



The clinical characteristics and surgical results of smoking-related young pneumothorax

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Abstract

Objective Primary spontaneous pneumothorax is a common disease that develops in relatively young healthy patients. Although smoking is generally believed to have a negative effect on the lungs, some authors reported that smokers with primary spontaneous pneumothorax had significantly lower postoperative recurrence rates than nonsmokers. This unexpected result suggests that primary spontaneous pneumothorax is classified into two categories: smoking-related young pneumothorax and residual primary spontaneous pneumothorax. We compared these two categories to determine their characteristics and corresponding surgical results.

Methods Between January 2009 and December 2018, we enrolled 267 consecutive cases that underwent first surgery for primary spontaneous pneumothorax in our hospital. A total of 252 eligible cases (211 residual primary spontaneous pneumothorax and 41 smoking-related young pneumothorax) underwent evaluation. Smoking-related young pneumothorax cases were defined as cases with characteristic HRCT findings and smoking habit.

Results The mean ages for the residual primary spontaneous pneumothorax and smoking-related young pneumothorax groups were 25.9 ± 13.1 and 30.5 ± 6.9 years, respectively. The groups included 186 (88.2%) and 41 (100.0%) men, and the mean body mass indices were 19.1 ± 2.2 and 20.0 ± 1.9 , respectively. Fifty-nine (28.0%) and 41 (100.0%) subjects were smokers, and there were 43 (20.4%) and 1 (2.4%) cases of postoperative recurrence, respectively. These results were significantly different between the two groups.

Conclusions Individuals with smoking-related young pneumothorax were older, predominantly men, and had higher body mass index and significantly lower postoperative recurrence rates than those with residual primary spontaneous pneumothorax.

Keywords Primary spontaneous pneumothorax · New classification · Smoking-related young pneumothorax

Introduction

Primary spontaneous pneumothorax (PSP) is a common disease that develops in relatively young healthy patients with no underlying lung disease [1–3]. The diagnosis is obtained by excluding secondary spontaneous

pneumothorax, which is related to chronic obstructive pulmonary disease (COPD), interstitial pneumonia, thoracic endometriosis, and so on. Therefore, if new disease concepts are advocated, some cases included in PSP at present might be classified into the new categories. Although smoking habit is generally thought to have a negative effect on lungs [4, 5], some authors [6–8] reported that smokers with spontaneous pneumothorax had significantly lower postoperative recurrence rate than nonsmokers. This unexpected result suggests that a part of PSP should be classified into a separate category. Focusing on the effect of smoking history since early adolescence, Moriyama et al. [9] described the relationship between smoking habit and young patients aged < 50 years with pneumothorax. Although they described the characteristic findings on high-resolution computed tomography (HRCT) attributed

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to a smoking habit, the clinical characteristics remained unclear. In this study, we defined all preoperative smoking cases with these characteristic findings on HRCT as smoking-related young pneumothorax (SRYP) and classified PSP into SRYP and residual PSP (rPSP). We compared rPSP and SRYP cases to determine their clinical characteristics and associated surgical results.

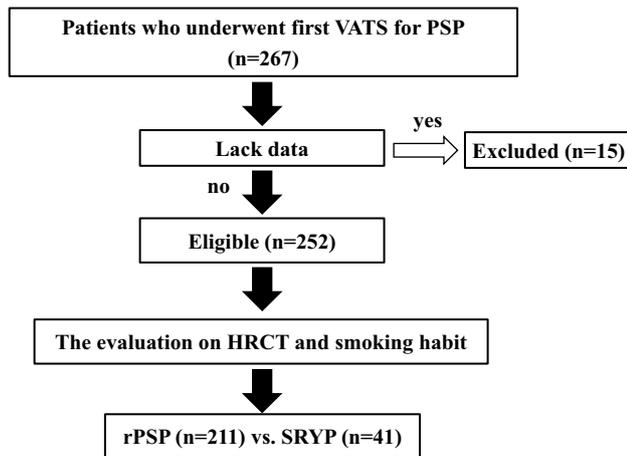


Fig. 1 Details of the study enrollment by new classification. *HRCT* high-resolution computed tomography, *PSP* primary spontaneous pneumothorax, *rPSP* residual primary spontaneous pneumothorax, *SRYP* smoking-related young pneumothorax, *VATS* video-assisted thoracoscopic surgery

Methods

This study was approved by the Institutional Review Board of Takasago Municipal Hospital (No. 2018-2). Between January 2009 and December 2018, we enrolled 267 consecutive PSP that underwent first video-assisted thoracoscopic surgery (VATS) in our hospital. Cases that lacked clinical data were excluded from our study. In total, 252 eligible cases (211 rPSP and 41 SRYP cases) were evaluated (Fig. 1).

Patients underwent VATS according to the following indications: ipsilateral PSP recurrence without surgery, persistent air leaks after chest tube drainage, hemothorax, tension pneumothorax, and patient's request. All procedures were performed by a single surgical team. The patient was placed in a lateral position under general anesthesia with differential lung ventilation. According to the difficulty of the surgery, the choice of procedure (single-port or multiport VATS) was made as we previously described [10, 11]. The bullae were resected by autosutures with sufficient margin distance and reinforcement using an absorbable sheet and/or fibrin glue, which was decided by the surgeon. Since September 2015, pleural coating using 50% glucose was performed [8].

SRYP cases were defined as cases with HRCT findings such as bullae that had unclear margins between the pulmonary parenchyma and emphysematous changes with smoking habit according to Moriyama et al.'s description [9], as shown in Fig. 2. rPSP cases were defined as cases with HRCT findings such as bullae projecting beyond the pulmonary surface and showing clear margins between the

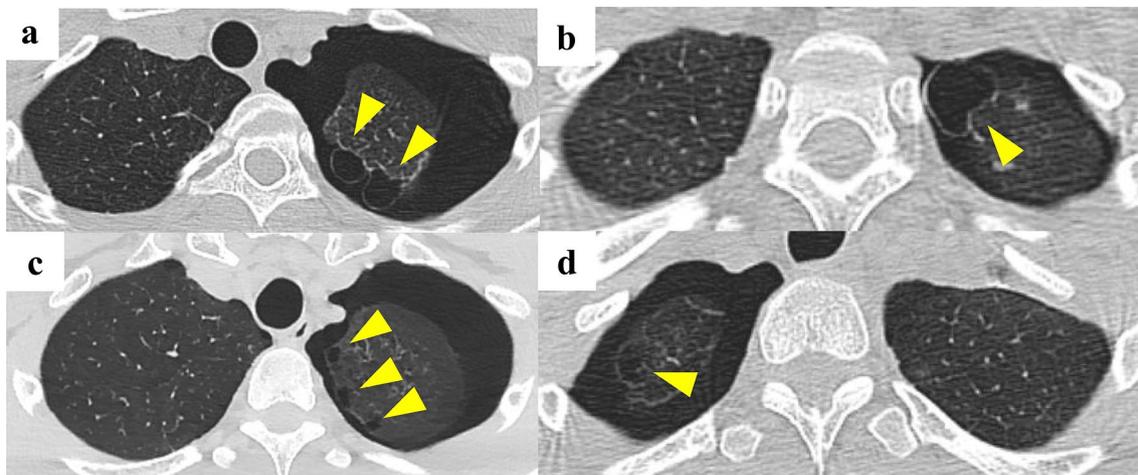


Fig. 2 HRCT findings. **a** A 17-year-old boy with left pneumothorax. Bullae projected beyond the pulmonary surface and showed clear margins between the pulmonary parenchyma for rPSP (arrows). **b** An 18-year-old woman with left pneumothorax. The characteristic findings for rPSP are indicated by arrows. **c** A 31-year-old man with left pneumothorax. Bullae show unclear margins between the pulmonary

parenchyma and emphysematous changes indicating SRYP (arrows). **d** A 23-year-old man with right pneumothorax. The characteristic findings for SRYP are indicated by arrows. *rPSP* residual primary spontaneous pneumothorax, *SRYP* smoking-related young pneumothorax

pulmonary parenchyma [9], as shown in Fig. 2. Patients with clear margins were classified as the distinct boundary group for imaging using HRCT. Other cases with characteristic findings for both SRYP and rPSP or no bullae on HRCT were classified as the indistinct group and included under rPSP. The follow-up period was defined as the time between the date of surgery and the last visit.

Patients underwent chest radiography every 3 months and HRCT 12 months after surgery even if they were basically asymptomatic. In case of any symptoms, patients visited our institution without reservation. Morbidity or mortality associated with our procedures was evaluated according to the Japan Clinical Oncology Group postoperative complication criteria based on the Clavien–Dindo classification [12]. According to the criteria, a grade of IIIB or higher is needed for invasive procedures under general anesthesia. Adverse events that corresponded to grade IIIb or higher were defined as severe morbidities.

Statistical analyses were performed using the Welch test and Fisher's exact test. Continuous variables are presented as mean \pm standard deviation. Univariate analysis of the postoperative recurrence rate between rPSP and SRYP was estimated based on the Kaplan–Meier method and compared by log-rank test. The hazard ratio and 95% confidence intervals (CIs) were calculated using Cox regression analysis for postoperative recurrence of SRYP. A *P* value < 0.05 indicated statistical significance. EZR software package (<https://www.jichi.ac.jp/saitama-sct/SaitamaHP.files/statmed.html>) was used for statistical analyses.

Results

The background characteristics for rPSP ($n = 211$) and SRYP ($n = 41$) patients who underwent first VATS are shown in Table 1. There were no significant differences in the operation side, pleural reinforcement, use of fibrin glue, and pleural coating by 50% glucose solution between the two groups. There were significant differences in the age, gender, BMI, smoking history, and HRCT findings between the groups. In the rPSP and SRYP groups, the mean patient ages were 25.9 ± 13.1 and 30.5 ± 6.9 years ($p = 0.0012$), and the groups included 186 (88.2%) and 41 (100.0%) men ($p = 0.019$), respectively. A history of smoking was noted in 59 (28.0%) and 41 (100.0%) cases ($p < 0.001$), respectively. The distinct boundary HRCT group comprised 147 (69.7%) and 41 (100.0%) cases ($p < 0.001$), respectively, and the surgical results are shown in Table 2. The mean operation times were 75.8 ± 24.4 and 86.3 ± 26.3 min ($p = 0.021$), respectively. There were 43 (20.4%) and 1 (2.4%) cases of postoperative recurrence ($p = 0.011$), respectively, as shown in Fig. 3. The hazard ratio was 0.12 [95% CI: 0.016–0.85] for postoperative recurrence of SRYP ($p = 0.034$). There were no significant

Table 1 Clinical characteristics of patients with rPSP and SRYP who underwent first VATS

Variables	rPSP ($n = 211$)	SRYP ($n = 41$)	<i>P</i> value
Age (years)	25.9 ± 13.1	30.5 ± 6.9	0.0012
Male	186 (88.2)	41 (100.0)	0.019
BMI	19.1 ± 2.2	20.0 ± 1.9	0.017
Smoking history			< 0.001
Absent	152 (72.0)	0 (0.0)	
Present	59 (28.0)	41 (100.0)	
Operation side			0.73
Right	94 (44.5)	20 (48.8)	
Left	117 (55.5)	21 (51.2)	
The findings on HRCT			< 0.001
Indistinct boundary group	64 (30.3)	0 (0.0)	
Distinct boundary group	147 (69.7)	41 (100.0)	
Pleural reinforcement	187 (88.6)	41 (100.0)	0.018
Fibrin glue	25 (11.8)	5 (12.2)	1.00
Pleural coating by 50% glucose solution	84 (39.8)	15 (36.6)	0.73

Values are presented as mean \pm standard deviation or n (%)

BMI body mass index, *rPSP* residual primary spontaneous pneumothorax, *SRYP* smoking-related young pneumothorax, *VATS* video-assisted thoracoscopic surgery

differences in other results such as those of postoperative drainage period and postoperative hospital stay. No cannabis abuse or severe morbidity was found in either group.

Discussion

PSP is a common disease that develops in relatively young healthy patients with no underlying lung disease [1–3]. The diagnosis is obtained by excluding secondary spontaneous pneumothorax, which is related to COPD, interstitial pneumonia, thoracic endometriosis, and so on. Therefore, if new disease concepts are advocated, some cases included in PSP at present might be classified into the new categories. Smoking habit is generally thought to have a negative effect on lungs in young adults [4, 5]. Marco et al. [4] reported that smoking prevention could reduce the incidence of COPD in the young population (20–44 years) by 29–39% for the population-attributable fraction. They described that the association between smoking and the incidence of COPD is more likely to reflect an early interaction of tobacco exposure with some genetic or immunologic host characteristics, rather than the effect of the cumulative exposure to cigarette smoke. According to Cheng et al. [5], smoking cases with PSP had higher rate of respiratory bronchiolitis on pathological examination than nonsmokers. Meanwhile, in Asia, a significant correlation between smoking habit and a low

Table 2 Surgical results of patients with rPSP and SRYP who underwent first VATS

Variables	rPSP (n=211)	SRYP (n=41)	P value
Operation time (min)	75.8 ± 24.4	86.3 ± 26.3	0.021
Drainage period (days)	1.7 ± 1.7	2.4 ± 2.4	0.12
Postoperative hospital stay (days)	3.7 ± 2.3	4.6 ± 3.2	0.11
Postoperative recurrence	43 (20.4)	1 (2.4)	0.011
Follow-up period (days)	509.9 ± 562.7	490.0 ± 566.6	0.84

Values are presented as mean ± standard deviation or n (%)

rPSP residual primary spontaneous pneumothorax, SRYP smoking-related young pneumothorax, VATS video-assisted thoracoscopic surgery

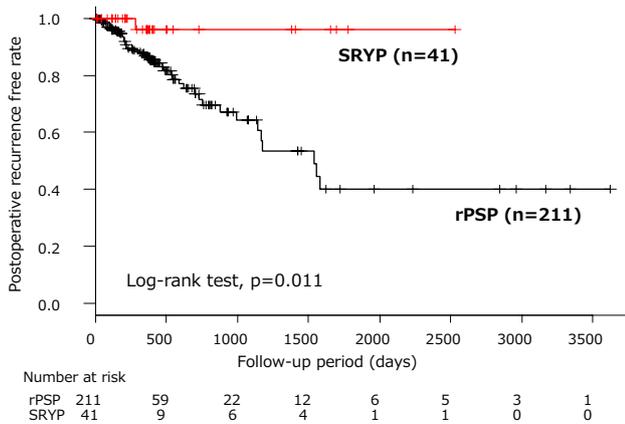


Fig. 3 Kaplan–Meier curve for rPSP and SRYP for postoperative recurrence. rPSP residual primary spontaneous pneumothorax, SRYP smoking-related young pneumothorax

postoperative recurrence rate for spontaneous pneumothorax was reported in some studies [6–8]. Hirai et al. [6] described that the freedom from postoperative recurrence rate for 279 cases with PSP was 95.1% and 88.5% on log-rank test in the smoker and nonsmoker groups, respectively, which differed significantly between the two groups. Uramoto et al. [7] reported that the postoperative recurrence rate of 214 cases with spontaneous pneumothorax was 9.3% and 20.1% in the smoker and nonsmoker groups, respectively. Multivariate analysis revealed that being a nonsmoker is a significant factor contributing to postoperative recurrence (odds ratio: 2.717, 95% confidence interval: 1.017–7.257, $p=0.046$) [7]. Our previous report showed that the postoperative recurrence rates during postoperative year 1 for 376 cases with spontaneous pneumothorax was 7.6% and 20.5% on the log-rank test in the smoker and nonsmoker groups, respectively, which differed significantly between the two groups [8]. Although smoking habit is generally believed to have a negative effect on the lungs, the above reports demonstrated the opposite results. The differences may be because smoking causes some patients to develop SRYP, but the impact of the condition is less severe than that of rPSP, which is associated with the patient’s constitution. We believe patients with

SRYP have little inherent risk of developing pneumothorax without smoking exposure. Therefore, we would like to emphasize that smoking exposure does not reduce the risk of postoperative recurrence. Rather, SRYP should be classified into a different category from PSP. Focusing on the effects of smoking history since early adolescence, Moriyama et al. [9] described the relationship between smoking habit and young patients aged < 50 years with pneumothorax. They thought the above group of patients with a smoking habit developed secondary pneumothorax and exhibited the characteristic findings on HRCT. Although the report is very interesting, the usefulness of this classification and the associated clinical characteristics remain unclear. In our study, we demonstrated significant differences in the characteristics such as age, gender, BMI, and smoking habit for rPSP and SRYP. The operation time for the SRYP group was also significantly longer than that for the rPSP group. This suggests that it takes more time to determine the resection line for the SRYP group using autosutures because the boundary between the bullae and pulmonary parenchyma is relatively unclear. In addition, the results of Kaplan–Meier and Cox regression analyses showed that the postoperative recurrence of SRYP was significantly lower than that of rPSP. Therefore, we believe SRYP should be established as a separate classification because rPSP and SRYP have different clinical characteristics and surgical results.

Our study had some limitations. First, the indistinct boundary group was included in rPSP cases. It was unclear why these patients had such HRCT findings. Occupational history, air pollution, and other factors may be related to the findings, but identifying the cause is currently difficult. Once the cause is determined, these cases may be separated into new categories in the future. Second, to the best of our knowledge, previous reports showed a relationship between smoking habit and low postoperative recurrence rate only in Asia, possibly owing to racial differences such as sensitivity to smoking. Third, information such as the Brinkman index and the age at which the patient first started smoking may be important. However, we could not investigate the smoking habit in detail because our study was performed retrospectively.

Conclusion

We demonstrated the importance of a new classification of SRYP for PSP. The clinical characteristics for SRYP are elderly age, male dominance, and higher BMI compared with rPSP. In addition, SRYP has a significantly lower post-operative recurrence rate than rPSP.

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Compliance with ethical standards

Conflict of interest KT, YM, TW, TU, and SM have no conflict of interest.

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