Does the indication for completion pneumonectomy affect outcome?

Endikasyon tamamlayıcı pnömonektomide akıbeti etkiler mi?

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Background: In this report, we reviewed our 20-year experience and investigated the factors affecting morbidity and mortality of completion pneumonectomy.

Methods: Fifty-four patients underwent completion pneumonectomy in our clinic between June 1987 and June 2008. Patients were divided into two groups according to their indications for completion pneumonectomy, either for a complication of the previous operation or a new disease in the remaining lung.

Results: The overall complication rate was 42.5%, and this morbidity was significantly higher in the complication group (p=0.04). The overall mortality rate was 22%, and age was found as the only factor affecting mortality (p=0.03).

Conclusion: The experience that we had over 20 years and the other information from the literature pointed out that the complications in the first operations adversely affected the outcome rather than the procedure itself in completion pneumonectomy.

Key words: Completion pneumonectomy; morbidity; mortality.

Amaç: Bu çalışmada 20 yıllık deneyimimiz gözden geçirildi ve tamamlayıcı pnömonektominin morbidite ve mortalite oranlarını etkileyen faktörler araştırıldı.

Çalışma planı: Haziran 1987 ile Haziran 2008 tarihleri arasında 54 hastaya kliniğimizde tamamlayıcı pnömonektomi yapıldı. Hastalar tamamlayıcı pnömonektomi endikasyonları açısından önceki ameliyatın komplikasyonu ya da kalan akciğerde yeni bir hastalık gelişimi nedeni ile iki gruba ayrıldı.

Bulgular: Genel komplikasyon oranı %42.5 idi ve bu morbidite komplikasyon grubunda anlamlı ölçüde daha yüksek idi (p=0.04). Genel mortalite oranı %22 idi ve yaş mortalite için tek etkili faktör olarak bulundu (p=0.03).

Sonuç: Yirmi yıllık deneyimimiz ve literatürdeki diğer bilgiler ışığında, tamamlayıcı pnömonektomide akıbeti kötü yönde etkileyen faktörün işlemin kendisinden ziyade, girişimin önceki ameliyatın komplikasyonu nedeni ile yapılması olduğu görüldü.

Anahtar sözcükler: Tamamlayıcı pnömonektomi; morbidite; mortalite.

Deslauriers[1] described completion pneumonectomy (CP) as the removal of the lung, or what is left of it, from a previous ipsilateral lung resection. Though it carries greater morbidity and mortality than standard pneumonectomy, CP offers the only chance for a cure for a majority of patients suffering from recurrent or complicated disease of the rest of the lung. Indications for CP can be classified into three groups: malignant diseases, benign problems, and complications after a previous operation. The majority of the reports have only two groups: patients with malignant diseases and those with benign problems. The morbidity and mortality analysis was based on this classification.[2-6] In these reports, the complication group was usually included in the benign group making the outcome of surgery in this group seem more hazardous.

We think that both morbidity and mortality are higher in patients who underwent CP due to complications from a previous operation. In this report, we aimed to analyze the clinical data of 54 patients regarding the indications, morbidity, and mortality.

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PATIENTS AND METHODS

Between 1987 and 2008, 915 standard pneumonectomies and 54 CP were performed at our thoracic surgery center. The patients were divided into two groups according to their indications for CP: group A was comprised of patients who had CP for treatment resulting from complications from the first operation, and group B consisted of patients who had CP for a new disease regardless of whether it was malignant or benign (Table 1).

The primary operation was defined as the first operation in which lung tissue was removed. Some patients had non-anatomic resection which can be defined as removal of lung tissue without observing anatomic landmarks. This usually results in parenchymal and small bronchopleural fistulas accompanied by infection. This interesting group included five patients who had been operated on by inexperienced thoracic surgeons from peripheral hospitals. Three patients underwent operations for lung cancer, one for pneumothorax, and one for trauma. All five operations ended with some amount of lung tissue resection with parenchymal air leaks and bronchial fistulas. All patients were staged according to the American Joint Committee on Cancer (AJCC)/ International Union Against Cancer (UICC) tumor node metastasis (TNM) classification system.[7] The discrimination between recurrent lung cancer and second primary lung cancer was made according to the criteria reported by Martini.[8] The patients were supported with oral or parenteral nutrition, and accompanying infections were treated with antibiotics and/or some kind of surgical intervention like tube thoracostomy. The records of the previous procedures were also checked. Associated comorbidities like diabetes mellitus, hypertension, arrhythmia, and chronic obstructive pulmonary disease were treated accordingly. A bronchoscopy was performed in order to evaluate the bronchial tree for possible inflammation and any kind of fistula. All patients underwent a standard posterolateral thoracotomy under general anesthesia with a single or double lumen endotracheal tube. Pleural dissection was usually extrapleural, and ligation of vessels was accomplished by opening the pericardium when necessary. Hospital mortality included all intraoperative and postoperative deaths within 30 days after surgery or late mortality occurring after 30 days during hospitalization.

Baseline patient data is presented as mean with standard deviation (SD) for quantitative variables and as absolute and relative frequency for qualitative variables. Prognostic relevance of different patient characteristics on morbidity, bronchopleural fistula (BPF) development, and 30-day mortality was assessed by Fisher's exact test and binary logistic regression analysis.

RESULTS

The overall complication rate was 42.5% (23/54), and BPF accompanied by empyema was the leading (11 out of 54, 20.3%) cause of morbidity. In univariate analysis, age, operation side, intrapericardial approach, extrapleural dissection, and presence of comorbidity did not affect morbidity significantly, but morbidity was significantly higher in the complication group than in the non-complication group (55% vs. 27%, p=0.04) (Table 2).

Bronchopleural fistula accompanied by empyema was found to be the most common (11 out of 54, 20.3%) and challenging problem in both groups, but it was significantly higher in the complication than in the non-complication group (31% vs. 8%, p=0.02). Bronchopleural fistula developed 2.42 times more on the right than on the left, but the difference was not statistically significant. Other factors like age, bronchial closure technique, and bronchial stump coverage did not affect the BPF rate in univariate analysis (Table 2). While less than 50% of the cases could be treated by tube thoracostomy alone or with the Clagett method, six patients failed to respond to treatment and died as a result of this complication.

None of the 54 patients died intraoperatively. The 30-day mortality and late mortality (mortality after 30 days) were 14.8% (8 out of 54) and 22% (12 out of 54), respectively. In univariate analysis, both 30-day and beyond 30-day mortalities were much higher in the complication group than in the non-complication group, but neither of them reached statistical significance (OR: 3.3, p=0.10). The only factor affecting mortality was age, especially age over 60 (OR: 1.142, p=0.03; Table 2).

DISCUSSION

Completion pneumonectomy, previously described as the removal of the lung, or what is left of it, from a previous lung resection, provides hope for patients having a new cancer, metastases, or a benign disease with progression. Sometimes it is the only chance for treatment of complications of the first resection. The series in the literature show major discrepancies regarding the risk of CP. The major reason for these discrepancies is that the series is generally comprised of two groups, malignant and benign, with the benign groups showing higher morbidity and mortality rates. A possible explanation for this might be that most of the series placed the patients having CP for complications of the first resection in the benign group.[2-6]

In most of the series, CP is performed mainly for malignant reasons, like a new cancer or cancer recurrences with benign diseases making up the

minority. Our series was comprised of 54 cases, and more than half (53%) of the patients underwent CP for complications. One of the earliest reports of CP came from the Mayo Clinic in 1988.[2] McGovern et al.[2] performed 113 CP: 64 for lung cancer, 20 for metastases, and 29 for (25%) for benign cases. However, more than 50% of the benign group was formed by patients having CP for complications (n=16). Jungraithmayr et al.[9] reported the first series of CP that had a distinct complication group. They studied 86 cases with CP, and CP for complications of the first operation accounted for nearly half of the patients.

In general, both morbidity and mortality are higher in the benign groups of the series in the literature (Table 3).[2-6,9-17] The overall 30-day mortality and late mortality rates of the current series were 14.8% and 22%, respectively, and the non-complication group had a much higher rate of mortality than the other group, although this was not statistically significant.

In one of the earliest series in the literature, McGovern et al.[2] pointed out that the benign group had higher mortality rates than the malignant group, and they stressed that the higher rate of patients with complications in the benign group was mainly

Table 1. Patient characteristics of the two groups

	Group A (Complication group)				Group B (Non-complication group)				*Total*				*p*
	n	%	Mean±SD	Range	n	%	Mean±SD	Range	n	%	Mean±SD	Range	
Number of patients	29	–	–	–	25	–	–	–	54	–	–	–	–
Mean age (years)	–	–	48.4±15.3	–	–	–	50.4± 15.1	–	–	–	49.29±15	15-79	0.511
Time up to CP (days)	–	–	81.5±113	5-430	–	–	835±1041	21-4900	–	–	434±803	5-4900	0.001
Indications for the first													
Malignant													
Lung cancer	21	–	–	–	18	–	–	–	–	–	–	–	–
Benign													
Tuberculosis, aspergilloma, bronciectasis, pneumothorax, hamartoma, hydatid cyst, trauma	8	–	–	–	–	–	–	–	–	–	–	–	–
Bronchiectasis, tuberculosis, aspergilloma, PHS hamartoma, hydatid cyst, trauma	–	–	–	–	7	–	–	–	–	–	–	–	–
Indications for CP													
BPF + empyema	10	–	–	–	–	–	–	–	–	–	–	–	–
Non-anatomic resection	5	–	–	–	–	–	–	–	–	–	–	–	–
Pulmonary infarct	5	–	–	–	–	–	–	–	–	–	–	–	–
Dehiscence of sleeve anastomosis	4	–	–	–	–	–	–	–	–	–	–	–	–
Hemorrhage	2	–	–	–	–	–	–	–	–	–	–	–	–
Others	3	–	–	–	–	–	–	–	–	–	–	–	–
Bronchovascular fistula, torsion, empyema													
Development of a new cancer	–	–	–	–	12	–	–	–	–	–	–	–	–
Recurrent cancer	–	–	–	–	6	–	–	–	–	–	–	–	–
Positive resection margin	–	–	–	–	3	–	–	–	–	–	–	–	–
Benign	–	–	–	–	4	–	–	–	–	–	–	–	–
Aspergilloma, tuberculosis, PHS													
Right side	19/29	66	–	–	7/25	32	–	–	26	48	–	–	0.06
Extrapleural dissection	12/29	40	–	–	20/25	80	–	–	32/54	61	–	–	0.04
Intrapericardial approach	13/29	44	–	–	19/25	75	–	–	32/54	61	–	–	0.02
Bronchial closure													
Hand suture	21/29	72	–	–	19/25	76	–	–	40/54	74	–	–	0.764
Stapler	8/29	18	–	–	6/25	24	–	–	14/54	26	–	–	
Tissue support	16/29	55	–	–	13/25	52	–	–	29/54	54	–	–	0.816
Comorbidity (DM, hypertension, COPD, cardiac problems, etc)	10/29	34	–	–	8/25	32	–	–	18/54	33	–	–	0.93

SD: Standard deviation; CP: Completion pneumonectomy; PHS: Pulmonary hemorrhagic syndrome; BPF: Bronchopleural fistula; DM: Diabetes mellitus; COPD: Chronic obstructive pulmonary disease.

Table 2. Risk factors affecting postoperative morbidity, bronchopleural fistula, and mortality rates in univariate and multivariate analysis

Risk factors	Broncho pleural fistula			Complication			Mortality		
	Odds ratio	%95 CI	*p*	Odds ratio	%95 CI	*p*	Odds ratio	%95 CI	*p*
Group (A/B)	6.053	1.18-31.05	0.02	3.16	1.01-9.80	0.04	3.3	0.78-13.9	0.10
Operation side (right/left)	2.42	0.63-9.29	0.16	1.16	0.39-3.42	0.50	1.54	0.42-5.63	0.51
Age (year)	1.04	0.9-1.09	0.11	1.03	0.9-1.07	0.11	1.142	1.031-1.264	0.03
Intrapericardial approach	–	–	–	2.29	0.75-6.96	0.14	1.05	0.28-3.86	0.94
Extrapleural dissection	–	–	–	1.92	0.63-5.85	0.24	1.16	0.31-4.28	0.82
Bronchial closure (stapler/manual)	1.6	0.39-6.45	0.37	–	–	–	–	–	–
Bronchial stump support with viable tissue	1.27	0.34-4.65	0.71	–	–	–	–	–	–
Comorbidity	1.11	0.28-4.37	0.56	1.30	0.41-4.14	0.43	2.81	0.75-10.5	0.12

responsible for this difference. Though Muysoms et al.[10] could not find a significant difference between the mortality rates of malignant and benign groups in his series, he found a significant difference (13.2% vs. 37.5%) when he compared the mortality rates of the malignant and the complication groups. Jungraithmayret al,[9] in their special series with a distinct complication group, reported that the complication group had significantly higher mortality rates than both the malignant and benign groups (33% vs. 10% and 0%, respectively). A recent study from France reported that the right side was a significant factor affecting mortality in contrast to our finding,[11] but the same study also reported age was a significant factor affecting mortality. This was also the case in our study.

Similarly, complications were encountered more frequently in the complication group than in the non-complication group, and the difference was found to be significant. Except for indications for CP, we could not find any other factor studied which influenced morbidity.

McGovern et al.[2] reported that the benign group had significantly higher morbidity than the malignant group (27.6% vs. 9.4%). Though cardiac dysrhythmia was more common in the malignant group, BPF and total complications were higher in the benign group. Jungraithmayr et al.[9] also reported a higher morbidity rate in the complication group than in the malignant and benign groups (49% vs. 29.3% and 33.3%, respectively).

Contrary to our finding that the most common and important complication in the current series was BPF, Al-Kattan and Goldstraw.[12] reported no

Table 3. Mortality, morbidity, and broncho pleural fistula rates in the literature

Study	No	Overall mortality (%)	Malignant (%)	Benign (%)	Overall mortality	BPF (%)
McGovern et al.[2]	113	12.4	9.4	27.6	38.1	11.7
Van Schil et al.[15]	19	15.8				10.5
Gregoire et al.[3]	60	10	12.2	5.3	27	13.3
Massard et al.[4]	37	10.8	10.8		24	2.7
Al-Kattan and Goldstraw[12]	38	2.6	0	8.3	18	0
Verhagen and Lacquet[5]	37	16.2	15.2	25	29	5.4
Muysoms et al.[10]	138	13.8	13.2	15.5	42	4.3
Regnard et al.[6]	80	5	6.4	0	19.5	3.8
Fujimoto et al.[16]	66	7.6			53	7.6
Terzi et al.[17]	59	3.4	3.4		30	
Miller et al.[14]	115	20.9	17.6	26.3	62.6	7
Guggino et al.[13]	55	16.4	11.9	30.8	58.2	12.7
Jungraithmayr et al.[9]	86	20.2			37.2	10.4
Chataigner et al.[11]	69	12	12.7	9	40.6	10
Current study	54	22			42.5	20

BPF: Broncho pleural fistula.

BPF development in his 38-patient series which was predominantly composed of right-sided completion pneumonectomies. A similar study reported that while 22 patients underwent CP for BPF, only six cases out of 138 (4.3%) developed BPF postoperatively.[10]

It is usually accepted that right-sided resections, accompanying diseases, and radiotherapy increase the chance for the development of BPF, but we could not find any factor affecting BPF development. Guggino et al.[13] reported one of the highest rates of BPF (12.7%), but they could find no difference between benign and malignant groups or any other factor affecting the development of BPF.

It seems that CP will always be a challenge for a thoracic surgeon. Though it carries considerable risks, sometimes CP becomes unavoidable and appears to be the sole treatment method. Because it is a redo operation, it is crucial to have information from the first procedure. Before the operation, the patient should be both mentally and physically prepared for the planned procedure. The patients in this study were in a chronic, debilitating state of infection and malnutrition, especially in the complication group. Many of them had thoracic drains that had been present for months, and they traveled to many hospitals in hope of treatment. Therefore, they were depressed, unable to work, and physically and mentally exhausted . To overcome the active infection, antibiotics should be used. For local control of the infection, the thoracic cavity could be irrigated by a modified Clagett method, and sometimes temporary stoma (Eloesser flap) could be performed. The patient should be informed about his situation, and close cooperation should be provided. They should also be supported nutritionally with high calorie and high protein content in order to endure the operation and help wound healing. During the operation, because the most dreadful complication of CP is empyema with or without a bronchopleural fistula, the thoracic cavity should be debrided carefully, and, if necessary, an irrigating catheter or a stoma should be provided. Wrapping the bronchial stump with viable tissue may help bronchial healing, and even an omental flap may be used for this purpose. The higher rate of bronchopleural fistulas and other complications in the complication group in our series might be due to insufficient preoperative management of these patients, such nutritional support and inadequate bronchial stump support. Though we did not encounter the need, the surgeon should not hesitate to open the pericardium when necessary to control the vascular structures safely because extensive hilar fibrosis may make it very difficult to dissect vascular structures extrapericardially, and massive hemorrhage may occur.

In conclusion, our experience of more than 20 years and the many series in the literature point out that the indication for CP affects the outcome rather than the procedure itself.

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