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Postoperative Respiratory Complications of Video-assisted Thoracic Surgery for Lung Cancer

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Abstract

Purpose: We analyzed the risk factors predisposing patients to develop postoperative respiratory complications (PRCs) in VATS lobectomy and segmentectomy for lung cancer, retrospectively.

Methods: Both univariate and multivariate analyses of PRCs were performed in seventy-five patients who had undergone VATS lobectomy and segmentectomy for lung cancer from November 1994 to December 2000.

Results: Univariate analysis of the development of PRCs revealed that the significant risk factors were age, ppo%VC, ppo%FEV, ppoFEV, poor pulmonary function, and duration of surgery. Multivariate logistic regression test in regard to the development of PRCs revealed that duration of surgery was the most significant risk factor. On the basis of the receiver operator characteristic analysis, duration of surgery more than 297 min had a sensitivity of 70% and a specificity of 66% for the development of PRCs.

Conclusions: The duration of surgery should be less than five hours not to lose advantages of VATS lobectomy and segmentectomy. Therefore, if the duration of surgery is more than five hours for any reasons, conversion to limited thoracotomy or muscle-sparing methods is recommended.

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Key words: primary lung cancer, video-assisted thoracic surgery, postoperative respiratory complications

Introduction

Video-assisted thoracic surgery (VATS) has been performed with acceptably low mortality and morbidity in the treatment of various pulmonary, pleural, or mediastinal diseases[1,2]. However, a survey conducted in North America in 1995 has shown that most of the respondents considered VATS lobectomy for lung cancer to be investigational or unacceptable because of complicated procedures or doubt about adequate clearance of malignancy[3]. We

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have performed VATS lobectomy and segmentectomy for lung cancer since 1994 as experience with VATS improved, and experienced various postoperative complications. In this study, we analyzed the risk factors predisposing patients to develop postoperative respiratory complications in VATS lobectomy and segmentectomy, retrospectively.

Methods

Our indications for VATS for lung cancer were as follows: (1) more than 70 years old (elderly patients), (2) the presence of concomitant diseases, (3) predicted postoperative FEV1.0 (ppoFEV1.0) of 1,000 m*l* or less (poor pulmonary function). When at least one of the above criteria was applicable, the patient underwent VATS.

Operative technique for VATS lobectomy and segmentectomy was as follows: The patients were prepared, anesthetized using a double-lumen endotracheal tube, and positioned as for a standard posterolateral thoracotomy. A 5 - to 7-cm minithoracotomy incision was made along the 5th or 6th intercostal space around the posterior axillary line and two or three trocar ports were placed if a tumor was located in bilateral lower lobes. A minithoracotomy incision was made along the 4th or 5th intercostal space around the anterior axillary line and two or three trocar ports were placed if a tumor was located in bilateral upper lobes or right middle lobe. Mediastinal lymph node dissection was performed except in 14 patients in the early phase. Our operative technique was primarily endoscopic. The bronchi, pulmonary arteries, and pulmonary veins were staple transected in 97%, 27%, and 56% of lobectomies and bilobectomies procedures, respectively. Incomplete fissures were divided in 87% with stapling devices. On the other hand, partial resection of the lobe was performed using three trocar ports.

The postoperative pulmonary functions were predicted according to a simplified system, which we developed using the plain chest roentgenograms of patients with primary lung cancer. The ppoFEV1.0, and ppo%FEV1.0 is $(42-R)/(42-T) \times$ preoperative FEV1.0 and %FEV1.0, respectively, where R is the number of subsegments scheduled for lung resection and T is the number of tumor-related subsegments. T is determined as follows: a) if a tumor is located in the periphery of the lung, the T factor is equal to 1 in the case of a tumor 3 cm or less in its largest dimension and equal to 2 in the case of a tumor more than 3 cm in its largest dimension; and b) if a tumor obstructs large airways, the T factor is equal to the number of subsegments involved in atelectasis or obstructive pneumonia[4].

Seventy-five patients underwent VATS for lung cancer at the Department of Surgery II of Nippon Medical School from November 1994 to December 2000. The VATS patients comprised 56 men and 19 women. Fifty-seven patients (76%) were elderly. Sixty-five patients (87%) underwent lobectomy, eight (11%) underwent segmentectomy, and two (3%) underwent bilobectomies. Twenty-eight patients (37%) had stage IA disease, 21 (28%) had stage IB disease, three (4%) had stage IIA disease, four (5%) had IIB disease, five (7%) had stage IIIA disease, and 14 (19%) had not lymph node dissection performed. Forty-three patients (57%) had adenocarcinoma, 28 (37%) had squamous cell carcinoma, and four (5%) had other types. Thirty-five patients had hypertension, 32 had pulmonary disease, 25 had cardiovascular disease, 15 had a history of carcinoma of other organs, 10 had diabetes, 11 had cerebrovascular disease, eight had renal dysfunction, and five had liver dysfunction. Of the 32 patients with pulmonary disease, 13 (41%) had old pulmonary tuberculosis, nine had (28%) pulmonary emphysema, five (16%) had pulmonary fibrosis, two (6%) had obstructive pneumonia, two (6%) had bronchial asthma, and one (3%) had adhesive pleurisy. Of the 25 patients with cardiovascular diseases, 10 (40%) had ischemic disease, nine (36%) had atrial fibrillation, three (125) had valvular disease, two (8%) had aortic dissection, and one (4%) had postoperative VSD.

The lung cancers of all the patients were staged pathologically according to the staging system of UICC[5].

The PRCs in this study were defined as those complications that occurred during the hospitalization period following surgery[6], and included pneumonia, adult respiratory distress syndrome (ARDS), respiratory failure necessitating mechanical

ventilation for more than 48 hours, bronchopleural fistula (BPF), atelectasis, and prolonged air leakage of more than seven days from the chest drain.

Operative mortality was defined as death occurring during the hospitalization period following surgery[6].

Univariate and multivariate analyses to determine independent risk factors predisposing 75 VATS patients to PRCs were performed using sex, age, smoking history, duration of surgery, amount of blood loss, number of concomitant diseases, ppoVC, ppo% VC, ppoFEV1.0, ppo%FEV1.0, ppo%FEV of 55% or less and/or ppoFEV1.0 of 1,000 m*l* or less, pathological stage, histological type, and operative procedures. Statistical analysis was performed using the StatView 5.0J software package (SAS Institute, Cary, NC, USA) and the SPSS 10.0 software package (SPSS, Chicago, IL, USA). A univariate analysis between the groups was performed by means of Mann-Whitney U-test or the chi-square test. A multivariate logistic regression test was performed using the "logistic regression" procedure of the SPSS, choosing the forward-stepping selection method with maximum-likelihood estimates and default criteria. The receiver operator characteristic curve was used to optimize sensitivity and specificity and to pursue cutoff points when using duration of surgery and ppoFEV to predict the development of PRCs. A p value of less than 0.05 was considered statistically significant.

Results

Of 76 cases scheduled for VATS, only one case (1.3%) converted to open thoracotomy because of severe pleural adhesions and was excluded from this study. Of 13 patients (17.3%) with PRCs, seven had prolonged air leakage, two had ARDS, one had respiratory failure, one had pneumonia, one had atelectasis, and one had pulmonary infarction. Fourteen patients (18.7%) had supraventricular arrhythmia.

The operative mortality rate was 4% (three patients). An 83-year-old man with cerebral infarction who underwent right lower lobectomy died of pneumonia on the thirteenth postoperative day. A 76-year-old man who underwent segmentectomy of right segment 6 developed severe prolonged air leakage and left spontaneous pneumothorax and died of ARDS on the fifth postoperative day. A 78-year-old woman with polycythemia vera who underwent left lower lobectomy died of pulmonary infarction on the second operative day. No patients died of cardiovascular complications.

Univariate analysis of the development of PRCs revealed that the significant risk factors were age, ppo%VC, ppo%FEV, ppoFEV, poor pulmonary function, and duration of surgery (**Table 1**). Multivariate logistic regression test in regard to the development of PRCs revealed that duration of surgery was the most significant risk factor (odds ratio, 1.013; 95% confidence intervals, 1.003～1.024; p = 0.012).

On the basis of the receiver operator characteristic analysis, duration of surgery more than 297 min had a sensitivity of 70% and a specificity of 66% for the development of PRCs (**Fig. 1**).

Discussion

VATS has been reported to lessen damage to the chest wall[7,8] and reduce pain[9,10] and loss of pulmonary function[11]. Therefore, VATS has been recommended in elderly patients, patients with concomitant disease, or patients with poor pulmonary function[7,12,13]. Our multivariate analysis to analyze the development of PRCs in VATS for lung cancer revealed the most significant risk factor to be duration of surgery.

The duration of surgery in our cases was long in comparison with that in other facilities[8,10,12]. Our operative technique was primarily endoscopic. VATS lobectomy was accomplished even in cases with old pulmonary tuberculosis, pulmonary emphysema, pulmonary fibrosis, or incomplete fissures. Of the 32 patients with concomitant pulmonary diseases, 41% had old pulmonary tuberculosis, 28% had pulmonary emphysema, and 16% had pulmonary fibrosis. It has been reported that the incidence of pulmonary tuberculosis in Japan is higher than that in Western countries, and tuberculosis is becoming rapidly a disease of the elderly in Japan. It took time to have good views, expose the pulmonary vessels, and repair lung destruction due to manipulation in these cases. However, the ratio of conversion from VATS

Table 1 Characteristics of patients with and without PRCs following VATS lobectomy and segmentectomy

	Without PRCs	With PRCs	P value
Number of Patients	62	13	
Sex Male	44	12	
Female	18	1	0.1077
Age	72 (69 ～ 76)	78 (74 ～ 80)	0.0072
Smoking[a] (Cigarettes/day x yrs)	785 (0 ～ 1,170)	1,000 (325 ～ 1,750)	0.1836
Duration of surgery	275 (238 ～ 312)	325 (273 ～ 510)	0.0090
Amount of blood loss	240 (87 ～ 407)	380 (135 ～ 582)	0.1954
Number of concomitant diseases	1 (1 ～ 2)	2 (2 ～ 3)	0.0627
PpoVC (L)[a]	2.19 (1.83 ～ 2.62)	2.07 (1.87 ～ 2.21)	0.1702
Ppo%VC (%)[a]	77 (68 ～ 87)	71 (59 ～ 74)	0.0089
PpoFEV1.0 (L)[a]	1.5 (1.2 ～ 1.7)	1.2 (0.8 ～ 1.6)	0.0152
Ppo%FEV1.0 (%)[a]	79 (66.9 ～ 92.6)	66 (44.4 ～ 84.5)	0.0492
Ppo%FEV of 55% or less and/or ppoFEV1.0 of 1,000 m*l* or less	8	5	0.0269
Pathological Stage			
Ⅰ	41	7	
Ⅱ	7	0	
Ⅲ	4	2	
unknown	10	4	0.2586
Histological Type			
Squamous cell carcinoma	22	6	
Adenocarcinoma	36	7	
Large cell carcinoma	3	0	
Others	1	0	0.7531
Procedures			
Segmentectomy	6	2	
Lobectomy	54	11	
Bilobectomy	2	0	0.6855

VATS = video-assisted thoracic surgery, [a]Data are expressed as median (25^{th} and 75^{th} percentiles), ppo = predicted postoperative, VC = vital capacity, FEV1.0 = forced expiratory volume in one second, * shows statistically significant.

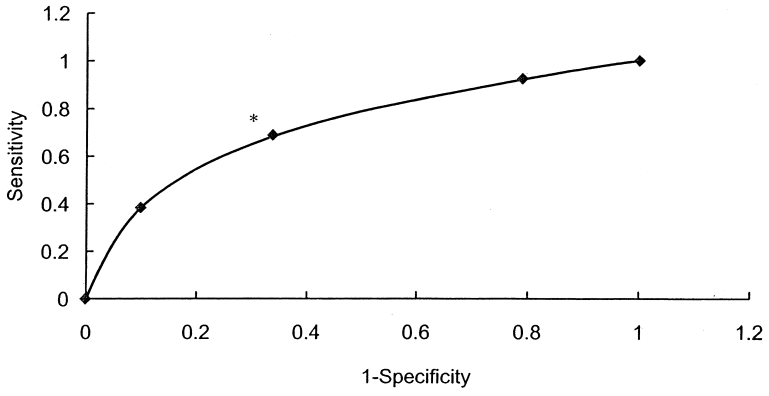

Fig. 1 Receiver-operator characteristic curve showing sensitivity and 1-specificity of duration of surgery for predicting the development of PRCs.

to conventional thoracotomy in our cases was 1.3%, which was low in comparison with the rates of 9.1～25% in other facilities[8,10,13－16], except at one facility which had no converted case[12]. Our study showed that a surgery duration of more than 297 min in VATS lobectomy for lung cancer developed PRCs significantly. There were thirty-six causes in thirty-four cases (10; intrapleural adhesion, 8; incomplete fissure, 7; calcified lymph nodes, 3; inexperience, 2; rethoracotomy, 2; lymph node dissection, 2; intraoperative diagnosis, and 2; others) of surgery lasting 300 min. This might be due to the side effect of anesthesia, blood loss, damage to the chest wall and lung by complex manipulation, and the effect of hypercapnia and hypoxia due to one-lung ventilation as previously reported in standard thoracotomy[17]. But recently, it has been reported that VATS lobectomy and anterior limited thoracotomy for lobectomy in lung cancer result in similar impairments of pulmonary function, respiratory muscle strength and walking capacity[18]. Therefore, if the duration of surgery is more than five hours for any reason, conversion to limited thoracotomy or muscle-sparing methods is recommended.

In conclusion, the duration of surgery should be less than five hours so as not to lose the advantages of VATS lobectomy. Therefore, if the duration of surgery would be more than five hours for any reason, conversion to limited thoracotomy or muscle-sparing methods is recommended.

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