariate analysis: chronic lung disease (\(P = .005\)), smoking status (\(P = .02\)), ipsilateral arytenoidectomy (\(P = .03\)), and FEV\(_1\)/FVC (\(P = .04\)). Chronic obstructive pulmonary disease was the most frequently identified risk factor for postoperative pulmonary complications.\(^10\) Chronic obstructive pulmonary disease is a preoperative variable that has been identified as significantly associated with a prolonged length of hospitalization after major elective head and neck surgery.\(^15\) Some investigators, however, have reported that a history of chronic obstructive pulmonary disease could not reliably predict the development of postoperative pulmonary complications after a partial laryngectomy.\(^4\) In this series, 8 of 11 patients (73%) with chronic obstructive pulmonary disease developed postoperative pulmonary complications, whereas 28 of 100 patients without chronic obstructive pulmonary disease had postoperative complications.

Typically, patients with head and neck cancer are heavy smokers and users of alcohol who may have tumor-induced dysphagia with associated chronic aspiration. van der Voet et al\(^16\) reported that 28% of patients with T1 glottic cancer who continued smoking had complications at 10 years compared with approximately 13% of those who stopped before or after radiotherapy. McCulloch et al\(^17\) reported that univariate analysis identified smoking and weight loss as significant factors associated with pulmonary complications postoperatively after head and neck surgery.
surgery. The multivariate analysis of 410 patients, who underwent elective general, orthopedic, urologic, or cardiovascular surgery, showed an adjusted OR of 5.5 (95% CI, 1.9-16.2) for the risk of postoperative pulmonary complications in current smokers vs nonsmokers. In this study, 14 nonsmokers in our patient group had a zero complication rate and 10 ex-smokers had a 30.0% complication rate, whereas 87 current smokers had a 37.9% complication rate by the univariate analysis.

During the act of swallowing after SCPL, the tongue base has to approximate to the arytenoids and also has to cover the neoglottis to protect the airway and prevent aspiration. The extent of the arytenoid resection may have an effect on aspiration and postoperative pulmonary complications. It was reported that the average feeding tube removal time was 16 days when both arytenoids were spared during SCPL, 21 days when 1 arytenoid was spared during SCPL, and 63 days when both arytenoids were resected during SCPL. However, reported that the type of SCPL and the presence or absence of arytenoid resection had no statistically significant effect on the occurrence of aspiration. However, the number of patients in their study with partial arytenoid resection was too few, and their results require confirmation with an adequate sample size. In this study, the postoperative pulmonary complication rate was 50.0% with an ipsilateral arytenoid-sparing SCPL, whereas it was 26.5% when both arytenoids were spared during SCPL.

Controversy exists about the usefulness of PFTs to assess the ability of patients to undergo partial laryngectomy. Although the PFTs diagnose obstructive lung disease, the results do not translate into effective risk prediction for individual patients. Chow et al reported that the PFTs of patients who undergo partial laryngectomy could not reliably predict postoperative complications. In this study, the FEV1/FVC was a statistically significant independent predictor of postoperative pulmonary complications. Other PFT parameters, such as FEV1 and an FVC less than 50%, showed a trend toward a greater risk for postoperative pulmonary complications (100%); however, these differences did not reach statistical significance. The PFTs might not be needed unless there is a serious impairment of ventilation detected in the history or physical examination.

In conclusion, all patients who undergo SCPL should be evaluated for the presence of the significant risk factors of old age (<60 years) and cricothyroidopexy to determine their risk for postoperative pulmonary complications. The presence of factors that increase the risk for postoperative pulmonary complications might help improve patient management and outcomes.

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REFERENCES