Sleeve Lobectomy Versus Standard Lobectomy for Lung Cancer: Functional and Oncologic Evaluation

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Background. **The purpose of this study was to compare functional and oncologic outcome of sleeve lobectomy (SL) with that of standard lobectomy (STL) in patients with non-small cell lung cancer.**

Methods. **Between January 2009 and April 2013, 44 consecutive patients undergoing upper SL (29 right side, 15 left side) were prospectively enrolled to be compared with 44 patients with the same side distribution who were randomly selected from patients undergoing upper STL during the study period. Functional and oncologic results of the two groups were compared.**

Results. **Pathologic tumor stage ranged between I and IIIa with similar patient distribution between the two groups. Postoperative complication rates were 20.5% in the SL group and 16% in the STL group. There was no postoperative mortality in either group. Mean postoperative decrease in forced expiratory volume in 1 second at 3 months postoperatively was 17.5% ± 6.2% in the SL group and 19% ± 14.8% in the STL group ($p = 0.52$). There also was no significant difference ($p = 0.15$) in mean postoperative decrease in 6-minute walk test (64.3 ± 2.5 m versus 69.1 ± 21.4 m) between the two groups. Evaluation of postoperative changes in quality of life at 3 and 6 months based on a standardized questionnaire (European Organization for Research and Treatment of Cancer Quality of Life Questionnaire—Core Questionnaire) did not show significant differences between the SL group and the STL group ($p > 0.05$) in terms of global health status, physical functioning, and fatigue. Actuarial survival rates at 3 and 5 years, respectively, were 85.3% and 60.1% in the SL group and 88.7% and 58.2% in the STL group, without significant difference ($p = 0.68$).**

Conclusions. **Functional and oncologic results of SL are comparable to those of STL in patients with non-small cell lung cancer.**

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Lobectomy with sleeve resection and reconstruction of the bronchus, the pulmonary artery, or both, has proved to be a valid therapeutic option for the treatment of centrally located non-small cell lung cancer (NSCLC) [1, 2]. According to a recent metaanalysis, there is clear evidence that sleeve lobectomy (SL) is oncologically comparable to pneumonectomy (PN), with no increased postoperative morbidity, lower mortality, and better quality of life because of functional preservation [3]. This parenchymal-sparing operation was first proposed to avoid PN in patients with compromised cardiac or pulmonary function, but recent experiences have shown that the advantages of saving lung parenchyma are evident also in patients without cardiopulmonary impairment [4].

When considering lobectomy with bronchial sleeve resection and anastomotic reconstruction, a higher incidence of airway complications has been reported in some experiences with respect to standard lobectomy (STL) and even PN [4–6]. These complications mainly include stenosis and dehiscence at the level of the anastomosis and may partially compromise or limit the functional benefit of lung sparing [7]. Even in uncomplicated patients, moderate stricture or angulation of the reconstructed bronchus may be responsible for impaired ventilation of the residual lung or incomplete patency of the segmental branches of the residual bronchus.

From an oncologic point of view, the main concern is the theoretic risk that a centrally located tumor resected with a SL could have a poorer prognosis because of less effective local control when compared with that achieved with STL for resection of more peripheral lesions. However, in the literature, SL has been compared only with PN, and no comparative studies are available to assess the postoperative functional and oncologic outcomes after SL with respect to the outcomes after STL. We have therefore conducted this study to compare functional and oncologic outcomes of NSCLC patients undergoing SL with those of patients undergoing STL.

Material and Methods

Between January 2009 and April 2013, 44 consecutive patients undergoing upper bronchial SL (29 right side, 15

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Abbreviations and Acronyms

CT = computed tomography
EORTC = European Organization for Research and Treatment of Cancer
FDG = F-18-fluorodeoxyglucose
NSCLC = non-small cell lung cancer
PET = positron emission tomography
PN = pneumonectomy
QOL = quality of life
6MWT = 6-minute walk test
SL = sleeve lobectomy
STL = standard lobectomy
TBNA = transbronchial needle aspiration

left side) were prospectively enrolled to be compared with 44 patients who were randomly selected with the same side distribution from those undergoing upper STL through thoracotomy during the study period. Patients undergoing upper STL through thoracotomy during the study period (n = 392) were prospectively enrolled in a database and grouped according to side of the operation. Twenty-nine patients receiving the operation on the right side and 15 receiving the operation on the left side were randomly selected from these patients and served as the control group (standard lobectomy group). Randomization was done using computer-generated sequences.

Functional and oncologic results including postoperative complications and mortality, postoperative decrease in pulmonary function tests and 6-minute walk test (6MWT) [8], postoperative changes in quality of life (QOL) and long-term survival of the two groups of patients (SL group and STL group) have been compared. Evaluation of pulmonary function included comparison of decrease in forced expiratory volume in 1 second (FEV_1) between the two groups. Changes in QOL were evaluated at 3 and 6 months in the two groups based on the European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire—Core Questionnaire (QLQ-C30) [9] including global health status, physical functioning, and fatigue. All patients were available for QOL assessment by this questionnaire.

Indication for SL was the presence of a centrally located primary tumor or hilar lymph nodes infiltrating the origin of the upper lobar bronchus thus precluding the possibility of a standard lobectomy, but not infiltrating the remaining lobes as far as to require PN. After induction therapy, a reconstructive procedure also may be indicated when indissociable fibrotic tissue embed the bronchus or the pulmonary artery.

The study was approved by the local Ethical Committee. All patients provided written informed consent for the operation, for their prospective inclusion in the study, and for use of personal data in a scientific database.

Preoperative work-up and staging included contrast-enhanced thoracic and abdominal computed tomography (CT), brain CT or magnetic resonance imaging and bone scintigraphy if indicated. Bronchoscopy was performed in all patients to assess the airway involvement and to obtain preoperative cytologic or histologic diagnosis. Endobronchial biopsy was performed in all cases of a tumor abutting the bronchial tree. Transbronchial needle aspiration (TBNA) or biopsy was performed in cases showing disease close to the bronchial wall. Mediastinoscopy was performed in the presence of enlarged mediastinal lymph nodes (long-axis diameter greater than 1.5 cm) at CT scan. The TBNA of the lymph nodes was performed in patients with significantly enlarged (more than 2 cm) or "bulky" peritracheal or subcarinal lymph nodes if histologic diagnosis on the primary tumor was already available. Patients with histologically or cytologically proven metastatic mediastinal lymphadenopathy underwent induction chemotherapy. Only patients with clinical N0-1 disease (even after induction therapy) underwent surgery. F-18-Fluorodeoxyglucose (FDG) whole-body positron emission tomography (PET) was performed if preoperative cytologic or histologic specific diagnosis on the primary tumor or on the mediastinal lymph nodes was not achieved or in presence of suspected metastatic lesions at CT scan.

Preoperative clinical evaluation to assess operability of patients also included respiratory function tests and blood gas analysis associated with perfusion lung scintigraphy if doubt on functional resectability was present. Preoperative mediastinal restaging after chemotherapy was performed by PET-CT scan. Systematic hilar and mediastinal lymphadenectomy was associated with lobar resection in all patients [10].

Baseline analgesia for all patients consisted of continuous intravenous infusion of tramadol (10 mg/h) and ketoralac tromethamine (3 mg/h) starting at thoracotomy and continuing until 48 hours after surgery. Subsequent intravenous analgesia was provided on patient request. In addition, patients received intrapleural intercostal nerve block from the fourth to the sixth space, performed by the surgeon at the time of thoracotomy. Additional nerve blocks were performed percutaneously at the intercostal spaces of chest drains (usually seventh and eighth). A total of 20 to 25 mL (7.5 mg/mL) ropivacain was used, approximately 4 to 5 mL for each space.

Postoperative management focused on early mobilization and physical and respiratory rehabilitation. Low-dose steroids (generally, methylprednisolone 10 mg intravenously twice a day) were administered postoperatively for 1 week or until discharge for patients who had undergone bronchial reconstruction [11].

Postoperative oncologic survey was performed with total body contrast CT scan, bone scintigraphy, and FDG-PET. Follow-up controls were planned every 3 months for the first 2 years and every 6 months for the next 3 years. All patients were available for follow-up. For patients who died, follow-up was considered continued until death. All patients who received bronchial reconstruction underwent bronchoscopic check of the bronchial anastomosis after 7 days or at discharge. Additional bronchoscopic controls were performed after 1, 3, and 6 months in the first year, and every 6 months thereafter, for a total of 5 years of follow-up.