

Sleeve Lobectomy Compared to Pneumonectomy for the Treatment of N0-N1 Non-Small Cell Lung Cancer

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OBJECTIVE: To compare survival, morbidity, and mortality rates for a series of patients who underwent either bronchoplastic sleeve lobectomy or pneumonectomy to treat non-small cell lung cancer (NSCLC).

PATIENTS AND METHOD: We reviewed the clinical records for patients who underwent sleeve lobectomy or pneumonectomy for NSCLC from January 1994 through December 2003.

RESULTS: From January 1994 through December 2003, 35 sleeve lobectomies and 220 pneumonectomies were performed at our department on patients with NSCLC. The perioperative mortality rate was 2.8% for the lobectomy group and 9.1% for the pneumonectomy group. The mean survival time for the pneumonectomy group was 45 months (95% confidence interval [CI], 37-53), with a 5-year survival rate of 32% (SE, 5.1%). The mean survival time for the sleeve lobectomy group was 72 months (95% CI, 56-87) ($P \leq 0.0041$), with a 5-year survival rate of 56% (SE, 9.6%). If we stratify the groups according to node involvement, patients classified as N0-N1 had a mean survival time of 52 months (95% CI, 43-61), with a 5-year survival rate of 39% (SE, 6.2%) for the pneumonectomy group. The mean survival time for patients undergoing sleeve lobectomy was 75 months (95% CI, 59-92) ($P \leq 0.018$), with a 5-year survival rate of 60% (SE, 10.4%). Survival for patients with N2 disease was similar to that of patients with N0-N1 disease.

CONCLUSION: For patients with N0-N1 non-small cell lung cancer, sleeve lobectomy offers better survival than pneumonectomy.

Key words: Sleeve lobectomy. Lung cancer. Sleeve resection. Survival. Pneumonectomy.

La lobectomía broncoplastica frente a la neumonectomía en el tratamiento del carcinoma de pulmón no microcítico

OBJETIVO: Comparar la supervivencia, morbilidad y mortalidad de una serie de pacientes operados por cáncer de pulmón no microcítico (CPNM) mediante lobectomía broncoplastica o neumonectomía.

PACIENTES Y MÉTODO: Hemos revisado los datos de pacientes a quienes se realizó una lobectomía broncoplastica o una neumonectomía por CPNM entre enero de 1994 y diciembre de 2003.

RESULTADOS: Entre enero de 1994 y diciembre de 2003 se realizaron en nuestra unidad 35 lobectomías con broncoplastia y 220 neumonectomías en pacientes con CPNM. La mortalidad perioperatoria fue del 2,8% en el grupo de las lobectomías y del 9,1% para las neumonectomías. La media de supervivencia de las neumonectomías fue de 45 meses (intervalo de confianza [IC] del 95%, 37-53) y la supervivencia a los 5 años del 32% (error estándar [EE]: 5,1). En el grupo de lobectomías broncoplasticas la media de supervivencia fue de 72 meses (IC del 95%, 56-87) ($p \leq 0,0041$) y la supervivencia a los 5 años del 56% (EE: 9,6). Si estratificamos los grupos según la afectación ganglionar, entre los pacientes clasificados como N0-N1 la media de supervivencia fue de 52 meses (IC del 95%, 43-61) y la supervivencia a los 5 años del 39% (EE: 6,2) en las neumonectomías. Los pacientes con lobectomía broncoplastica presentaron una media de supervivencia de 75 meses (IC del 95%, 59-92) ($p \leq 0,018$) y la supervivencia a los 5 años del 60% (EE: 10,4). La supervivencia no fue diferente en caso de enfermedad N2.

CONCLUSIÓN: La lobectomía broncoplastica ofrece mejor supervivencia que la neumonectomía en pacientes con CPNM con afectación N0-N1.

Palabras clave: Lobectomía broncoplastica. Cáncer de pulmón. Resecciones broncoplasticas. Supervivencia. Neumonectomía.

Introduction

Bronchoplastic sleeve lobectomy and other bronchoplastic resections were initially limited to lung

cancer patients who were unable to tolerate a pneumonectomy due to poor lung function. The belief was that the expected results of bronchoplasty, in terms of survival, would be worse than pneumonectomy. However, recent studies have shown that the cure rate for sleeve lobectomy is similar to that of pneumonectomy,¹⁻³ with a combined morbidity and mortality rate similar to that of conventional lobectomies, even for patients who have undergone chemotherapy or neoadjuvant radiation therapy.^{4,5}

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According to recent data, sleeve lobectomy is more cost-effective than pneumonectomy and offers better survival and quality of life for patients with non-small cell lung cancer (NSCLC).⁶

The aim of our study was to compare survival rates—after controlling for other prognostic variables associated with these types of patients—for a series of NSCLC patients who underwent either sleeve lobectomy or pneumonectomy.

Patients and Method

We retrospectively reviewed all the clinical records in our computer database of patients who underwent sleeve lobectomy or pneumonectomy for NSCLC at our hospital from January 1994 through December 2003. Selection and operability⁷ criteria, the surgical team, and postoperative care were largely unchanged during this time period.

For all the bronchoplastic procedures, intraoperative biopsy was performed to evaluate the presence or not of tumor infiltration of the resected margins while pathological staging was accomplished by lymphadenectomy of the accessible mediastinal and hilar lymph node stations.

Nodes that appeared normal on macroscopic examination were not evaluated intraoperatively unless N1 involvement was suspected, in which case an intraoperative evaluation was requested. If the analysis confirmed involvement of interlobar nodes, then—provided that forced expiratory volume in the first second (FEV₁) estimated for the postoperative period was greater than 30%—a pneumonectomy was performed.

The following variables were analyzed: age, cardiorespiratory comorbidity, preoperative lung function, postoperative morbidity (all medical or surgical complications associated with the intervention), length of hospital stay, histologic type, and pathological stage.

Death was deemed perioperative if occurring within 30 days of the intervention or if the patient had not yet been discharged; otherwise, all deaths occurring after 30 days—regardless of cause—were considered postoperative. Follow-up was performed by reviewing patient medical records or, when necessary, by contacting the patients, their families, or the referring physician.

Statistical Analysis

Contingency tables (for binary variables) and analysis of variance (for continuous variables) were used to confirm homogeneity between the 2 groups. Survival was analyzed

with the Kaplan-Meier method and the differences were compared using a log-rank test. Statistical analysis was performed with the SPSS 11.0 Statistical Software Package (SPSS; Chicago, IL, USA).

Results

We carried out 857 anatomical lung resections for NSCLC during the study period. A bronchial (35 cases) or tracheobronchial (6 cases) sleeve lobectomy was carried out in 41 patients (4.7%) while 220 patients (25%) underwent standard pneumonectomy. The 6 tracheobronchial procedures were excluded from the analysis.

The sleeve lobectomies were performed in the following locations: upper right lobe (29 cases); upper left lobe (4 cases); lower left lobe (1 case), and in 1 case an upper and middle bilobectomy with reconstruction of the bronchial tree was performed. Of the pneumonectomies, 136 were left-sided and 84 right-sided.

The groups studied were homogeneous (Table) in terms of age and sex. The age range for the sleeve lobectomy group was 44 to 81 years and the mean age was 62, while the age range for the pneumonectomy group was 34 to 80 years and the mean was 62. There was a ratio of 34 males to 1 female in the lobectomy group and 14 males to 1 female in the pneumonectomy group. Induction therapy was given to 9.1% of patients in the lobectomy group and 16.4% of the pneumonectomy group, with no significant difference between both groups.

The 2 groups were also similar in terms of lung function and histologic type. In the pneumonectomy group, the mean (SD) FEV₁ was 2.25 L (0.62 L) compared to 2.24 L (0.63 L) in the sleeve lobectomy group ($P=.5$). The prevalence of squamous cell carcinoma was 70% in the pneumonectomy group and 80% in the sleeve lobectomy group ($P=.24$). Cardiorespiratory comorbidity was significantly higher in the sleeve lobectomy group (25 cases, 71%) compared to the pneumonectomy group (116 cases, 52%) ($P=.03$).

There were no significant differences between groups in the length of hospital stay (8.4 [3.7] days for the lobectomy group and 7.3 [4.2] days for the pneumonectomy group) ($P=.6$). Postoperative morbidity was similar for both groups (36.1% for the lobectomy

TABLE
Population Characteristics*

	Bronchoplastic Sleeve Lobectomies (n=35)	Pneumonectomies (n=220)	P
Age, years	62 (range, 44-81)	62 (range, 34-80)	NS
Male:female ratio	34:1	14:1	NS
Preoperative FEV ₁	2.24 (0.63)	2.25 (0.62)	NS
Squamous cell carcinoma	80%	70%	NS
Comorbidity	25 (71%)	116 (52%)	0.03
Neoadjuvant chemotherapy	9.1%	16.4%	NS
Hospital stay, days	8.4 (3.7)	7.3 (4.2)	NS
Morbidity	13 (36.1%)	80 (36.3%)	NS
Mortality	1 (2.8%)	20 (9.1%)	NS

*Except where indicated, the data is expressed as mean (SD) or as the number of patients (percentage). FEV₁ indicates forced expiratory volume in the first second; NS: not significant.

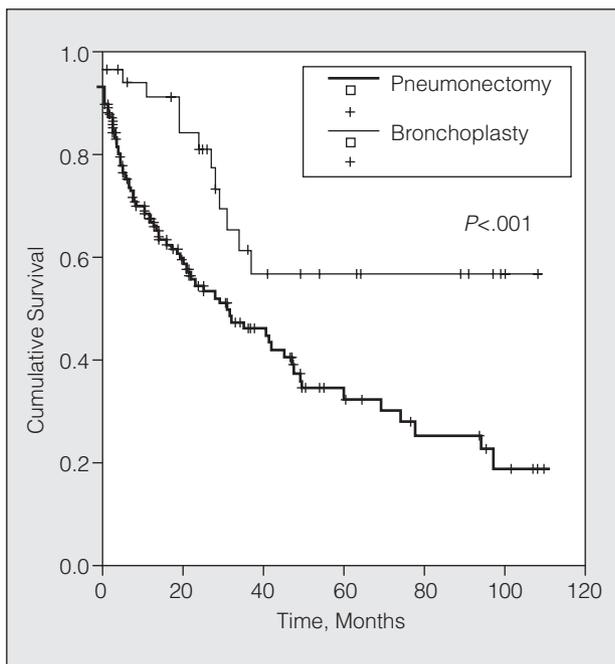


Figure 1. Survival according to the Kaplan-Meier method. Bronchoplastic sleeve lobectomy compared to pneumonectomy, all patients included.

group compared to 36.3% for the pneumectomy group). The 30-day perioperative mortality rate for the sleeve lobectomy group was 2.8% (1 death, caused by intestinal ischemia and infarction) and 9.1% (20 deaths) for the pneumonectomy group, although the differences were not significant ($P=.2$).

For the pneumonectomy group, mean survival time was 45 months (95% confidence interval [CI], 37-53 months) with a median survival time of 31 months (95% CI, 16-46 months); the 5-year survival rate was 32% (SE, 5.1). For the sleeve lobectomy group, mean survival time was 72 months (95% CI, 56-87 months); median survival could not be calculated at the time the study concluded, although the 5-year survival rate for this group was 56% (SE, 9.6). The overall survival rate showed a significant difference ($P \leq .0041$) between groups (Figure 1).

If we stratify the groups according to node involvement, the survival rate for patients at pathological stage N0-N1 who underwent sleeve lobectomy (31 patients) was greater than that for patients at the same stage who underwent pneumonectomy (179 patients) ($P \leq .018$) (Figure 2). The mean survival time for stage N0-N1 patients in the sleeve lobectomy group was 75 months (95% CI, 59-92 months) compared to 52 months (95% CI, 43-61 months) for patients in the pneumonectomy group; median survival time for the pneumonectomy patients was 47 months (95% CI, 39-55 months). The 5-year survival rate for the sleeve lobectomy group was 60% (SE, 10.4), compared to 39% (SE, 6.2) for the pneumonectomy group.

No significant differences between groups were observed for patients with N2 disease (Figure 3). Only 10% of these patients in the pneumectomy group were alive at 3 years (mean survival time was 20 months [95% CI, 10-30 months]) and no patient in the lobectomy group was alive at 3 years (mean survival time: 20 months; 95% CI, 5-35 months).

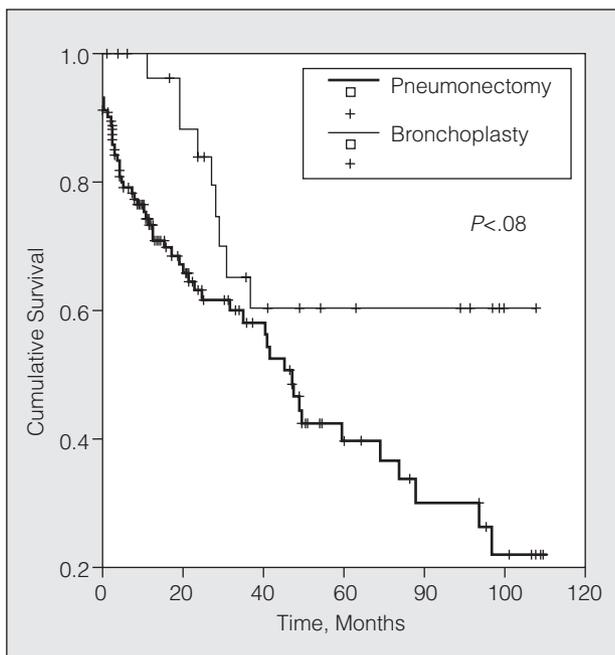


Figure 2. Survival according to the Kaplan-Meier method. Bronchoplastic sleeve lobectomy compared to pneumonectomy in patients with N0-N1 disease.

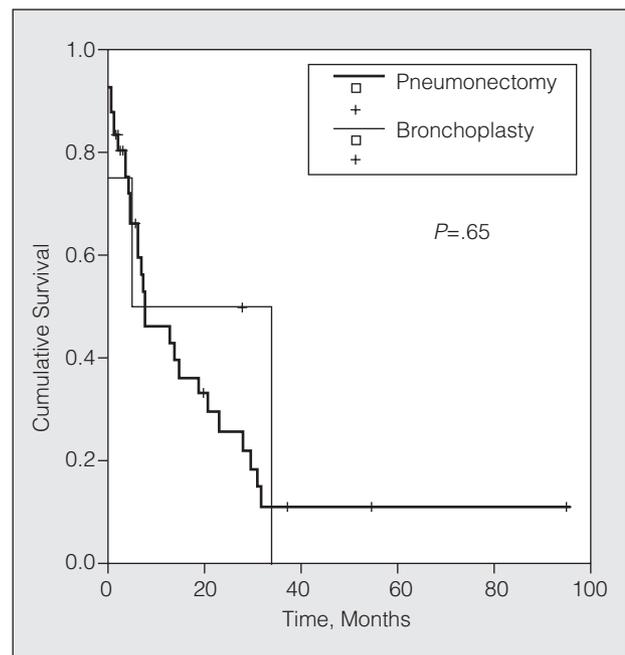


Figure 3. Survival according to the Kaplan-Meier method. Bronchoplastic sleeve lobectomy compared to pneumonectomy in patients with N2 disease.

Discussion

Based on a review by Tedder et al⁸ and given our own prior experience, we have—since 1993—routinely performed sleeve lobectomies whenever possible to treat NSCLC, even for cases in which the patient is functionally able to tolerate pneumonectomy. We prefer to perform pneumonectomy, however, when metastasis involves the interlobar nodes.

The preservation of functional lung tissue and, consequently, functional reserve, offers improved survival, perhaps because the preserved lung capacity reduces morbidity and mortality. Perhaps the most important factor to consider in our population (mean age, 62 years) is the impact that loss of function has on medium term survival. According to the classifications of the Global Initiative for Asthma, a FEV₁ below 50% indicates severe chronic obstructive pulmonary disease, and published evidence demonstrates that FEV₁ is an independent predictor of mortality—regardless of the cause of death—in the general population.⁹

No tumor invasion was found in any of the resected bronchial margins taken from the sleeve lobectomy patients in our series. Moreover, we observed no incidences of recurrence in the bronchial stump during the follow-up period, even though the reported incidence of such recurrence ranges from 5% to 22%, according to the literature we reviewed.^{3,10} Nevertheless, because autopsies for the deceased patients in our series are not available, we cannot rule out the possibility of bias.

It is imperative that the margins of the bronchial resections be biopsied intraoperatively, especially for patients able to functionally tolerate a pneumonectomy. However, no evidence exists in the literature with regard to the appropriate margin of safety.¹¹

In our study, as in other published studies,¹² the mean operating time for patients undergoing sleeve lobectomy was slightly longer than for patients undergoing pneumonectomy, although this difference was not significant.

Sleeve lobectomy was performed on the upper right lobe in 82% of patients and on the upper left lobe in 11%; similar percentages have been described by other authors.¹³

The rate of complications was similar between the 2 groups in our series. However, mortality was higher in the pneumonectomy group, although this finding was not statistically significant. Only 2 complications were directly related to the procedure: atelectasis developed in 2 patients due to retention of secretions along the suture line. No cases of stenosis, dehiscence, or arterial fistula were observed during the follow-up period; indeed, precautions were taken in order to avoid such complications: bronchial dissection was routinely performed with great care in order to preserve vascularization, absorbable sutures were used in all cases, and reconstructive surgery was performed with pericardial fat, pleura, or intercostal muscle tissue.¹⁴ Like Vogt-Moykopf et al,¹⁵ we prefer sleeve resection to wedge resection because, in our experience, the functional result is better.

Only 1 death—caused by intestinal ischemia and infarction—occurred after sleeve lobectomy in our series. The mortality rate observed in our study was similar to that reported by Massard et al.²

Because operative mortality may influence the interpretation of the results, we included this data in the analysis of survival. Darling et al¹⁶ found that the presence of a bronchial fistula was the factor most closely associated with death in patients undergoing pneumonectomy, especially for right-sided pneumonectomies. Like Darling et al,¹⁶ we perform fewer right pneumonectomies at our unit, in keeping with our performance of many right-sided bronchoplastic procedures. Nonetheless, in our series, no deaths in the pneumonectomy group were attributable to a bronchial fistula.

Our results confirm that, for patients with NSCLC, pneumonectomy has a negative effect on survival (after controlling for other prognosis-related variables) when compared to sleeve lobectomy. Like other working groups, we are thoroughly convinced that, in order to improve survival, sleeve lobectomies should be performed whenever possible on NSCLC patients. With these techniques, we can even operate on patients with limited lung function—especially the elderly—and thereby improve the overall prognosis for lung cancer.¹⁷ Although we only have data from nonrandomized case series,^{1,5,16} including our own retrospective study, we believe that, given this evidence, it would be unethical to carry out a clinical trial in an attempt to validate these results.

We cannot be completely sure that the 2 groups studied were similar in terms of the biological behavior of the tumors—as Deslauriers et al³ acknowledged in their own case series—even if we had selected, in terms of local aggressiveness, the best cases for the sleeve lobectomies.

In conclusion, our results show that sleeve lobectomy offers better survival than pneumonectomy for NSCLC patients at the same stage of N0-N1 disease.

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