Does lobectomy for lung cancer in patients with chronic obstructive pulmonary disease affect lung function? A multicenter national study

Sergio Baldi, MD,[a] Enrico Ruffini, MD,[b] Sergio Harari, MD,[c] Gian Carlo Roviaro, MD,[d] Mario Nosotti, MD,[e] Nadia Bellaviti, MD,[e] Federico Venuta, MD,[f] Daniele Diso, MD,[f] Federico Rea, MD,[g] Claudio Schiraldi, MD,[h] Alberto Durigato, MD,[i] Maurizio Pavanello, MD,[j] Angelo Carretta, MD,[k] and Piero Zannini, MD[k]

Objective: The purpose of this study was to evaluate the effect of lobectomy on pulmonary function in patients with chronic obstructive pulmonary disease.

Methods: One hundred thirty-seven patients were analyzed; 49 had normal pulmonary function tests, and 88 had chronic obstructive pulmonary disease. Different functional parameter groups were identified: obstructive (forced expiratory volume in 1 second [FEV_1], forced expiratory volume in 1 second/forced vital capacity [FEV_1/FVC], and chronic obstructive pulmonary disease index), hyperinflation (residual volume and functional residual capacity), and diffusion (transfer factor of the lung for carbon monoxide). Also, the ratio between observed and predicted postoperative FEV_1 was calculated.

Results: In patients with preoperative FEV_1 greater than 80% of predicted, postoperative FEV_1/FVC slightly but not significantly decreased, and postoperative FEV_1 significantly decreased. In patients with preoperative FEV_1 less than 65%, postoperative FEV_1 and FEV_1/FVC significantly increased. In patients with preoperative FEV_1/FVC greater than 70%, postoperative FEV_1 and FEV_1/FVC significantly decreased. In patients with preoperative FEV_1/FVC less than 70%, postoperative FEV_1/FVC increased, and FEV_1 remained unchanged. In patients with a chronic obstructive pulmonary disease index greater than 1.5, postoperative FEV_1 and FEV_1/FVC significantly decreased, whereas in patients with a chronic obstructive pulmonary disease index less than 1.5, postoperative FEV_1/FVC significantly increased and FEV_1 remained unchanged. In patients with residual volume and functional residual capacity greater than 115% and transfer factor of the lung for carbon monoxide less than 80% of predicted, postoperative FEV_1 diminished less (not significant) compared with patients who had residual volume and functional residual capacity less than 115% (P = .0001). Observed postoperative/predicted postoperative FEV_1 was higher if FEV_1/FVC was less than 55% (1.46), if FEV_1 was less than 80% of predicted (1.21), or if the chronic obstructive pulmonary disease index was less than 1.5 (1.17).

Conclusions: Patients with mild to severe chronic obstructive pulmonary disease could have a better late preservation of pulmonary function after lobectomy than healthy patients.

From the Pulmonary Division[a] and Division of Thoracic Surgery,[b] University Hospital S. Giovanni Battista of Torino, Torino, Italy, Pulmonary Division[c] and Department of Surgery, Division of General Surgery,[d] University Hospital S. Giuseppe, Milano, Italy, Division of Thoracic Surgery, Policlinico IRCCS, University of Milano, Milano, Italy,[e] Department of Thoracic Surgery, Division of Thoracic Surgery, Policlinico Umberto I, University of Roma La Sapienza, Rome, Italy,[f] Department of Thoracic Surgery, Division of Thoracic Surgery,[g] and Pulmonary Division,[h] University Hospital of Padova, Padova, Italy, Pulmonary Division[i] and Division of Thoracic Surgery,[j] Ospedale Ca' Foncello, Treviso, Italy, and Division of Thoracic Surgery, Ospedale S. Raffaele IRCCS, Milan, Italy.[k]

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Address for reprints: Sergio Baldi, MD, Respiratory Diseases, Ospedale S. Giovanni Battista, 3 Via Genova, Torino 10126, Italy (E-mail: baldi_sergio@hotmail.com).

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Lung cancer remains an important cause of death among smokers, and this condition is often associated with chronic obstructive pulmonary disease (COPD). Surgical resection offers the best chance for curing lung cancer, and lobectomy is the most frequent operation performed. Postoperative respiratory failure is a widely known complication that limits parenchymal resection in patients with COPD; exclusion criteria have been adopted to evaluate these patients, and

Abbreviations and Acronyms

COPD = chronic obstructive pulmonary disease
FEV_1 = forced expiratory volume in 1 second
FEV_1(%) = FEV_1 percentage of predicted
FRC = functional residual capacity
FVC = forced vital capacity
PFT = pulmonary function test
RV = residual volume
TLCO = transfer factor of the lung for carbon monoxide

most of them outline the importance of preoperative forced expiratory volume in 1 second (FEV_1), FEV_1/forced vital capacity (FVC), and transfer factor of the lung for carbon monoxide (TLCO). The 6-minute walking test, Master test, maximum oxygen consumption per unit time test, and prediction of postoperative FEV_1 by different formulas are also used to evaluate postoperative risk.[1] More recently, lung volume reduction surgery and recent reports on COPD patients operated on for lung cancer have revised the lung function evaluation and predictors for COPD patients who are candidates for lung resection.[2-7] Unfortunately, most of these reports on lobectomy in patients with airway obstruction reviewed a limited number of cases, and the selection of operable patients remains a great challenge.[2-7] The goal of this study was to evaluate the effect of lobectomy on pulmonary function in COPD patients.

Materials and Methods

This was a retrospective, multicenter national study. Data from 7 Italian hospitals with thoracic surgery experience (including lung transplantation, lung volume reduction surgery, or both) were collected. All patients with at least 1 preoperative and 1 postoperative pulmonary function evaluation who underwent lobectomy for lung cancer from March 1997 to March 2003 were considered; usually no more than a 6-month period was analyzed for each center. Postoperative pulmonary function tests (PFTs) were performed not earlier than the third postoperative month and not later than the 15th month. Patients who received any adjuvant or neoadjuvant therapy were not considered eligible for this study. One hundred thirty-seven patients met the criteria (35 women and 102 men); 49 had normal static and dynamic pulmonary function, according to European Respiratory Society 1993, whereas 88 had COPD ranging from grade 1 to 3 according to Global Initiative on Obstructive Lung Disease guidelines. Hyperinflation was considered if residual volume (RV) and functional residual capacity (FRC) were greater than 115% of predicted and vital capacity was in the normal limit, and impairment of gas transfer was defined as TLCO less than 80% of predicted. PFTs were performed in different laboratories by using the European Respiratory Society 1993 predicting values. All tests were performed with the same methods, and static volumes were measured by the nitrogen washout method. Patients were evaluated by radiograph and computed tomographic scan to stage the tumor, to ascertain the presence of

TABLE 1. Study population

Variable	COPD (88 patients)	Normal (49 patients)	*P* value
FVC%	96 ± 17	102 ± 16	$P = .04$
FEV_1(%)	63 ± 8	98 ± 15	$P = .00001$
FEV_1/FVC	58 ± 8	76 ± 5	$P = .00001$
COPD index	1.28 ± 0.26	1.71 ± 0.23	$P = .00001$
RV%	117 ± 26	103 ± 27	$P = .001$
TLC%	100 ± 13	99 ± 13	$P = .6$
TLCO%	69 ± 17	85 ± 22	$P = .00001$
Pao_2-pre (mm Hg)	80 ± 9	84 ± 8	$P = .01$
$Paco_2$-post (mm Hg)	36 ± 5	39 ± 3	$P = .002$

COPD, Chronic obstructive pulmonary disease; *FVC,* forced vital capacity; *FEV_1(%),* forced expiratory volume in 1 second percentage of predicted; *RV,* residual volume; *TLC,* total lung capacity; *TLCO,* transfer factor of the lung for carbon monoxide.

a flattening diaphragm, and to distinguish bullous from nonbullous emphysema.

Ninety-two patients underwent upper lobectomy, 37 underwent lower lobectomy, and 8 underwent middle lobectomy; 17% of these patients had bullous emphysema, and 32% had diaphragmatic flattening. Thirty-one had squamous cell cancer, 72 had adenocarcinoma, 5 had small cell lung cancers, and 4 had carcinoid tumors. In 25 patients, histologic results were not available or were uncertain.

In all patients, the observed postoperative FEV_1 was compared with the predicted postoperative FEV_1 by the observed postoperative/predicted postoperative FEV_1 ratio. The predicted postoperative FEV_1 value was calculated with the following equation:

$$\text{Predicted postperative } FEV_1 = \text{Preoperative } FEV_1 \times (\text{No. of segments remaining} / \text{Total no. of segments})$$

The COPD index was calculated according to Korst and associates[5] to evaluate the severity and purity of obstructive airway disease; the preoperative FEV_1 (percentage of predicted in decimal form; FEV_1%) was added to the preoperative ratio of FEV_1 to FVC. Patients with the lowest COPD index are those with the most severe airway obstruction. Patients with a COPD index greater than 1.5 do not have obstructive diseases.

The mean age of COPD patients was 68 ± 15 years, and the mean age of non-COPD patients was 66 ± 13 years (mean ± SD). FEV_1 ranged from 980 mL (34% of predicted) to 4050 mL (115% of predicted) in the entire study population. Preoperative functional data in healthy and COPD patients are shown in Table 1.

Statistical analysis included the paired *t* test for comparison of preoperative and postoperative mean values, because the patients were observed before and after a single treatment. Smith's statistical software package version 2.5, 2001 (by G. Smith, Claremont, Calif) was used for all analyses. Statistical methods included multiple comparisons of interrelated parameters, and this may cause problems with determining the appropriate significance level. To overcome this problem, we computed the number of comparisons for each category group (each table) and decreased the significance level by an appro-

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