Brief Report

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Risk factors for recurrence of primary spontaneous pneumothorax after thoracoscopic surgery

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Summary **Primary spontaneous pneumothorax recurs at a certain rate after thoracoscopic surgery, and risk factors for that recurrence are in question. The medical records of 248 patients with primary spontaneous pneumothorax who were followed for more than 2 years after thoracoscopic surgery were reviewed and retrospectively analyzed. Univariate and multivariate binary logistic regression analysis were used to identify possible risk factors. Twelve patients experienced the recurrence of primary spontaneous pneumothorax. Patients who experienced the recurrence of primary spontaneous pneumothorax were younger than patients who experienced no recurrence. A larger proportion of the patients who experienced recurrence did not undergo pleurodesis. The variables age, height, weight, body mass index, duration of air leakage, and pleurodesis (performed or not) with a *p* value less than 0.2 in univariate analysis were entered in multivariate analysis. A younger age and not undergoing pleurodesis were associated with a higher risk of postoperative ipsilateral recurrence of primary spontaneous pneumothorax. Not undergoing pleurodesis and a younger age are possible risk factors for recurrence of primary spontaneous pneumothorax after thoracoscopic surgery. Thoracic surgeons should pay more attention to pleurodesis, especially in younger patients.**

Keywords: Primary spontaneous pneumothorax, thoracoscopy, recurrence, risk factor

1. Introduction

Primary spontaneous pneumothorax (PSP) is a common clinical problem occurring in previously healthy subjects, with a reported annual incidence of 7.4 to 18 per 100,000 population in males and an incidence of 1.2 to 6 per 100,000 population in females (*1,2*). PSP also remains a significant clinical problem because of its high rate of recurrence, which has been variously reported as being from 20-60% with conservative treatment (*3,4*).

Thoracoscopic surgery has been widely used to treat PSP with less pain, lower morbidity, and a shorter hospital stay than an open thoracotomy. However, several studies have reported that the rate of PSP recurrence after thoracoscopic surgery ranged from 5% to 10% (*5,6*), and this figure is thought to be higher than that after open thoracotomy.

Recurrent attacks require additional hospitalization and hospitalization costs. Moreover, postoperative recurrence is a very embarrassing and challenging event for the thoracic surgeon. Preventing recurrence is difficult because its pathogenesis and mechanisms are not well known. If risk factors contributing to postoperative recurrence of PSP can be identified and improved, then a lower rate of recurrence could be achieved. The aim of this study was to identify these risk factors.

2. Patients and Methods

After a consent waiver was obtained from the patient or a family member, medical records of 412 patients who experienced PSP after undergoing thoracoscopic surgery from January 2008 to December 2012 at Qilu Hospital at Shandong University were retrospectively reviewed with the approval of the Institutional Review Board of this hospital. Patient records were reviewed

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and sex, age, height, weight, body mass index (BMI), history of smoking, whether PSP occurred on the left or right side, the frequency of ipsilateral attacks, the frequency of contralateral attacks, the surgical procedure, operating time, the postoperative duration of chest tube drainage, the duration of postoperative hospitalization, postoperative duration of air leakage, and follow-up time were recorded. To avoid any bias in the rate of PSP recurrence as a result of too short a follow-up, this study only examined the records of 248 patients with complete follow-up data (outpatient follow-up or telephone follow-up) and a follow-up of more than 2 years.

All operations were performed by the same surgical team including 5 surgeons. All patients were placed in the lateral decubitus position and underwent surgery under general anaesthesia. All patients underwent single-lung ventilation with a double-lumen endotracheal tube. All patients underwent three-port thoracoscopic surgery. The lungs and thoracic cavity were carefully explored. If any bullae or blebs were found, they were resected with a stapling device. Two surgical stapling devices were used: the EndoGIA (Auto Suture Company, Norwalk, CT, USA) and ECHELON (Ethicon Endo-Surgery, Inc., Cincinnati, OH, USA). Two pleurodesis procedures were used in this study. Mechanical pleurodesis was performed by complete mechanical pleural abrasion with dry gauze. Chemical pleurodesis was performed by complete pleural abrasion with 10% povidone-iodine-soaked gauze, and 50 milliliters of 10% povidone-iodine (Aqueous Betadine 10%, Qilu Pharmaceutical Co., Ltd., Ji'nan, Shandong, China) was left in the thoracic cavity. After surgery, the chest tube was raised 30 centimeters higher than the drainage port for 24 h to avoid the outflow of povidone-iodine.

Recurrence was defined as a further pneumothorax, which was confirmed with a chest X-ray or computed tomography of the chest, occurring more than 30 days after discharge with full lung expansion.

Statistical analysis was performed using the Statistical Package for Social Sciences for Windows (v. 19.0; IBM SPSS Inc., Armonk, NY, USA). Univariate and multivariate binary logistic regression were used to determine risk factors. Variables with a p value less than 0.2 in univariate analysis were entered in multivariate analysis. Differences were considered to be statistically significant when $p < 0.05$.

3. Results and Discussion

3.1. *Univariate analysis of clinical demographic variables*

This study retrospectively reviewed the medical records of 248 patients (226 males and 22 females). Twelve patients experienced recurrence during follow-up, with a recurrence rate of 4.84%. Patients had a median age of 19 years (range, 14 to 38 years). The median age of patients who did not experience a recurrence of PSP was 19 years (range: 14 to 38 years), and the median age of those who did experience a recurrence of PSP was 17 years (range: 14 to 21 years). Twenty-nine patients had a history of smoking (1 patient with recurrence of PSP and 28 patients with no recurrence of PSP). PSP occurred on the left side in 115 patients and on the right side in 133 patients. Forty-five patients had contralateral PSP. The height and weight of each patient were measured on the day of admission and the patient's BMI was calculated. The mean frequency of attacks before surgery was 2.25 for patients with recurrence of PSP and 2.23 for patients with no recurrence of PSP.

The clinical demographics of patients with recurrence of PSP and patients with no recurrence of PSP are shown in Table 1. There were no statistically significant differences between the two groups in terms of sex, the side on which PSP occurred, height, weight, BMI, history of smoking, frequency of attacks, follow-up time, or contralateral PSP. However, patients with recurrence of PSP were younger than patients with no recurrence of PSP ($p = 0.007$).

3.2. *Univariate analysis of surgery-related variables*

All patients underwent thoracoscopic surgery. Of these, 29 (2 patients with recurrence of PSP and 27 patients with no recurrence of PSP) exhibited no bullae or blebs during the operation. Bulla or bleb resection was done with the EndoGIA stapling device in 111 patients and the ECHELON device in 108 patients. Twenty-seven patients (9 with recurrence of PSP and 18 with no recurrence of PSP) did not undergo pleurodesis because inflammation of the pleura was evident during surgery. Mechanical pleurodesis was performed in 112 patients and chemical pleurodesis was performed in 109 patients. The mean postoperative duration of chest tube drainage and air leakage was 1.67 days in the patients with recurrence of PSP and 0.85 days in the patients with no recurrence of PSP. The mean duration of chest tube drainage was 3.75 days for patients with recurrence of PSP and 3.61 days for patients with no recurrence of PSP. Surgery-related variables are shown in Table 2. There were no statistically significant differences between the groups in terms of operating time, duration of chest tube drainage, the stapling device used, and whether bullae or blebs were resected. The postoperative duration of air leakage for patients with recurrence of PSP was longer than that for patients with no recurrence of PSP ($p = 0.001$). A larger proportion of patients with recurrence of PSP did not undergo pleurodesis than did patients with no recurrence of PSP ($p = 0.001$).

3.3. *Multivariate analysis*

The variables age, height, weight, BMI, pleurodesis

(performed or not), and duration of air leakage with a *p* value less than 0.2 were included in multivariate logistic regression analysis (Table 3). Results indicated that a younger age and not undergoing pleurodesis were risk factors for postoperative ipsilateral recurrence of PSP ($p = 0.003$ and 0.001, respectively).

PSP is more common in young male patients with a low BMI (also referred to as an ectomorphic body type (*1*)), and this finding was corroborated by the current study. Several studies have found that a younger age, being male, and having a lower BMI are risk factors for recurrence after the first attack of PSP (*3,7*). However, whether these variables are risk factors for the postoperative recurrence of PSP is still unclear.

The current study found that a younger age was one risk factor for postoperative recurrence of PSP while sex, height, and BMI were not. Although the pathogenesis of PSP is still somewhat unclear, PSP tends to be a condition caused by the imbalanced development of the lungs and body (*8*). In younger

Table 1. Univariate analysis of clinical demographic variables (*n* = 248)

Characteristics	Recurrence of PSP	Non-recurrence of PSP	*p* value
Total	12	236	
Median age (years)	17	19	0.007
range	14-21	14-38	
Sex			0.33
Male	10	216	
Female	2	20	
Side			0.39
Left	7	108	
Right	5	128	
Height (meters)	1.71 ± 0.05	1.73 ± 0.05	0.14
Weight (kilograms)	52.46 ± 6.49	55.42 ± 7.19	0.16
Body Mass Index	17.67 ± 1.78	18.5 ± 1.82	0.12
History of smoking			0.71
Yes	1	28	
No	11	208	
History of contralateral PSP			0.89
Yes	2	43	
No	10	193	
Duration of hospitalization (days)	11.58 ± 8.04	8.62 ± 3.32	0.22
Frequency of attacks	2.25 ± 0.45	2.23 ± 0.55	0.92
Follow-up (months)	50.42 ± 13.10	50.14 ± 16.30	0.95

Table 2. Univariate analysis of surgery-related variables (*n* = 248)

Characteristics	Recurrence of PSP	Non-recurrence of PSP	*p* value
Bulla or bleb resection			0.58
Yes	10	209	
No	2	27	
Pleurodesis			
Pleurodesis not performed	9	18	0.001
Mechanical pleurodesis	2	110	0.58
Chemical pleurodesis	1	108	0.60
Stapling device			
None	2	27	0.69
ECHELON stapling device	6	102	0.44
EndoGIA stapling device	4	107	0.48
Duration of air leakage (days)	1.67 ± 0.65	0.85 ± 0.73	0.001
Duration of chest tube drainage (days)	3.75 ± 0.62	3.61 ± 0.76	0.54
Operating time (minutes)	58.33 ± 4.92	63.24 ± 18.62	0.36

Table 3. Multivariate analysis of variables with a p value less than 0.2 in univariate analysis

Characteristics	*p* value	Odds ratio	95% confidence interval
Pleurodesis not performed	0.001	100.26	16.04–626.60
Age	0.003	0.527	0.33–0.80
Height	0.23		
Weight	0.21		
Body Mass Index	0.16		
Duration of air leakage	0.12		

patients (and especially male adolescents), the body develops rapidly and a younger age also means the lungs and body will need a longer time to grow. Therefore, PSP is more common at a younger age. In younger patients, the imbalanced development of the lungs and body is not corrected by surgery, so postoperative recurrence of PSP is more common.

Smoking is thought to play an important role in the pathogenesis of PSP (*9*). However, whether smoking is a risk factor for the recurrence of PSP is controversial (*3,10,11*). In the current study, smoking was not a risk factor for postoperative recurrence of PSP. Few of the patients in this study had a history of smoking. This implies that smoking is not the main factor responsible for PSP in these patients. Thus, smoking is not related to the postoperative recurrence of PSP.

Resection of bullae and blebs is one of the main objectives of surgery for PSP according to the guidelines of the British Thoracic Society (BTS) (*12*). In the past, overlooking bullae or blebs and incomplete resection of these air-filled blisters with fibrous walls were thought to be the main reason for increased recurrence of PSP after thoracoscopic surgery (*13*). However, advances in technology and thoracoscopic procedures are believed to have decreased the possibility of overlooking bullae or blebs or incomplete resection of these air-filled blisters with fibrous walls during thoracoscopic surgery. A recent study found that the rate of PSP recurrence in video-assisted thoracic surgery was comparable to that in a thoracotomy (*14*). No bullae or blebs were detected in only a few patients (29 patients, 11.69%) in the current study. Not resecting bullae or blebs was not a risk factor for postoperative ipsilateral recurrence of PSP.

Pleurodesis is the other main objective of surgery to treat PSP according to the guidelines of the BTS (*12*). Only a small number of patients (27 patients) did not undergo pleurodesis in the current study. In these 27 patients, the pleura exhibited inflammation, and this inflammation may have led to pleural symphysis, like the aseptic inflammatory changes caused by pleurodesis. There were also concerns about pleurodesis causing complications such as postoperative bleeding since the pleura exhibited inflammation. During follow-up, however, patients who had not undergone pleurodesis had a markedly higher rate of PSP recurrence. Thus, not undergoing pleurodesis is a risk factor for postoperative recurrence of PSP.

There are several pleurodesis procedures in clinical use (*15*): mechanical pleurodesis, such as pleural abrasion and parietal pleurectomy, and chemical pleurodesis with different agents. Whether the pleurodesis procedure is a risk factor for the postoperative recurrence of PSP is still controversial (*16,17*). Apical parietal pleurectomy is another common method of mechanical pleurodesis for PSP. Given the possibility of complications like severe bleeding and severe chest pain and increased operating time, a pleurectomy was not performed at this hospital. Since 10% povidone-iodine is inexpensive and easily available, it was used for chemical pleurodesis at this hospital. Results indicated that neither approach was associated with a higher risk of PSP recurrence.

A longer duration of chest tube drainage and a longer duration of air leakage were once thought to decrease the effects of a pleurodesis and they thought to be risk factors for postoperative recurrence of PSP. However, the current results indicated that a longer duration of chest tube drainage and a longer duration of air leakage were not associated with a higher risk of PSP recurrence.

This study has several limitations. This study was retrospective in design and it was conducted at a single facility. There were only 12 cases of PSP recurring, so selection bias may have occurred, limiting the power of multivariate analysis. The role of pleurodesis cannot be considered definite until randomized controlled trials are conducted with a larger sample.

In conclusion, the current study revealed that not undergoing pleurodesis and a younger age are possible risk factors for ipsilateral recurrence of PSP after thoracoscopic surgery. Although the role of pleurodesis cannot be considered definite without conducting randomized controlled trials, thoracic surgeons should pay more attention to pleurodesis, especially in younger patients.

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