

Agreement Between Type of Lung Resection Planned and Resection Subsequently Performed on Lung Cancer Patients

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OBJECTIVE: To assess agreement between planned lung resections and the type subsequently performed on a series of patients, to assess whether tumor location (central or peripheral) affected the degree of discrepancy, and, in the case of unscheduled pneumonectomies, to examine why the planned resection had to be extended.

METHOD: Prospective, observational clinical study of 199 patients scheduled for lung cancer surgery. Tumors were preoperatively classified as central or peripheral, and the type of operation planned—lobectomy (or bilobectomy) or pneumonectomy—was compared with the operation finally performed. Rates of agreement and Wilks' lambda statistic were calculated.

RESULTS: Twenty unscheduled pneumonectomies were performed. Agreement between planned and performed operations was found in 86.9% of cases (76.9% in central tumors and 95.4% in peripheral tumors). Wilks' lambda statistic was 0.38 (0.42 for central tumors and 0.17 for peripheral tumors). Seven unscheduled pneumonectomies were performed due to hilar node involvement.

CONCLUSIONS: The resections performed differed from the resections initially planned in 13% of the bronchial carcinoma operations, in most cases because the planned lobectomy had to be converted to pneumonectomy, a situation which occurred more often with central tumors and was more often due to direct invasion of anatomic structures rather than hilar spread.

Key words: *Non-small cell lung cancer. Lung resection. Risk prediction.*

Concordancia entre el tipo de resección programada y la efectuada en pacientes con carcinoma pulmonar

OBJETIVO: Cuantificar la concordancia entre la cirugía de resección planeada y la efectuada en una serie de pacientes, evaluar si la localización del tumor (central o periférico) influye en el grado de discrepancia encontrado y valorar, en los casos de neumonectomías no programadas, la causa que obligó a ampliar la resección prevista.

MÉTODO: Estudio clínico prospectivo observacional en 199 pacientes programados para intervención quirúrgica por cáncer de pulmón. Se clasificaron los tumores preoperatoriamente como centrales o periféricos, y el tipo de intervención programada—lobectomía (o bilobectomía) o neumonectomía—se comparó con la efectuada. Se han calculado las tasas de concordancia y el estadístico lambda.

RESULTADOS: Se practicaron 20 neumonectomías no programadas. Se encontró concordancia entre lo programado y lo efectuado en el 86,9% de los casos (un 76,9% en tumores centrales y un 95,4% en periféricos). El valor del estadístico lambda es de 0,38 (0,42 en tumores centrales y 0,17 en periféricos). En 7 ocasiones la neumonectomía no programada se debió a afectación ganglionar hilar.

CONCLUSIONES: En el 13% de los pacientes sometidos a cirugía por carcinoma bronquial, la resección efectuada no coincide con la que se había programado inicialmente, la mayor parte de las veces debido a la necesidad de efectuar una neumonectomía cuando se había previsto una lobectomía. Este hecho es más frecuente en los tumores centrales y es debido con más frecuencia a invasión directa de las estructuras anatómicas que a extensión ganglionar hilar.

Palabras clave: *Carcinoma bronquial no microcítico. Resección pulmonar. Predicción del riesgo quirúrgico.*

Introduction

In earlier studies we found that logistic regression models lack precision in predicting surgical risk when applied to individual patients, at least in our series of cases.^{1,2} The present study was designed to test the

hypothesis that one of the many factors that could affect this lack of precision is the discrepancy between scheduled resections and the resections subsequently performed as, logically, estimation of surgical risk is made on the information available prior to the resection. We have not found articles in the medical literature that analyze this aspect, one undoubtedly familiar to surgeons. The main objective of this study, then, was to quantify the agreement between planned lung resections (lobectomy or pneumonectomy) and the resections subsequently performed, in a series of

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consecutive patients operated on by the same surgical team. The specific objectives of the study were: to assess whether the location of the tumor (central or peripheral) affected the degree of discrepancy and to examine, in the cases of unscheduled pneumonectomies, the reasons for extending the resection initially planned.

Methods

A prospective, observational, clinical trial was carried out on all patients scheduled for lung cancer resection at our unit between November 2001 and December 2003. The enrollment criteria, which have been previously published,^{1,2} remained unchanged for the duration of the study period.

Patients in whom, for whatever reason, the resection of the tumor consisted of an atypical segmentectomy (9 patients) and cases of exploratory thoracotomy (12 patients) were excluded from the study.

Tumors were preoperatively classified as central or peripheral. Tumors were classified as central when they reached the proximal third of the lung hilar in computed tomography images or when endoscopy revealed the tumors to have infiltrated the main bronchus or the beginning of a lobe.

The type of resection needed—lobectomy (or bilobectomy) or pneumonectomy—was decided in a clinical surgical session following individualized discussion of preoperatively available clinical data and endoscopic and radiographic results, according to the subjective experience of the surgeons.

To assess possible intraluminal growth, fiberoptic bronchoscopy was performed on all patients, following intubation in the operating theatre, and was followed by a posterior muscle sparing thoracotomy or a video-assisted anterior minithoracotomy, in each case at the head surgeon's discretion. Standard posterolateral thoracotomy was not performed on any patient. Bronchoplasty was attempted as an alternative in all patients scheduled for pneumonectomy irrespective of the patient's respiratory function. Node dissection was performed on all patients excepting those in clinical stage I and with epidermoid carcinoma, in whom biopsy of all accessible areas was performed. Intraoperative studies were not carried out on lymph node biopsies except when bronchial or arterial invasion by node metastasis could affect the anatomical extension of the resection. An intraoperative study of the bronchial margin was carried out in all bronchoplasty cases. Macroscopic mediastinal node extension was not taken into consideration when deciding on major or minor lung resection, nor was the involvement of areas 10 and 11, providing the surgeon was able to excise nodes that simple inspection showed to be affected.

Agreement between scheduled and subsequently performed surgery was quantified using the statistical program SPSS 10. The asymmetric lambda statistic was calculated and the type of resection performed was considered as the dependent variable.

Results

A total of 199 patients were enrolled in the study (181 men), with a mean (SD) age of 64.3 (9.4) (range, 37-83). Induction chemotherapy had been indicated in 26 cases (13.1%). One patient died in hospital from

TABLE 1
Agreement Between Scheduled Surgery and Surgery Subsequently Performed, All Cases*

Performed Resection	Scheduled Resection		Total
	Lobectomy	Pneumonectomy	
Lobectomy	151	6	157
Pneumonectomy	20	22	42
Total	171	28	199

*Lambda statistic, 0.38; percentage agreement, 86.9%; percentage discrepancy, 13.1%.

TABLE 2
Agreement Between Scheduled and Performed Resection, Distinguishing Between Central and Peripheral Tumors

Performed Resection	Scheduled Resection		Total
	Lobectomy	Pneumonectomy	
Central tumors*			
Lobectomía	50	5	55
Pneumonectomy	16	20	36
Total	66	25	91
Peripheral tumors†			
Lobectomía	101	1	102
Pneumonectomy	4	2	6
Total	105	3	108

*Lambda, 0.42; percentage agreement, 76.9%; percentage discrepancy, 23.1%.

†Lambda, 0.17; percentage agreement, 95.4%; percentage discrepancy, 4.6%.

acute myocardial infarction and a second patient was readmitted to another hospital and died from respiratory insufficiency secondary to pneumonia within 30 days of the operation, bringing the series mortality to 1%. Lobectomies had been performed in both cases.

In the preoperative assessment, tumors were classified as peripheral in 108 cases (54.3%), rib resection was considered necessary in 12 patients (6%), and 171 (85.9%) lobectomies and 28 (14.1%) pneumonectomies were scheduled. Subsequently, 157 lobectomies (78.9%) and 42 pneumonectomies (21.1%) were performed. We were able to perform bronchoplasty on 12 patients (6%) instead of pneumonectomy, and rib resection was performed on 12 patients (6%). Histology of the resected specimen revealed nodal involvement in 39 patients: in the hilar nodes in 20 patients, in the hilar and mediastinal nodes in 2 patients, and only in mediastinal nodes in 17 patients.

Table 1 shows the scheduled and performed resections. Twenty unscheduled pneumonectomies were performed. Agreement between scheduled and performed resections was recorded in 86.9% of patients. The lambda statistic was 0.38. Table 2 shows the same information grouped by central or peripheral tumor location. The lambda statistics were 0.42 and 0.17 respectively. The scheduled and performed resections were the same in 76.9% of patients with central tumors and 95.4% of patients with peripheral tumors.

Most unscheduled pneumonectomies (13 cases) were attributable to direct tumor invasion of anatomic

TABLE 3
Influence of Hilar Lymph Node Involvement on the Type of Surgery Performed

Performed Resection	Scheduled Resection		Total
	Lobectomy	Pneumonectomy	
With hilar lymph node metastasis*			
Lobectomy	10	2	12
Pneumonectomy	7	3	10
Total	17	5	22
Without hilar lymph node metastasis†			
Lobectomy	141	4	145
Pneumonectomy	13	19	32
Total	154	23	177

*Percentage agreement, 59.1%; percentage discrepancy, 40.9%;

†Percentage agreement, 90.4%; percentage discrepancy, 9.6%.

TABLE 4
Influence of Induction Chemotherapy on the Type of Surgery Performed

Performed Resection	Scheduled Resection		Total
	Lobectomy	Pneumonectomy	
With induction chemotherapy*			
Lobectomy	13	2	15
Pneumonectomy	6	5	11
Total	19	7	26
Without induction chemotherapy†			
Lobectomy	137	4	141
Pneumonectomy	14	17	31
Total	151	21	172

*Percentage agreement, 69.2%; percentage discrepancy, 30.8%;

†Percentage agreement, 89.5%; percentage discrepancy, 10.5%.

structures without hilar node involvement (Table 3). Agreement was 69.2% in the group of 26 patients with induction chemotherapy (Table 4); discrepancies in these cases were mostly due to lobectomies being performed on patients scheduled for pneumonectomies.

Discussion

Authors who have published on lung resection risk assessment and prognosis have usually simply identified variables related to postoperative events such as major morbidity or mortality,^{4,5} with 1 exception.³ Other authors retrospectively applied classification criteria to a series of previously performed resections.⁶ Few studies can be found in the literature that examine whether the application of certain predictive models to a series of different cases enables the correct identification of patients who will present complications. Authors who have done so have found the positive predictive value of the model to be low and its negative predictive value to be high; in other words, patients who will not present complications can be identified but positive prediction of complications is inaccurate in individual patients.³

This is logical, involving as it does the prediction of very rare events, such as operative mortality or the appearance of complications which depend on variables that cannot always be identified. In a study recently published by our group, we found the area under the receiver operating characteristics curve to be very high when using a model calculated with an artificial intelligence program, but this result needs to be confirmed in further studies.⁷

In the present study, we have tried to quantify the degree of discrepancy between the type of resection scheduled with the resection eventually performed, given that the error in estimating the type of surgery necessary could be an important confounding factor in the estimation of surgical risk. We deliberately excluded cases of exploratory thoracotomy from the analysis as the risk of this kind of surgery bears no relation to the amount of parenchyma excised.

We used the Goodman and Kruskal⁸ lambda association statistic, rarely mentioned in the medical literature. Lambda statistic involves measuring the proportional reduction of error and quantifying to what extent the error of estimating a categorical, nonordinal, variable is reduced when another variable is known. The statistic ranges between 0 (no association at all) and 1 (perfect association). The information we presented, then, can be interpreted in the following way: a lambda of 0.38 in the general series signifies that there is a 38% possibility of predicting the variation of the performed resection on the knowledge of what the scheduled resection was. An association of more than 0.30 is considered strong in the literature.

Once the above is known, we can establish a marked distinction between agreement in the cases of central and peripheral tumors. Correlation with peripheral tumors was much lower but most of the errors were found in the group of central tumors (25 pneumonectomies were scheduled and 36 performed for central tumors, while 3 were scheduled and 6 performed for peripheral tumors), indicating better association for peripheral tumors. Paradoxical behavior of association statistics has been discussed regarding the kappa statistic,⁹ and some authors¹⁰ recommend the presentation of agreement and discrepancy percentages, as presented in our study, and not statistical values alone.

In this series, as mentioned above, bronchoplasty was performed when possible, irrespective of the patient's lung function. Survival is similar for bronchoplasty and pneumonectomy^{11,12} but pneumonectomy continues to be a high risk operation¹³ that could be associated with lower, long-term survival.¹⁴

Hilar node involvement is a frequent reason for performing pneumonectomies, but not the major one. Both hilar node invasion and extrabronchial tumoral spread, undetected by bronchoscopy, can be predicted from images, but they cannot be demonstrated preoperatively so choice of surgery is based on the surgeon's experience. This subjectivity was a major limitation to our study, reducing its reproducibility.

Moreover, we can not compare our results with the literature as we have not found similar recent studies. Despite these limitations we believe that our results are very useful as they quantify a known fact. Knowing the repercussion a change of scheduled surgery could have on patients with limited lung function is particularly relevant. We have carried out a preliminary study on this aspect¹⁵ and hope to be able to publish more conclusive results in the near future

Assessment of the influence of induction chemotherapy on agreement between scheduled and subsequent surgery was not one of the specific objectives of this study. Nevertheless, in our series we have shown that most discrepancies in these patients consisted of lobectomies being performed when pneumonectomies had been scheduled but we do not feel that this finding should be taken into account as criteria used to indicate induction chemotherapy varied. This aspect definitely deserves a separate, properly designed study.

In conclusion, we found that in 13% of patients who underwent bronchial carcinoma operations, the resection performed did not coincide with the resection initially scheduled. Most of the discrepancy occurred in centrally located tumors on which a pneumonectomy was performed due to invasion of anatomical structures. This result is particularly important for patients whose poor lung function does not allow pneumonectomy to be indicated.

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