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Postoperative Recurrences of Pneumothorax in Video-assisted Thoracoscopic Surgery for Primary Spontaneous Pneumothorax in Young Patients

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Abstract

Purpose: The postoperative recurrence rate of pneumothorax tends to be higher with thoracoscopic bullectomy than with conventional plication of bullae by axillary thoracotomy or posterolateral thoracotomy. We analyzed the risk factors for postoperative recurrence of pneumothorax in young patients treated with thoracoscopic bullectomy alone for primary spontaneous pneumothorax.

Methods: Univariate and multivariate analyses were performed of a consecutive series of 53 patients (62 sides) who underwent video-assisted thoracoscopic bullectomy from March 1994 through March 2004.

Results: Pneumothorax recurred after 10 operations (16.1%). Eighty percent of postoperative pneumothorax recurrences developed within 5 months after surgery. Univariate analysis of postoperative pneumothorax recurrences revealed significant risk factors to be the early period of video-assisted thoracoscopic surgery (VATS) experience for primary spontaneous pneumothorax and a low number of pack-years ($p<0.05$ and $p<0.05$, respectively). Multivariate logistic regression test revealed that the early period of VATS experience was the single significant risk factor (odds ratio, 0.275; 95% confidence interval, 0.095–0.797; p value, 0.0174). Seventy percent of postoperative pneumothorax recurrences probably developed because of overlooked bullae and incomplete resection of bullae in the early period of VATS experience. Close observation of the pleural cavity to find bullae and bullectomy with a sufficient margin of normal pleurae and pulmonary parenchyma prevented postoperative pneumothorax recurrences significantly in the middle and recent periods.

Conclusion: Close observation of the pleural cavity to find bullae and bullectomy with a sufficient margin of normal pleurae and pulmonary parenchyma are important measures for preventing postoperative recurrence of pneumothorax.

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Key words: spontaneous pneumothorax, video-assisted thoracoscopic surgery, postoperative pneumothorax recurrence

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Introduction

Video-assisted thoracoscopic surgery (VATS) has been performed most frequently for the treatment of spontaneous pneumothorax in the field of thoracic surgery. VATS is beneficial for reducing pain[1,2], scarring[1], and the duration of hospitalization[1–6], but the postoperative recurrence rate of pneumothorax tends to be higher with thoracoscopic bullectomy alone than with conventional plication of bullae by means of axillary thoracotomy[3–9] or posterolateral thoracotomy[2]. In this study, we reviewed our experience with a series of 53 consecutive young patients treated with thoracoscopic bullectomy alone for primary spontaneous pneumothorax to analyze risk factors for postoperative recurrence of pneumothorax.

Materials and Methods

Seventy-three patients (61 male and 12 female) underwent 83 VATS procedures for spontaneous pneumothorax at the Department of Surgery, Nippon Medical School Musashi Kosugi Hospital from March 1994 through March 2004. Excluded from the present series were 12 patients with apical partial pleurectomy, gauze abrasion of the pleurae, chemical pleurodesis, or staple line coverage with absorbable mesh, 6 patients with secondary spontaneous pneumothorax, and 2 patients older than 40 years with primary spontaneous pneumothorax. Therefore, 53 patients (62 sides) underwent thoracoscopic bullectomy alone. These 53 patients were followed up for a median time of 64 months (range, 25–144). Bilateral thoracoscopic operations were performed concurrently for 5 male patients and at different times for 4 patients (3 male and 1 female). The median age of patients with primary spontaneous pneumothorax was 24 years (range, 15–39 years). Twenty-four operations were performed for ipsilateral pneumothorax at the second episode. Thirty-eight operations were performed at the first episode of pneumothorax (16 for air-leakage persisting for more than 5 days; 10 for concurrent bilateral pneumothorax; 6 for identifiable bullae on chest X-ray films; 4 for metachronous contralateral pneumothorax; and 2 for massive air leakage).

Operative procedures for VATS were as follows: The patients were prepared, received anesthesia with a double-lumen endotracheal tube, and positioned as for a standard posterolateral thoracotomy. First, 1 trocar port was placed along the 5th intercostal space near the midaxillary line. Then, a second trocar port was placed along the 3rd or 4th intercostal space near the anterior axillary line. Finally, a third trocar port was placed along the 5th or 6th intercostal space near the posterior axillary line. All patients underwent thoracoscopic bullectomy with stapling devices (Endopath Endocutter ETS-Flex 45, Ethicon, Cincinnati, OH, USA; ENDO GIA Universal, U.S. Surgical Corp., Norwalk, CT, USA).

The resected specimens were fixed with 20% formalin solution and embedded in paraffin. Deparaffinized sections were stained with hematoxylin-eosin (HE) and elastica-Masson trichrome. So-called emphysematous bullae consisted of blebs and bullae. A bleb is defined as a collection of air between the layers of the visceral pleura, and a bulla is defined as an emphysematous space[10].

Postoperative pneumothorax recurrence was not considered to include air leakage around the staple line or air inflow into the pleural space at the removal of chest tube.

To investigate changes in the postoperative pneumothorax recurrence rate, the early, middle, and recent periods of a surgeon's experience with VATS bullectomy for treating primary spontaneous pneumothorax were defined as the first 21 cases, the next 21 cases, and the last 20 cases, respectively.

Univariate and multivariate analyses to determine independent risk factors for postoperative pneumothorax recurrences were performed using sex, age, smoking status, pack-years, side of the thorax, number of emphysematous bullae, pathological findings (bulla, bleb, or scar), number of stapling devices, first or second episode, and surgeon's VATS experience. Statistical analysis was

Table 1 Data of patients with and without postoperative pneumothorax recurrence

Parameter	Recurrence	No recurrence	P value
Number of operations	10	52	
Sex Male	9 (90)	45 (87)	
Female	1 (10)	7 (13)	0.7649
[a]Age	21.6 ± 5.4	24.0 ± 7.0	0.3153
Right side	4 (40)	27 (52)	
Left side	6 (60)	25 (48)	0.4898
Smoker or ex-smoker	2 (20)	22 (42)	
Non-smoker	8 (80)	30 (58)	0.1847
[a]Pack-years	1.1 ± 2.3	3.8 ± 6.1	0.0216*
First episode	7 (70)	27 (52)	
Second episode	3 (30)	25 (48)	0.2928
Bilateral	3 (30)	15 (29)	
Unilateral	7 (70)	37 (71)	0.9413
[a]Number of bullae	2.6 ± 1.6	2.5 ± 2.4	0.9002
[a]Number of stapling devices	3.8 ± 1.1	3.7 ± 2.1	0.787
VATS experience			
Early period	7 (70)	14 (26)	
Middle period	2 (20)	19 (37)	
Recent period	1 (10)	19 (37)	0.0287*
Pathological findings			
Bullae	7 (70)	29 (56)	
Blebs	1 (10)	11 (21)	
Bullae and blebs	1 (10)	4 (7)	
Scar	0 (0)	1 (2)	
Normal	0 (0)	1 (2)	
Specimen not available	1 (10)	6 (12)	0.9360

[a]Data are shown as mean ± standard deviation; ( )=percent, *indicates statistical significance.
VATS=video-assisted thoracoscopic surgery

performed with the StatView 5.0J software package (SAS Institute, Cary, NC, USA). Univariate analysis between groups was performed with the unpaired two-tailed *t*-test, Welch's test, or the chi-square test. Multivariate analysis was performed with a multivariate logistic regression test. A p value of less than 0.05 was considered to indicate statistical significance.

Results

The mean operation time was 70 ± 32 minutes (range, 23–150 minutes). The mean duration of drainage was 2.0 ± 1.8 days (range, 1–11 days). The mean postoperative hospital stay was 7.5 ± 6.7 days (range, 3–52 days). There was no operative mortality, but there were two operative morbidities. One patient had atelectasis, which improved spontaneously on the first postoperative day, and 1 patient had pyothorax and sepsis, which resolved with antibiotic therapy. Patient data are listed in **Table 1**. Pathological examinations of resected emphysematous bullae showed that 36 patients had bullae, 12 had blebs, 5 had bullae and blebs, 1 had scar, and 1 had an almost normal lung. Specimens were not available for 7 patients. Some bullae and blebs had extensively degraded elastic fibers in circumference where the surface of the lung looked almost normal. Pneumothorax recurred after 10 of 62 operations (16.1%). The recurrence rates were 33%, 9.5%, and 5% in the early period, the middle period, and the recent period, respectively. Of these 10 patients with recurrence, 7 had bullae, 1 had bullae and blebs, 1 had bleb, and 1 had no available specimen. Eighty percent of postoperative pneumothorax recurrences developed within 5

months after surgery: in 2 patients at 1 month, in 4 patients at 2 months, and in 1 patient each at 3, 5, 23, and 34 months. Seventy percent of postoperative pneumothorax recurrences developed in the early period of VATS experience. Of 7 patients, 3 first underwent VATS, but no bulla was identified at re-operation. These procedures were then converted to axillary thoracotomy through which plication of 1 overlooked bullae and a scar and apical parietal pleurectomy were performed. Two bullae were less than 5 mm in diameter. One bulla and a scar were present in the caudal and mediastinal sides, and one bulla was present in segment 8. The other 4 patients had bullae located around the old staple lines and underwent bullectomy. Additional parietal pleurectomy or pleural abrasion was performed in 3 or 1 patient, respectively, in the apical portions of the lung. Twenty percent of postoperative pneumothorax recurrences developed in the middle period. One patient refused re-operation and underwent tube thoracostomy and chemical pleurodesis. One patient had bullae around the old staples lines and underwent bullectomy and pleural abrasion. Ten percent of postoperative pneumothorax recurrences developed in the recent period. The patient refused re-operation and underwent tube thoracostomy and chemical pleurodesis.

Univariate analysis of postoperative pneumothorax recurrences showed that the early period of VATS experience for treating primary spontaneous pneumothorax and a low number of pack years were significant risk factors (**Table 1**). A multivariate logistic regression test using VATS experience for primary spontaneous pneumothorax and pack-years to analyze the postoperative pneumothorax recurrences also showed that the early period of VATS experience was the single significant risk factor (odds ratio, 0.275; 95% confidence interval, 0.095–0.797; and p value, 0.0174).

Discussion

VATS has become a standard procedure in Japan for the tratment of primary and secondary spontaneous pneumothorax and is performed in 90% and 70% of the cases respectively[11]. However, a high postoperative pneumothorax recurrence rate decreases the benefits of VATS. The postoperative pneumothorax recurrence rate previously reported for thoracoscopic bullectomy alone[3,5,12] was 4.1% to 16%, and that in the present series was 16.1%.

The present study showed that postoperative pneumothorax recurrences occurred significantly in the early period of VATS experience. Overlooking emphysematous bullae in the early period lead to postoperative pneumothorax recurrences in 3 of our cases and has been reported at other institutions[7,13]. Likely reasons emphysematous bullae and a scar were overlooked were collapsed emphysematous bullae during unilateral ventilation and inappropriate visualization of the diseased areas in the mediastinal side in 2 cases and insufficient observation of rarely diseased areas in 1 case. Another 4 patients in the early period had emphysematous bullae located around the old staple lines.

We have previously reported that blebs and bullae have abnormal elastic fibers, probably degraded due to an imbalance between elastase and alpha1-antitrypsin[9,14,15], and that the degraded elastic fibers in the walls of blebs and bullae are responsible for their protrusion and rupture into pleural cavities[14]. In addition, some blebs and bullae have extensively degraded elastic fibers in circumference, and incomplete resection of the degraded elastic fibers may lead to the formation of new blebs and bullae. Intraoperative and pathological findings cannot differentiate the regrowth of residual emphysematous bullae due to incomplete resection from the formation of new emphysematous bullae. However, postoperative pneumothorax recurrences in the early postoperative period seem to support overlooking emphysematous bullae and incomplete resection of emphysematous bullae as causes. Therefore, we have tried to perform bullectomy with a sufficient margin of normal pleurae and pulmonary parenchyma in the middle and recent periods and have significantly reduced the postoperative recurrence rate of pneumothorax. However, extensive pulmonary resection is limited by stapling devices. Therefore, additional apical pleurectomy, pleural abrasion, or staple line

coverage with absorbable mesh to reinforce the visceral pleura[16] should be performed to compensate up for weaknesses of thoracoscopic bullectomy alone, even if the circumferential lung tissues appear normal.

Univariate analyses in the present study showed that a low number of pack-years was a significant risk factor for postoperative pneumothorax recurrence. Lippert and others[17] have also reported that the patients who have never smoked have the highest recurrence rate after pleural tubulation performed at the first episode of primary spontaneous pneumothorax. These findings seem to be inconsistent with the fact that tobacco smoking increases the risk of spontaneous pneumothorax[17]. However, we have reported that abnormal degraded elastic fibers of blebs and bullae reacted with antibodies against alpha1-antitrypsin even in nonsmokers[14]. Therefore, additional studies are needed to clarify whether postoperative pneumothorax recurrence is related to factors other than smoking.

In conclusion, close observation of the pleural cavity to find emphysematous bullae and bullectomy with a sufficient margin of normal pleurae and pulmonary parenchyma are important measures for preventing pneumothorax recurrence after VATS for primary spontaneous pneumothorax in young patients.

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