Original Article

Risk factors for recurrence of primary spontaneous pneumothorax after thoracoscopic surgery

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Background: Recurrence of pneumothorax after thoracoscopic surgery is a concerning issue for thoracic surgeons. In this study, we aimed to determine the risk factors for recurrence of spontaneous pneumothorax after thoracoscopic surgery.

Methods: A total of 192 patients with spontaneous pneumothorax aged <50 years who underwent thoracoscopic surgery from January 2010 to December 2016 were included in this study. Pre- and post-operative characteristics were obtained from medical records, and recurrent and non-recurrent cases were compared.

Results: Fourteen patients (7.3%) experienced pneumothorax recurrence. Pneumothorax recurrence was observed more frequently in patients aged <20 years (P=0.041) and those in whom bullae were not identified on preoperative computed tomography (CT) (P=0.049). The use of polyglycolic acid (PGA) sheets during surgery significantly decreased the recurrence rate (P=0.031). A history of ipsilateral pneumothorax before surgery was a significant risk factor for recurrence after thoracoscopic surgery (P=0.001). In the multivariate analysis, a history of ipsilateral pneumothorax and identification of bullae on CT were identified as significant risk factors for recurrence.

Conclusions: A history of ipsilateral pneumothorax, and inability to identify bullae on preoperative CT were risk factors for postoperative recurrence of pneumothorax.

Keywords: Spontaneous pneumothorax; thoracoscopic surgery; recurrence

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Introduction

Surgery represents the most effective treatment for preventing recurrence of spontaneous pneumothorax. Thoracoscopic surgery is widely performed for spontaneous pneumothorax. However, the recurrence rate of pneumothorax after thoracoscopic surgery is higher than that for open thoracotomy (1,2). The reasons underlying the high recurrence rate after thoracoscopic surgery are speculated to be the fewer adhesions observed after thoracoscopic surgery than after thoracotomy, and failure to identify bullae intraoperatively. However, the factors affecting the high recurrence rate after thoracoscopic surgery remain unclear. The aim of this study was to identify the risk factors for postoperative recurrence for primary spontaneous pneumothorax after thoracoscopic surgery.

Methods

This study was approved by the institutional review board, and the informed consent requirement was waived. A retrospective review was conducted on all consecutive

Table 1 Comparison of the characteristics of patients with or without recurrence of pneumothorax

Characteristic	Recurrence (n=14)	No recurrence (n=178)	P value
Sex			
Male	10	154	
Female	4	24	0.128
Age (years)			
<20	5	24	
≥20	9	154	0.041
Smoking history			
Yes	4	79	
No	10	99	0.399
Body mass index			
>19	10	84	
≤19	4	94	0.243
Serum albumin			
>3.5	0	4	
≤3.5	14	174	1
Complete collapse of the lung			
No	11	127	
Yes	3	51	0.761
Identification of bullae on CT			
Yes	9	149	
No	5	29	0.049
Buttressing of staple line with PGA sheet			
Yes	9	156	
No	5	22	0.031
History of ipsilateral pneumothorax			
Yes	12	70	
No	2	108	0.001

CT, computed tomography; PGA, polyglycolic acid.

patients aged <50 years who underwent thoracoscopic surgery for primary spontaneous pneumothorax at Jikei University Hospital from January 2010 to December 2016. The age, sex, body mass index (BMI), smoking history, serum albumin level, degree of pneumothorax, history of ipsilateral pneumothorax, degree of emphysema, identification of bullae before surgery on computed tomography (CT), surgical procedure, and follow-up time were evaluated. All surgeries were performed by the same surgical team. Bullae or blebs were resected with a stapling device. In some patients, staple line coverage was performed with a polyglycolic acid (PGA) sheet with fibrin glue at the surgeon's discretion. A follow-up was conducted for all patients. All the statistical analyses were performed with EZR statistical software (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria) (3). Categorical variables were evaluated using the chi-square test and the *t*-test was utilized to analyze continuous variables between the two groups. In addition, follow-up analysis using time-to-event data was also performed, with the event rates estimated bay Kaplan-Meier methods and compared with log-rank test. Differences with P values of <0.05 were considered to be statistically significant.

Results

We identified 192 patients who underwent thoracoscopic surgery. Of these 192 patients, ipsilateral recurrence occurred in 14 (7.3%). The differences in sex, smoking history, BMI, and serum albumin level between the patients with and without recurrence were not significant (*Table 1*). The incidence of recurrence was higher in the patients aged <20 years than in the patients aged ≥20 years (P=0.041). Complete lung collapse on chest roentgenogram was not related to the postoperative recurrence of pneumothorax. Identification of bullae on preoperative CT was associated with a lower recurrence rate. The incidence of recurrence was higher in the patients who did not undergo intraoperative staple line reinforcement with PGA sheets (P=0.031), and in those with a history of ipsilateral pneumothorax (P=0.001). Kaplan-Meier curves for age, history of ipsilateral pneumothorax, the use of PGA sheet, and the identification of bullae on CT are shown in *Figure 1*. Patients aged <20 years, the history of ipsilateral pneumothorax, the use of PGA sheet were related to recurrence of pneumothorax (P<0.05). Identification of bullae on CT was marginally related to recurrence (P=0.078). Multivariate analysis revealed that history of ipsilateral pneumothorax, and negative preoperative identification of bullae on CT were related to recurrence of pneumothorax (*Table 2*).

The clinical details of the 14 patients who experienced postoperative recurrence are provided in *Table 3*. There

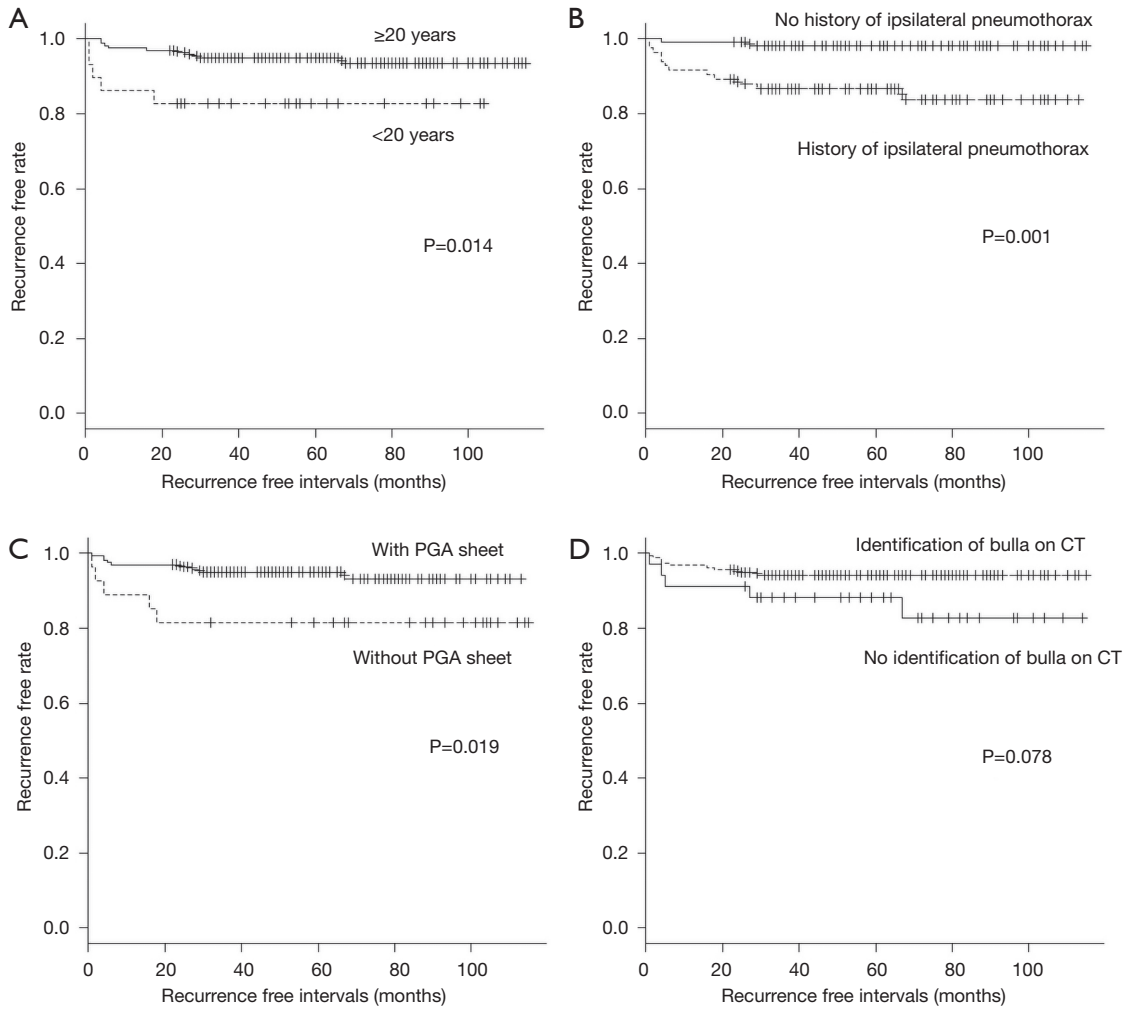

Figure 1 Kaplan-Meier curves for each group showing recurrence free rate after thoracoscopic surgery for pneumothorax. (A) Aged <20 years or aged ≥20 years; (B) history of ipsilateral pneumothorax; (C) use of PGA; (D) identification of bullae preoperatively by CT. PGA, polyglycolic acid; CT, computed tomography.

Table 2 Multivariate analysis of the factors related to recurrence

Variables	Hazard ratio	P value
Age (<20 *vs.* ≥20 years)	3.76	0.073
History of ipsilateral pneumothorax (yes *vs.* no)	8.34	0.001
Use of PGA sheet (no *vs.* yes)	3.33	0.095
Identification of bullae on CT (no *vs.* yes)	4.78	0.031

PGA, polyglycolic acid; CT, computed tomography.

were eight patients in which pneumothorax recurred within 1 year of surgery. The median time from surgery to recurrence was 5.5 months.

Discussion

Thoracoscopic surgery for spontaneous pneumothorax is currently established as a standard surgical procedure. However, recurrence of pneumothorax after thoracoscopic

Table 3 Details of patients who had ipsilateral recurrence of pneumothorax after surgery

Case	Age (years)	Sex	Time to recurrence (months)	Covering material	History of ipsilateral pneumothorax	Identification of bullae on CT
1	16	F	4	No	No	Yes
2	16	M	18	No	Yes	Yes
3	17	M	2	No	Yes	Yes
4	18	M	1	PGA	Yes	Yes
5	19	M	1	No	Yes	No
6	20	F	16	No	Yes	Yes
7	22	M	67	PGA	Yes	No
8	23	M	5	PGA	Yes	No
9	25	F	4	PGA	Yes	Yes
10	25	F	6	PGA	Yes	Yes
11	26	M	4	PGA	Yes	No
12	26	M	24	PGA	Yes	Yes
13	40	M	17	PGA	No	No
14	45	M	38	PGA	Yes	Yes

CT, computed tomography; F, female; M, male; PGA, polyglycolic acid.

surgery has been reported to occur in 5–19% of patients (4-6). Nonetheless, the specific reasons underlying pneumothorax recurrence after thoracoscopic surgery remain unclear, and prevention of recurrence remains a challenge for thoracic surgeons.

We evaluated the risk factors for postoperative recurrence of primary spontaneous pneumothorax in patients who underwent thoracoscopic surgery. We found that patients aged <20 years had a higher recurrence rate in the univariate analysis. Five of 29 patients aged <20 years experienced recurrence of pneumothorax, and four of these patients did not have reinforcement with PGA sheets. We believe that the low rate of PGA sheet use may have influenced the results. Another reason for the higher incidence of recurrence in the younger population is that the rapid development of the body in younger patients causes imbalance of the body and lungs, which leads to fragility of the visceral pleura (7). We also found that patients aged <20 years, the history of ipsilateral pneumothorax, the use of PGA sheet were related to recurrence of pneumothorax in the time dependent analysis.

Preoperative identification of bullae on CT was associated with a lower incidence of postoperative recurrence in the univariate and multivariate analyses. We identified bullae on preoperative CT in 158 of 192 patients (82.3%), which was a similar finding to that of a previous study (8). We speculate that the reason for the lower recurrence rate in the patients in whom bullae were identified on preoperative CT was that such identification leads to easier intraoperative detection of bullae, resulting in appropriate resection of the bullae and a consequent decrease the recurrence rate. We also found that the size of the pneumothorax was not related to postoperative recurrence, which was comparable with the findings of a previous study (9). Staple line coverage with PGA sheets resulted in a lower incidence of postoperative recurrence of pneumothorax as determined by the univariate analysis. Postoperative recurrence of pneumothorax is speculated to result from the formation of new blebs adjacent to the staple line, or incomplete resection of bullae at the time of surgery. Applying a PGA sheet to the resection margin causes inflammation of the pleura and accompanying infiltrations of eosinophils and macrophages (10), resulting in reinforcement of the pleura.

The multivariate analysis indicated that a preoperative history of ipsilateral pneumothorax was a significant risk factor for recurrence after surgery. This is the first report that a preoperative history of ipsilateral pneumothorax was related to the postoperative recurrence. We were unable

to determine the exact reason for this finding. However, a history of ipsilateral pneumothorax may be related to fragility of the visceral pleura, which might be a risk for postoperative recurrence. The median time from surgery to recurrence in this study was 5.5 months. We believe it is necessary to conduct careful observation for 1 year after surgery.

This study has several limitations, including the fact that this was a retrospective, single-center study. In addition, although the number of the patients included in this study was large, only 14 patients experienced recurrence. Furthermore, selection bias may have been present, which limits the power of the statistical analysis.

Conclusions

A history of ipsilateral pneumothorax, and negative preoperative identification of bullae on CT were risk factors for postoperative recurrence of pneumothorax.

Acknowledgments

None

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: Institutional review board (IRB) approval for this study was obtained from the Medical Research Ethics Committee of Jikei University (approval number 30-245). Informed consent was waived by the IRB because of the retrospective nature of this study.

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