

Surgical Results of Completion Pneumonectomy

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Purpose: We report our experience with completion pneumonectomy (CP).

Methods: We report on operative procedure and morbidity, mortality, and survival rates.

Results: CP was performed for malignancy in 12 patients and postoperative complications after the first operation in 4 patients. Intrapericardial dissection of vessels was performed in 14 patients (87.5%). Partial vertebrectomy from the second to the fifth vertebrae was performed in 1 patient. Carinal resection was performed in 2 patients. Morbidity including bronchopleural fistula, pulmonary insufficiency, pyothorax, and pulmonary infarction developed in 6 of the 16 patients (37.5%). Mortality rate was 18.8%. The actuarial 1-, 3-, and 5-year overall survival after CP for all malignancy was 80.8%, 49.0%, and 49.0% respectively.

Conclusions: The morbidity and mortality rates are high in CP. Combined resection, especially carinal resection, appears to be contraindicated in CP. CP is one of the treatments of choice, even for malignancy, if complete resection is possible because of the good long-term survival.

Key words: lung cancer, completion pneumonectomy, mortality, morbidity.

Introduction

Completion pneumonectomy (CP) refers to the resection of the remaining lung tissue after a previous pulmonary resection. Increased frequency of metachronous non-small cell lung cancer provides an indication to perform CP¹; however, CP remains a risky procedure.^{2–14} In the present study, we report our experience with CP, considering the operative procedure, morbidity, mortality, and survival of patients.

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Received: September 14, 2009; Accepted: February 3, 2010
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Materials and Methods

From April 1988 to September 2008, 17 patients including 13 males and 4 females underwent CP at the Division of Thoracic Surgery, Department of Surgery, Nippon Medical School and the Department of Surgery, Nippon Medical School Musashikosugi Hospital. Of these patients, 1 was excluded because she underwent resuscitation and rescue CP for massive hemoptysis due to local recurrence of lung cancer. Therefore, 16 patients with a mean age of 62 years (range, 37–80 years) were analyzed in the present study (**Table 1**). They accounted for 11.6% of all pneumonectomies performed during the same period. Nine and 7 patients underwent right and left CP, respectively. Fifteen patients (94%) underwent lung resection for primary lung cancer and 1 patient (6%) underwent lung resection for pulmonary tuberculosis at the first operation. According to the UICC staging system,¹⁵ 8 patients had stage I disease, 3 had stage II disease, and 5 had stage III disease. The procedures were performed through posterolateral thoracotomy in 9 patients, video-assisted thoracic surgery (VATS) in 2,

Table 1 Clinical characteristics of 16 patients who underwent completion pneumonectomy.

Patient	Age & Sex	Side	1st Disease	1st Approach	1st Procedure	2nd Disease	2nd Approach
1	45M	Right	LC (IB)	PL	RUL + ND2a	Second LC (IIB)	PL
2	52F	Left	LC (IB)	MS	LUL + ND2a	Second LC (IIIB)	Bilateral PL
3	55M	Left	LC (IIIA)	PL	LUL + ND2a	Pulmonary infarction	PL
4	64M	Right	Tbc	PL	RUL	LC (IIIA)	AL
5	50M	Right	LC (IB)	PL	RUL + ND2a	Local recurrence of LC	PL
6	58M	Right	LC (IIIA)	PL	RUL + ND2a	Pulmonary metastasis	MS + AL
7	65M	Right	LC (IIIA)	MS	RUSL + ND3a	BPF	PL
8	78M	Right	LC (IB)	PL	RLL + ND2a	Pulmonary metastasis	PL
9	76M	Left	LC (IIB)	MS + AL	RUD + ND2a	Pulmonary metastasis	AL
10	52M	Left	LC (IIIA)	AL	LLSL + ND2a	Broncho-PA fistula	AL
11	77F	Left	LC (IA)	PL	LLL + ND2a	Second LC (IB)	MS + AL
12	63M	Right	LC (IIB)	PL	RMLL + ND2a	Pyothorax	MS + AL
13	65M	Right	LC (IIB)	PL	RLL + ND2a	Second LC (IA)	PL
14	37M	Right	LC (IA)	VATS	S8 seg + ND2a	Local recurrence of LC	PL
15	80M	Left	LC (IB)	MST	LLL + ND2a	Second LC (IA)	MS + AL
16	75F	Left	LC (IB)	VATS	RUD + ND2a	Pulmonary metastasis	MST

M, male; F, female; LC, lung cancer; (), pathological stage of LC; Tbc, pulmonary tuberculosis; PL, posterolateral thoracotomy; MS, median sternotomy; AL, anterolateral thoracotomy; VATS, video-assisted thoracic surgery; MST, muscle-sparing thoracotomy; RUL, =right upper lobectomy; LUL, left upper lobectomy; ND, nodal dissection; RUSL, right upper sleeve lobectomy; RLL, right lower lobectomy; RUD, resection of upper division; LLSL, left lower sleeve lobectomy; LLL, left lower lobectomy; RMLL, right middle and lower lobectomy; seg, segmentectomy; BPF, bronchopleural fistula

median sternotomy in 2, and median sternotomy plus anterolateral thoracotomy, anterolateral thoracotomy, and muscle-sparing thoracotomy each in 1 patient. For the first operation, 13 patients (81%) underwent lobectomy: right upper lobectomy in 4, left lower lobectomy, left upper lobectomy, right lower lobectomy each in 2, and right upper sleeve lobectomy, left lower sleeve lobectomy and right middle and lower lobectomy each in 1, and 3 underwent segmentectomy: resection of left upper division in 2 and right S⁸ in 1. Combined resection of the chest wall resection was performed in 1. Six patients had adenocarcinoma, 5 had squamous cell carcinoma, 2 had large cell neuroendocrine carcinoma, 1 had adenocarcinoma, 5 had squamous cell carcinoma, 2 had large cell neuroendocrine carcinoma, 1 had adenocarcinoma, and 1 had carcinoid tumor.

Mortality was defined as death occurring during the hospitalization period following surgery. Morbidity in this study was defined as complications that occurred during the hospitalization period during and after surgery, and included respiratory failure necessitating mechanical ventilation for more than 48 hours, bronchopulmonary artery fistula, bronchopleural fistula (BPF), pyothorax, and bleeding.

Results

CP was performed for malignancy including second

primary lung cancer in 5, metastatic lung tumor in 4, local recurrence in 2, and primary lung cancer in 1, and postoperative complications after the first operation in 4 patients (**Table 1**). The same approach with the prior thoracotomy was used in 7 patients (posterolateral thoracotomy: 5; and anterolateral thoracotomy: 2). Different approaches were used in 9 patients (median sternotomy plus anterolateral thoracotomy: 4; posterolateral thoracotomy: 2; bilateral posterolateral thoracotomy, muscle-sparing thoracotomy, and anterolateral thoracotomy each in 1). Intrapericardial dissection of vessels was performed in 14 patients (87.5%). Partial vertebrectomy from the second to the fifth vertebrae was performed in patient 5. Carinal resection was performed in 2 patients (patients 2 and 6). Carinal resection, interrupted anastomoses, and closure of the left bronchial stump were performed by right posterolateral thoracotomy, and left completion pneumonectomy by left posterolateral thoracotomy in patient 2 because she had undergone left upper lobectomy by median sternotomy before. Carinal resection, interrupted anastomoses, and right completion pneumonectomy were performed by median sternotomy and anterolateral thoracotomy in patient 6. Mean operating time was 398 ± 166 min. Mean volume of blood loss was 2423 ± 2888 ml. Mean duration of hospital stay after surgery was 74 ± 93 days (**Table 2**).

Table 2 Operative procedures, short and long-term surgical results of 16 patients.

Patient	Combined Resection	Intrapericardial dissection	Operating time (min)	Blood loss (ml)	Morbidity	Postoperative hospital stay (day)	Survival (month)
1	None	Done	510	2107	None	38	29D
2	Carinal resection	Done	840	1730	BPF	106	3D
3	None	Done	300	335	None	95	17D
4	None	Done	370	1990	None	23	20D
5	Vertebrectomy	Done	585	2000	None	58	11D
6	Carinal resection	Done	250	2000	Pulmonary infarction	1	0D
7	None	Done	420	1755	BPF	256	36A
8	None	Done	347	1640	RI	63	21D
9	None	Done	500	2560	None	58	26A
10	None	None	209	1250	None	43	36A
11	None	Done	250	490	None	21	29A
12	None	Done	380	4750	Pyothorax	289	23A
13	None	Done	214	110	None	40	169A
14	None	Done	448	1400	None	23	40A
15	None	Done	495	12500	RI	1	0D
16	None	None	255	2155	None	19	3A

BPF, bronchopleural fistula; RI, respiratory insufficiency; PA, pulmonary artery; D, dead; A, alive

Morbidity developed in 6 of the 16 patients (37.5%); BPF and pulmonary insufficiency each in 2 patients, and pyothorax, pulmonary infarction each in 1 patient. BPF developed in 2 patients who underwent CP with carinal resection (patient 2) and CP for BPF after right upper sleeve lobectomy (patient 7), respectively. Bronchial anastomoses were covered with pedunculated precordial fat (patient 2) and intercostal muscle (patient 7) at the first operation. BPF was covered with omental flap and fenestration of left pleural cavity was added in patient 2, but the patient died of massive bronchial bleeding 106 days after CP. Bronchial stump after CP covered with pedunculated intercostal muscle in patient 7 developed sutural insufficiency. He recovered after fenestration and thoracoplasty, but finally died of lung cancer.

Three patients (18.8%) died during hospitalization because of pulmonary thromboembolism 1 day after CP (Patient 6), massive bronchial bleeding after bronchopleural fistula 106 days after CP (Patient 2), and adult respiratory distress syndrome 1 day after CP (Patient 16). Two of the 3 patients underwent carinal resection (patients 2 and 6). Patient 6 suddenly developed severe hypoxia and hypotension during the procedure so that completion pneumonectomy was performed under a percutaneous cardiopulmonary support (PCPS). An autopsy

revealed pulmonary thromboembolism, which occluded left main pulmonary artery. Perforation of the aorta occurred during dissection of the carina in patient 16, which was closed under a PCPS.

During the follow-up period, 4 men died of lung cancer and 1 woman died of another disease. Eight patients (6 male and 2 female) were alive. The actuarial 1-, 3-, and 5-year overall survivals after CP for all malignancy was 80.8%, 49.0%, and 49.0% respectively (**Fig. 1**).

Discussion

Recent advances in operative techniques, anesthesia, and postoperative care have remarkably decreased the morbidity and mortality after surgery for lung cancer in Japan.¹⁶⁾ However, the previous²⁻¹⁴⁾ and present studies revealed that CP still had a high morbidity of 18%–53% and mortality up to 20.9%. The present study revealed that carinal resection seemed to be risky. Either a complication of the initial lung resection or adjuvant radiation therapy or persistence of infectious pulmonary disease was a risky indication for CP.²⁾ Maneuvers such as intrapericardial blood vessel ligation, division of the bronchus first, local application of glues and hemostatic agents, and bronchial reinforcement were routinely used to avoid

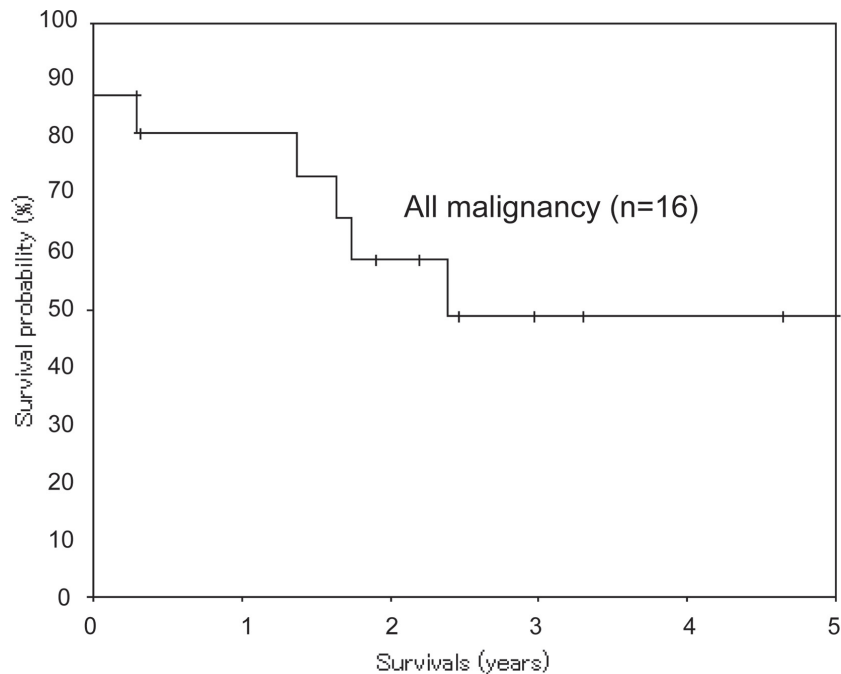


Fig. 1 Actuarial overall survival after completion pneumonectomy for all malignancy.

perioperative troubles.^{4, 8)} Advanced age, preoperative corticosteroid use, or low operative hemoglobin,¹¹⁾ and renal failure¹⁴⁾ were reported to be the significant risk factors based on the multivariate analysis. In the present study, no patient had preoperative corticosteroid use or renal failure. Two patients who underwent carinal resection died of bronchopleural fistula and pulmonary infarction, respectively. Patient 2 in the present study also underwent a left radical mastectomy and irradiation of 60Gy to the left parasternal area before left upper lobectomy for the first lung cancer. The second lung cancer developed in the area of the 2nd to the 4th bronchial cartilage ring of the left main bronchus and seemed to be a radiation-induced carcinoma, and led to bronchopleural fistula. To our knowledge, resection of the carina has not been performed in previous studies.²⁻¹⁴⁾ Recently, various therapeutic bronchoscopy including laser therapy, electrocautery, brachytherapy, stents, and photodynamic therapy is reported to be useful in retrieving large airway obstruction.¹⁷⁾ Direct intratumoural injection with 5-fluorouracil is reported to reduce the size of tumors in the majority of cases and increase the diameter of the airway lumen.¹⁸⁾ Therefore, therapeutic bronchoscopy or the combination of bronchoscopic and surgical management should be performed to avoid carinal resection in these risky CP cases.

The actuarial 5-year overall survivals after CP for lung cancer have been reported to be 26.4% to 54%.²⁻¹⁴⁾ In the present study, the actuarial 5-year overall survivals after CP for all malignancy were 49.0%. Accordingly, the good long-term survival of malignancy suggests that CP is one of the treatments of choice for selected patients if complete resection is possible.

In conclusion, the morbidity and mortality remain high in CP. Carinal resection appears to be contraindicated in CP. CP is one of the treatments of choice even for malignancy if complete resection is possible because of the good long-term survival.

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