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Original Article

Lung sparing surgery by means of extended broncho-angioplastic (sleeve) lobectomies

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ABSTRACT

Objective: To determine the morbidity, mortality and survival of sleeve lobectomy procedures extended to more than one lobe compared with bronchoplasty.
Patients and methods: Between September 2005 and May 2010, a total of 535 patients diagnosed with bronchogenic carcinoma who fulfilled the criteria of clinical, oncological and functional operability were treated in our unit. Central tumors (n = 95) that were unresectable using simple lobectomy were scheduled for sleeve lobectomy techniques or, if not possible, pneumonectomy.
Results: A total of 58 (11%) procedures were performed: 46 simple bronchoplastic lobectomies (SBL) and 12 extended sleeve lobectomies (ESL). In the SBL group, there were 32 bronchial (70%), 7 vascular (15%) and 7 bronchovascular (15%) reconstructions. In the ESL group, 8 (66.7%) were bronchial and 4 (33.3%) were bronchovascular reconstructions. The most frequent type of resection was the right upper lobe (RUL) + segment 6 in five (41%) cases, followed by RUL + middle lobe. There were 2 (3%) deaths in the SBL group. Morbidity was 34% in the SBL and 33% in the ESL group ($P > 0.05$). Fifteen patients received neoadjuvant chemoradiotherapy for histologically-confirmed cN2; the number of complications, however, was not significantly higher. No risk factors were detected in any variable studied that would affect ESL compared to the SBL group ($P > 0.05$). The patients in both groups with a higher morbidity were pN1, located in the left upper lobe and associated with vascular reconstruction ($P < 0.05$). The overall five-year survival was 61.6%; SBL (61%) and ESL (68.9%) with no differences between groups ($P > 0.05$).
Conclusions: ESL are technically more demanding procedures, but they do not increase morbidity or mortality compared to simple bronchoplasty, and have similar survival.

Cirugía de preservación pulmonar mediante reconstrucciones broncoangioplásticas extendidas

Palabras clave:
Cáncer de pulmón
Complicaciones
Preservación pulmonar

RESUMEN

Objetivo: Determinar la morbimortalidad y supervivencia de los procedimientos broncoangioplásticos extendidos a más de un lóbulo en comparación con las técnicas broncoangioplásticas simples.
Pacientes y métodos: Entre septiembre de 2005 y mayo de 2010, 535 pacientes diagnosticados de carcinoma broncogénico que cumplían criterios de operabilidad clínica, oncológica y funcional fueron tratados en nuestra unidad. Los tumores centrales(n = 95) no resecables mediante lobectomía simple fueron programados para técnicas broncoangioplásticas y en caso de imposibilidad, neumonectomía.
Resultados: Se realizaron 58 (11%) procedimientos, 46 lobectomías broncoangioplásticas simples (LBS) y 12 extendidas (LBE). En el grupo de LBS (bronquiales 32 [70%], reconstrucción broncovascular 7 [15%] y vascu-

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lar sola 7 [15%]). En el grupo de LBE, 8 (66,7%) fueron reconstrucciones bronquiales y 4 (33,3%) broncovasculares. El tipo de resección más frecuente es el lóbulo superior derecho (LSD) + segmento 6 en 5 (41%) casos, seguido del LSD + lóbulo medio. La mortalidad fue de 2 (3%) casos en el grupo LBS. La morbilidad ocurrió en el 34% LSB y en el 33% LBE (p > 0,05). Quince pacientes recibieron tratamiento quimiorradioterápico neoadjuvante, por cN2 confirmado histológicamente, sin embargo no se detectó mayor número de complicaciones significativamente (p > 0,05). No se detectaron factores de riesgo respecto a ninguna variable estudiada que afectaran a las LBE respecto a las LBS (p > 0,05). En ambos grupos, los pacientes con mayor morbilidad fueron pN1, localización en lóbulo superior izquierdo y con reconstrucción vascular asociada (p < 0,05). La supervivencia global a los 5 años fue 61,6% LBS (61%) y LBE (68,9%) sin diferencia entre ambos grupos (p > 0,05).

Conclusiones: Las LBE son procedimientos técnicamente más demandantes pero no aumentan la morbimortalidad respecto a las técnicas broncoangioplásticas simples con una supervivencia similar.

Introduction

The mortality related with lung resection surgery in patients with bronchogenic carcinoma directly depends on the procedure and on whether pneumonectomy is performed. The mortality rate after pneumonectomy in patients who are functionally estimated to be able to tolerate the procedure is 9-17%.[1,2] This percentage can be greater under certain conditions, such as previous chemo-radiotherapy,[3] limited lung function and older age. Therefore, the current tendency is to select candidates for pneumonectomy depending on identified risk factors.[4] In addition, the greater the amount of pulmonary parenchyma resected, the poorer the long-term later quality-of-life[5,6] and greater the number of side-effects from adjuvant therapy. Bronchoplastic reconstruction techniques have been developed to offer surgical treatment in central tumors while preserving the lung parenchyma and avoiding pneumonectomy.[7-10] These techniques are indicated in all patients in whom they are oncologically feasible, regardless of respiratory functionality, affected interlobar nodes, age or other factors. In patients in their seventies or eighties and in patients with borderline respiratory tests is essentially where these techniques usually play an essential part. These patients require bronchoplasty resection techniques, or extended sleeve lobectomy if simple techniques are not oncologically feasible, in order to avoid the complications of pneumonectomy.[11,12]

The objective of this study is to report the morbidity and mortality of sleeve lobectomy procedures extended to more than one lobe. Likewise, we intend to report the survival rate of these procedures compared with that of simple bronchoplasty procedures.

Patients and Methods

Between September 2005 and May 2010, 535 patients in our unit were diagnosed with non-small cell bronchogenic carcinoma (BC) that met with criteria for clinical, oncological and functional operability. This study was centered mainly on central BC with doubtful resectability using simple lobectomy and especially in patients with bronchoplasty resection techniques with extirpation of more than one lobe. All patients were evaluated oncologically[13] and funcionally[14] by the Multidisciplinary Oncological Committee of our center in accordance with the clinical guidelines of the *European Society of Thoracic Surgeons*. Pre-operative studies included thoracic CT with contrast and 18-FDG PET/CT for clinical staging of all patients[15] following the TNM 1997 classification, and later patients were re-staged using the newly-proposed stratification of the IASCL.[16] In the case of suspected cN2 mediastinal node affectation, histopathology was confirmed by means of the most convenient and less invasive exploration for each case (EBUS, EUS-FNA, mediastinoscopy or extended). Cases where mediastinal affectation was confirmed were given neoadjuvant treatment and were later re-evaluated using imaging techniques (thoracic CT and 18-FDG PET/CT) for surgical rescue.

The choice of surgical technique was focused on sparing the maximum amount of lung parenchyma, as long as it was considered oncologically optimal. In cases where lung-preservation techniques were not able to be followed due to oncological reasons, quality of the lung remnant, or extreme tension in the anastomosis, pneumonectomy was performed if the patient could functionally tolerate the procedure. Patients were informed of the risks of the intervention and the different possible procedures and informed consent was given in all cases.

Surgical Technique

All patients underwent bronchoscopy prior to surgical intervention to evaluate *in situ* the possibility of performing bronchoplasty techniques by the surgical team. Lobectomy was initiated following standard surgical techniques until the bronchus was properly exposed along with the pulmonary artery, if possible. At this time, a decision was made about the most adequate type of surgical resection for each individual patient. Once the bronchoplastic technique was considered, the lung tumor was isolated and the vascular and airway structures of the lobe were disconnected in order to prepare for later reconstruction. We performed circumferential resection of the either bronchus or the pulmonary artery, or both, allowing to create enough of a margin with the lesion using a cold scalpel. The bronchial manipulation was painstaking, trying to maintain the blood flow and preserving the bronchial arteries, avoiding electrocoagulation on the surrounding tissue. The resected margins were evaluated intraoperatively to ensure complete resection (R0). In the case of R1 or doubts regarding the viability of the lung remnant or the vitality of the perianastomotic tissue (excess tension, absence of evident flow, etc.), pneumonectomy was completed. Bronchial anastomosis was done with continuous 4-0 polydioxanone sutures (PDS, Ethicon Inc, Somerville, NJ) starting in the membrane-cartilage union at the mediastinal side of the bronchus until the middle of the cartilaginous ring.[17] The rest of the anastomosis was carried out with loose 4-0 polydioxanone sutures in X, which were tied at the end of the anastomosis. All the stitches were tied outside the bronchus. We avoided telescoping sutures, and discrepancies were resolved with the correct placement of the stitches and careful surgical technique. Bronchial torsion was avoided by painstaking completion of the technique.[9] The sutured closure was then checked for watertightness in all cases with airway pressure of at least 30 mmHg. For arterial anastomosis, we used continuous 5-0 Prolene (Ethicon) sutures after local and systemic heparinization (3,000-5,000 IU of sodium heparin). Reperfusion of the preserved lobe was done slowly and avoiding sudden unclamping, initiating reperfusion at less than 20

mmHg of pressure after reexpansion, whenever possible. The sutures were not covered systematically using intercostal flaps or pericardial fat. We did not administer either inhaled prophylactic antibiotics or other drugs such as corticosteroids or expectorants. To minimize tension in the anastomosis, the pulmonary ligament was systematically released and, if necessary, a pericardial incision was made around the pulmonary veins.

After checking for watertightness intraoperatively and the secretions had been cleaned, we confirmed that the bronchial sutures were correct with a flexible bronchoscope. We attempted extubation in all patients in the operating room. Patients spent immediate post-op in the Intermediate Care Unit for the first 24 hours. If there were no complications, the patients were later transferred to the Thoracic Surgery Unit ward. In the case of persistent air leak, hemoptysis or any other clinical sign indicating suture dehiscence, flexible bronchoscopy was ordered. Meanwhile, in cases with no symptoms, bronchoscopy was done before discharge.

Postoperative analgesia was administered by epidural catheter that had been placed before the surgical intervention while the patient was awake at the T7-T10 level. One hour before finishing surgery, a bolus of peridural ropivacaine at 2% (5 ml) was administered and continuous peridural perfusion was initiated in PCA mode of ropivacaine at 0.14% with 2 μg/ml of fentanyl (perfusion rhythm 4-8 ml/h with the possibility of self-administered supplements of 2 ml every 30 minutes). All cases were administered intravenous complementary analgesia with dexketoprofen 50 mg/8 h/iv and paracetamol 1 g/8 h/iv if EVA > 3 at rest. Before withdrawing the catheter, a bolus of methadone (4-6 mg) was administered, continuing with the complementary intravenous analgesia. We were insistent upon the patients doing respiratory physical therapy to avoid sputum retention and respiratory complications.

Endoscopic follow-up of the anastomosis took place at one and three months, and a later imaging follow-up was ordered following the oncological follow-up protocol of the ACCP.[18]

Statistical analysis was calculated using the SPSS v.11 program (SPSS Inc., Chicago, IL, USA). The quantitative variables were compared with the χ^2 statistical test or the Fisher's exact test when appropriate, with a level of significance of $p < 0.05$. The bivariate analysis was first done in order to identify risk factors for their inclusion in a Cox proportional hazard model. The results were expressed as estimated relative risk with a 95% confidence interval. The expected survival was calculated by means of survival charts, with Kaplan-Meier and log rank for the comparison of curves.

Results

In these 535 patients, 95 presented central non-small cell BC. In those that were not resectable by simple lobectomy, either due to direct affectation of the tumor or N1 affectation, 58 (11%) bronchoplastic lobectomies and 22 (4%) pneumonectomies were performed. In the group of bronchoplastic lobectomies, 12 extended sleeve lobectomies (ESL) affecting more than one lobe and 46 simple bronchoplastic lobectomies (SBL) were carried out. The characteristics of both groups are compiled in table 1.

In the SBL group, the most frequent techniques were bronchial 32 (70%), bronchovascular reconstruction 7 (15%) and vascular alone 7 (15%). As for situation, the most frequent was right upper lobe 24 (52%), followed by LUL (table 1).

In the ESL group, 8 (66.7%) were bronchial reconstructions and 4 (33.3%) bronchovascular. The most frequent type of resection (fig. 1) was right upper lobectomy (RUL) + segment 6 in 5 (41%) cases followed by RUL + middle lobe (ML) (table 2). Only in 9 (15%) cases were bronchoplastic resections necessary due to pN1, and out of these only 2 were ESL.

Mortality occurred in the LBS group in two cases (1.7%) (bronchial artery fistula and adult respiratory distress syndrome - ARDS).

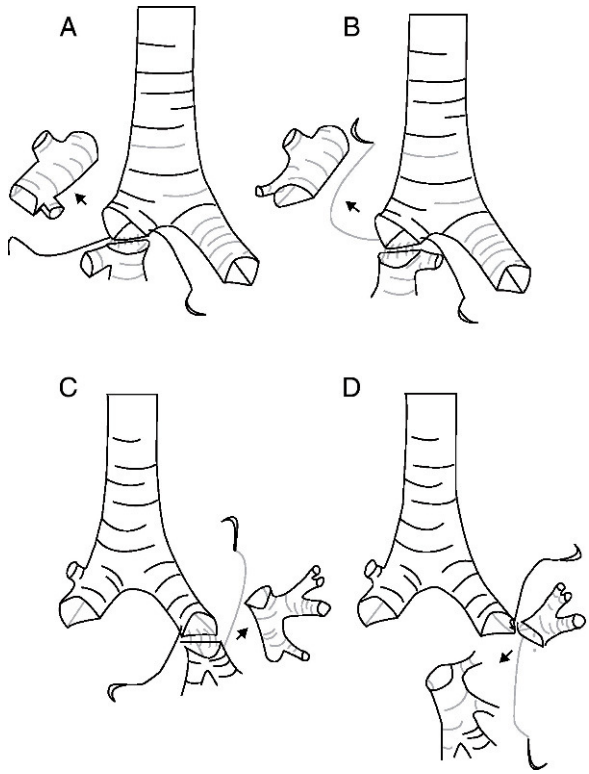

Figure 1. Different types of extended sleeve lobectomy: A) right upper lobe and middle lobe; B) right upper lobe and segment 6; C) left upper lobe and segment 6. D) left lower lobe and lingula.

Morbidity was similar in both groups ($p < 0.05$) and the most important complications are shown in table 3. The most frequent complication was sputum retention in 13 (22%) cases.

Anastomotic complications occurred in only 1 patient. Long-term anastomotic complications were not detected during bronchoscopic follow-up. Anastomoses were covered (24; 41%) especially if bronchial and arterial combined reconstruction was carried out, with no significant differences with or without flap protection ($p > 0.05$).

Complete resection (R0) was achieved in all cases but one, on a vascular edge that was reported post-op as R1. Ten (17%) patients were programmed exclusively for SBL or ESL, due to functional reasons or to excess risk caused by age > 75. Fifteen patients received neoadjuvant chemo-radiotherapy for histologically-confirmed cN2. Nevertheless, we did not detect a significant increase in complications ($p > 0.05$).

In the variables studied (tumor situation, histology, double reconstruction, neoadjuvant treatment, low FEV), there were no individual risk factors affecting ESL compared to SBL ($p > 0.05$). However, in both groups the patients with greater morbidity were pN1, situation in left upper lobe and associated vascular reconstruction ($p < 0.05$), although they did not present significantly higher mortality ($p > 0.05$).

Systemic recurrences occurred in 16 (27%) patients, with no differences between groups ($p > 0.05$). Only one case of local mediastinal recurrence appeared in the SBL group. No recurrences were detected in the anastomotic area, except in the R1 case in which pneumonectomy was not completed due to excessive surgical risk, and treatment was completed with coadjuvant chemo-radiotherapy.

Overall five-year survival rate was 61.6%, SBL (61%) and ESL (68.9%), with no difference between groups ($p > 0.05$) (fig. 2). Patients over 70 and pN2 were identified as risk factors in the bivariate analysis. In the multivariate analysis, only age > 70 negatively affected survival (table 4).

Table 1
Characteristics of the series of patients with bronchoplasty techniques

Variable	Bronchoplasty n = 58	Simple bronchoplasty n = 46	Extended sleeve lobectomy n = 12	p
Age (mean, years ± SD, range)	63 ± 10.2 (38-82)	63.4 ± 10.7 (38-82)	66 ± 8 (49-79)	0.41
Sex (male:female)	54:4	44:2	10:2	0.13
Active smokers	12	8	4	0.06
Neoadjuvant therapy	11 (19%)	10	1	0.29
Tumor side (R:L)	36:22	28:18	8:4	0.71
Tumor size (medium, cm ± SD, range)	4.2 ± 1.7 (1.2-9.4)	4.1 ± 1.5 (1.2-8)	4.6 ± 2.1 (1.9-9.4)	0.39
Situation (n, %)				NS
RUL	31 (53%)	24 (52%)	7 (58%)	
ML	6 (10.3%)	3 (6.5%)	3 (25%)	
RLL	2 (3.4%)	2 (4.3%)	−1 (8%)	
LUL	15 (26%)	14 (30%)	1 (8%)	
LLL	4 (7%)	3 (6.5%)		
Histology (n, %)				NS
Adenocarcinoma	23 (39%)	18 (39%)	5 (42%)	
Squamous carcinoma	33 (57%)	26 (56.5%)	7 (58%)	
Neuroendocrine carcinoma	2 (3.4%)	2 (4.3%)	–	
Clinical stage/pathology (n, %)				NS*
cIA/pIA	4 (7%)/3 (5%)	4 (8.4%)/2 (4.3%)	–/1 (8.3%	
cIB/pIB	29 (50%)/16 (27.6%)	23 (50%)/14 (30%)	6 (50%)/2 (16%)	
cIIA/pIIA	15 (26%)/17 (29.3%)	12 (26%)/15 (32%)	3 (25%)/2 (16.7%)	
cIIB/pIIB	8 (14%)/11 (19%)	6 (13%)/8 (17.4%)	2 (16.7%)/3 (25%)	
cIIIA/pIIIA	2 (3.4%)/11 (19%)	1 (2.2%)/7 (15%)	1 (8.3%)/4 (33%)	
cIIIB/pIIIB	–	–	–	
cIV/pIV	–	–	–	
Respiratory function test (mean ± SD, range)				
FEV1 (L)	2.6 ± 0.65 (1.4-3-9)	2.7 ± 0.6 (1.7-3.9)	2.2 ± 0.66 (1.4-2.9)	0.16
FEV1%	77.6 ± 14.5 (53-110)	78.4 ± 14.3 (53-110)	73 ± 16 (63-103)	0.50
CVF (L)	4.0 ± 0.81 (2.0-5.6)	4.1 ± 0.7 (2.8-5.6)	3.1 ± 1.0 (2.0-4.4)	0.02
CFV%	89 ± 13.3 (61-118)	90.3 ± 12 (63-118)	82 ± 19 (61-111)	0.25
DLCO	75 ± 14.2 (49-102)	73 ± 15 (49-102)	82 ± 3 (79-86)	0.27
PO2	85 ± 12.6	84 ± 13	86 ± 11	0.31
Associated diseases				NS
COPD *(Gold guidelines)*	23 (39%)	17 (38%)	5 (41%)	
Heart disease	10 (17%)	6 (13%)	4 (33%)	
HTN	19 (32%)	15 (32%)	4 (33%)	
Peripheral vascular disease	12 (20%)	9 (19%)	3 (25%)	
Diabetes mellitus	8 (13%)	5 (10%)	3 (25%)	

Discussion

Extended sleeve lobectomy techniques are equally effective in the treatment of central tumors and they do not have any additional morbidity or mortality compared with simple bronchoplastic techniques. The survival observed in these techniques ensures optimal oncological treatment with advantages over the massive extirpation of pulmonary parenchyma.

However, the decision to carry out either a lung preservation technique or pneumonectomy can depend on a difficult balance between later quality of life and the risk of disease recurrence and post-operative complicacions.[12]

Several studies have compared the quality of life[5,19] and survival[7,20] of both lung preservation techniques and pneumonectomies. It seems clear that quality of life is notably better in patients without pneumonectomy.[5] Likewise, these patients are apt for adjuvant chemoradiotherapy with a higher tolerance derived from this better quality of life, with fewer side-effects and interruptions of said treatment. As for survival, there are various studies that consider the local oncological control capacity to be similar between pneumonectomy and lung preservation techniques. Nevertheless, others show an improvement in survival in patients without pneumonectomy.[7,20]

The initial utility of bronchial-arterial reconstructive techniques was applied in patients with impaired respiratory function. In these

Table 2
Characteristics of the patients with extended sleeve lobectomy

n	Age/Sex	Type	Vascular	pTNM	pN1/pN2	Histology	Disease-free	Survival (m)
2	68/H	RUL+ segment 6	+	IIB		Squamous	YES	YES/45
7	66/H	LLL+ Lingulectomy	+	IIA		Squamous	YES	YES/35
8	49/H	RUL+ML	−	IB		Squamous	YES	YES/43
13	66/H	RUL+ML	−	IB		Adenocarcinoma	NO	NO/26
15	72/H	LUL+ segment 6	+	IIIA		Squamous	NO	NO/32
18	73/H	RUL+ML	−	IIB		Squamous	NO	YES/28
22	55/M	RUL+ segment 6	−	IIB		Squamous	YES	YES/25
25	62/H	RUL+ segment 6	−	IIIA		Adenocarcinoma	YES	YES/32
31	64/H	RUL+ segment 6	−	IA		Adenocarcinoma	YES	YES/16
41	79/H	RUL+ML	+	IIIA		Adenocarcinoma	YES	YES/12
54	65/M	RUL+ segment 6	−	IIIA		Squamous	YES	YES/9
58	75/V	ML+ segment 6	+	IIA		Adenocarcinoma	YES	YES/3

Table 3
Complications in both simple and extended bronchoplasty groups

Complications	Series (n = 58)	SBL (n = 46)	ESL (n = 12)	p
Mortality	2 (3.4%)	2	–	NS
Complications	20 (%)	16 (34%)	4 (33%)	NS
Acute respiratory insufficiency[a]	17 (%)	13	4	
Mechanical Ventilation	1 (%)	1	–	
ARDS	1 (%)	1	–	
Infectious complications				NS
Pneumonia	6 (%)	5	1	
Empyema	2 (%)	2	–	
Wound infection	3 (%)	2	1	
Sputum Retention	13 (%)	9	4	NS
Atelectasis	8 (%)	7	1	NS
Bronchoscopic aspiration	10 (%)	5	2	NS
Tracheostomy	1 (%)	1	–	NS
Supraventricular arrhythmias				
Auricular fibrillation	2 (%)	1	1	NS
Surgical complications				NS
Bronchial fistula (bronchovascular)	1 (%)	1	–	
Thrombosis of the pulmonary artery	1 (%)	1	–	
Persistent air leak[d]	7 (%)	6	1	
Chylothorax	–	–	–	
Transfusions	8 (%)	7	1	
Intraoperative bleeding	3 (%)	3	–	
Hemothorax	1 (%)	1	–	
Reoperation	2 (%)	2	–	
Hospital stay	9,8 ± 4	9,3 ± 4	8,7 ± 4	

[a]Acute respiratory insufficiency: PO_2 < 60 mmHg without oxygen.
[b]Mechanical ventilation >24 h after intervention.
[c]Criteria for pneumonia: unilateral pulmonary infiltrates, fever, leukocytosis, gasometric deterioration.
[d]Persistent air leak: > 7 days or when the air leak delayed the mean programmed discharge.

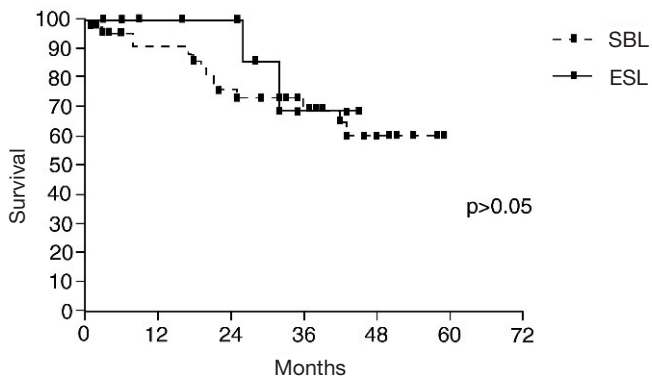

Figure 2. Survival in both bronchoplasty groups, simple (SBL) and extended (ESL).

subjects, it has demonstrated an effect on their function that is much more limited than pneumonectomy,[21,22] with an improvement in respiratory capacity in a certain number of patients due to multifactorial causes. Among these are: optimization of medical treatment for COPD (concomitant in many pacientes[23]), hyperinflation of the preserved lobe(s), smoking abstention after intervention, and the possible shunt effect of the extirpated lobes, frequently without respiratory exchange capacity.[21] For these reasons, and due to the morbidity associated with pneumonectomy itself, this group of techniques are recommendable in older patients in whom massive lung parenchyma extirpation[6] involves post-operatory complications[1,24] and a more marked loss in quality of life.[25] It is in this group of patients over the age of 75 in whom lung preservation can be more significant; it offers a curative treatment to patients in whom, due to their associated diseases, chemoradiotherapy can have major associated morbidities or be contraindicated. In our series, ten patients were successfully

Table 4
Results of Cox bivariate and multivariate analyses for survival

Risk Factors	Bivariate			Multivariate		
	HR	CI 95%	p	HR	CI 95%	p
Age (< 70 vs. > 70)	0.26	0.09-0.72	0.01	0.26	0.09-0.73	0.01
pN2	0.32	0.14-2.82	0.04	0.71	0.16-3.16	0.55
Type of operation (ESL vs. SBL)	0.64	0.14-2.84	0.56			
Sex (female vs. male)	0.04	0.0-120.4	0.43			
Tumor side (right vs. left)	0.78	0.27-2.25	0.65			
Tumor size (continuous v.)	1.07	0.76-1.50	0.69			
Histology (no-ADK)	0.66	0.24-1.77	0.41			
pT (T1-T2, T3-T4)	0.92	0.21-4.28	0.92			
Pre-op COPD*	0.83	0.25-4.25	0.82			
Post-op Complications (yes, no)	0.65	0.24-1.74	0.39			
p (I-II,III-IV)	1.7	0.48-6.01	0.40			

resected by means of SBL or ESL, with no possibility for performing pneumonectomy due to its unacceptable risk for premature death. Likewise, 22 (39%) interventions of our series were carried out in patients over the age of 70, with a similar percentage of LBE and LBS.

The recurrence index of these techniques is similar to that of pneumonectomy, the main problem being systemic recurrence.[8,10,26,27] Similar results in SBL and ESL have been published in series with slightly more experience.[10-12]

The strategy for avoiding pneumonectomy is currently commonly accepted even in patients with normal pulmonary function[9] and in patients with interlobar node affectation. However, it is not always easy in tumors that affect more than one lobe due to local infiltration, thus small variations of these techniques can be useful. Johnston et al. first described these techniques with interesting results.[28] Okada et al. reported a series of 15 patients over the age of 13, representing 9% of all the bronchoplastic procedures in their experience.[12]

The longest retrospective series published demonstrated results for morbidity and mortality similar to SBL,[11] with a similar survival compared to the patients that underwent pneumonectomy in the same period. The anastomotic complications were not high in any of the series published, as could be expected due to the large discrepancies in bronchial caliber or the smaller size of the remaining pulmonary parenchyma.[10-12]

Morbidity is similar in both groups, without an increase in postoperative problems due to the bronchoplastic techniques. Nevertheless, the complications related with these techniques are usually as formidable as those appearing in pneumonectomy. These anastomotic problems are not higher in the presence of previous chemoradiotherapy treatment, although in these patients special care must be taken when doing the anastomosis, with coverage using muscular o pericardial flaps, accompanied by the use of inhaled antibiotics.[29]

Nevertheless, surgical experience itself in this group of interventions exercises individual bias: excessive tension or a very limited lung remnant usually lead to pneumonectomy. This bias is similar in all the original articles comparing pulmonary reconstructive techniques and pneumonectomies, or SBL with ESL.[7,11,17]

We can observe a close relationship between pneumonectomies and bronchoplastic lobectomies, where there are current reports of a dramatic decrease in pneumonectomies when these reconstruction techniques have been applied aggressively.[30] It is essential to reduce the total percentage of SBL or ESL related with the right upper lobe, including cases on the left side, although this implies associated vascular reconstruction in a great number of cases. Frequently, using biological materials for the reconstruction of the pulmonary artery, this index easily increases.[31] In patients with extensive vascular, arterial or venous affectation, oncological resection of the tumor may be considered in bench surgery, followed by the re-implantation of the remnant lobe with bronchial, arterial and venous reconstruction. Self-transplant, therefore, has been communicated anecdotally, although it could be a surgical option to avoid pneumonectomy.[32]

In short, the use of pulmonary preservation techniques offers many advantages with few minor associated morbidities in expert hands. The candidates should be considered for these techniques for many reasons: greater tolerance to multimodal complementary treatments, possibility to surgically recuperate patients who doubtfully could be treated with pneumonectomy, less loss in respiratory capacity,[21] better long-term quality of life[5] and, equally important, lower incidence of complications related to pneumonectomy, such as bronchial fistula or ARDS.

In the authors' opinion, whenever possible and especially in older patients or those with neoadjuvant treatment, any bronchoplastic technique is better than a pneumonectomy. Extended sleeve lobectomy techniques are safe and, although they are technically more demanding and need very careful post-op observation, they provide immediate and long-term advantages that are undeniably important.

Conflict of Interest

The authors declare having no conflict of interest.

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