ORIGINAL ARTICLE

Surgical Outcomes in Secondary Spontaneous Pneumothorax and Prognostic Factors of Disease Recurrence

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Background: Treating secondary spontaneous pneumothorax (SSP) is challenging owing to its association with underlying lung diseases and potential life-threatening complications. Surgical intervention is usually not recommended because of the poor outcome.

Materials and Methods: We conducted a retrospective analysis of 92 patients who underwent surgical treatment for SSP at Vajira Hospital between January 2020 and May 2023. Ethical approval for the study was obtained from the institutional review board (221/66 E). We routinely perform lung bullectomy and pleurodesis. Patient demographics, surgical procedures, postoperative outcomes, and survival rates were analyzed. Using univariate analysis, we identified prognostic factors associated with recurrence pneumothorax.

Results: Most patients were male (83%), with a median age of 52 years. Chronic obstructive pulmonary disease was the most common underlying disease (28%), followed by tuberculosis (21%) and lung cancer (3%). Video-assisted thoracoscopic surgery was the primary surgical approaches, with bullectomy and pleurodesis performed in most cases. Disease-free survival rates at 12 and 36 months were 97.5% and 93.1%, respectively. Dyslipidemia, diabetes, and cardiovascular disease were identified as significant prognostic factors for disease recurrence.

Conclusion: Surgical treatment for SSP demonstrated favorable outcomes, with high overall survival rates and a low incidence of postoperative complications. Treatment should be optimized based on the patient's condition and underlying comorbidities.

Keywords: Video assisted thoracoscopic surgery; Secondary pneumothorax; Open thoracotomy

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Secondary spontaneous pneumothorax (SSP) occurs when a spontaneous pneumothorax arises in individuals with underlying chronic lung conditions such as chronic obstructive pulmonary disease (COPD) or interstitial lung disease or during acute infections such as COVID-19 pneumonitis[1,2]. SSP presents a significantly higher risk of co-morbidity than primary spontaneous pneumothorax (PSP). This increased risk is attributed to the potential for life-threatening symptoms, the diverse locations of ruptured bullae within the lungs, and the increased likelihood of recurrence and mortality[3,4].

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Although current recommendations suggest considering surgical intervention for patients with SSP who are experiencing persistent air leak beyond 48 hours[5], surgical treatment has not typically been the first-line approach because of high mortality rates (5%)[6-8]. However, advances in surgical techniques and medical devices offer promise for improving the outcomes of surgical treatment, potentially making it a viable option for patients with SSP.

In this retrospective study, the authors aim to evaluate the outcomes of surgical intervention for SSP within a single institution. The authors' objective is to identify prognostic factors associated with surgical outcomes, enhance risk assessment, and inform treatment decisions for individuals diagnosed with SSP.

Materials and Methods

The authors conducted a retrospective and descriptive review of 92 patients who underwent surgical treatment for SSP at Vajira Hospital between 2020 and 2023. The inclusion criteria comprised patients diagnosed with SSP, defined as spontaneous pneumothorax with evidence of underlying lung disease and persistent air leaks lasting

longer than 72 hours. This was a retrospective cohort, all data were data extracted from the hospital's electronic health records through the E-Phis program included patient demographics, clinical characteristics, surgery details, and postoperative outcomes. Demographic data and postoperative complications were collected and reviewed.

Ethical approval for the study was obtained from the institutional review board (221/66 E), and patient consent was obtained before data collection. The duration and frequency of follow-up were standardized, with efforts made to account for any cases lost to follow-up during the analysis.

Statistical analysis

Categorical variables were presented as frequency and percent. Continuous variables were presented as median and interquartile range. One-way ANOVA and Student t-test were used to compare categorical variables and continuous variables, respectively. Univariate regression analysis was performed to assess the association characteristic and risk for recurrence. A p-value <0.05 was consider statistically significant. All statistically analysis was performed using Statistical Package for the Social Science for Windows (SPSS) version 18.

Indications for surgical treatment

Surgical intervention is indicated in SSP patients with a persistent air leak more than 72 hours, after recurrent ipsilateral or contralateral pneumothorax, in cases of bilateral or tension pneumothorax, and also first episode of pneumothorax in high risk occupation such as airline pilots or where medical attention is inaccessible.

Surgical technique

All procedures were performed with general anesthesia using lung isolation technique with or without a double-lumen endotracheal tube or bronchial blocker. Principle of the operation are (1) to identify the part of the lung responsible for the air leak and to deal with it appropriately; and (2) to prevent collapse of the lung in the future by promoting adhesions between the lung and chest wall. We routinely use chemical pleurodesis such as Talc. For VATS, the number of ports depended on the surgeon techniques, we routinely performed uniportal VATS with 3 cm incision was incised at 4th ICS at anterior axillary line for utility port and then explore the thoracic cavity. Open thoracotomy is preserved in case that could not operable under VATS. A standard technique of posterolateral thoracotomy, axillary thoracotomy or muscle sparing thoracotomy with rib spreading was used.

During exploration, our institution usually ventilates both lung using low tidal volume to find cause of pneumothorax. Any circumscribed pulmonary leaks or blebs were identified, and resected with an endo-stapling device or resected and sutured using absorbable suture. For reinforced endo-staple will be use in very fragile lung tissue such as severe COPD patients. In case that could not resect lung parenchyma due to fragile lung tissue and no persistent air leak. For Pleurodesis, 4 g of Talc pleurodesis was preferred to insufflated spread over the entire lung surface and also parietal pleura. Single small chest tubes (24-French or 28-French) were inserted through at incision site placed under endoscopic vision in superior and posterior chest wall, respectively. Patients were normally extubated immediately after operation. Chest x-ray was done within 8 to 12 hours postoperatively. Routine postoperative cares included adequate pain control, pulmonary toilet exercise and early mobilization. Chest drain was removed if the content drainage was clear (no fresh blood or pus), was less than 200 mL/day and there was no air leakage. All patients were followed with chest x-ray and evaluated for clinical symptoms at the cardiovascular thoracic clinic 2 weeks after discharged.

Results

From January 2020 to May 2023, 92 patients underwent surgical interventions for the treatment of SSP. Among these patients, the majority were male (83%). The median age of the patients at the time of surgery was 52 years. Smoking profiles showed slight differences, with 55% being smokers and 45% nonsmokers. COPD was the underlying disease in 26 patients (28%). Of the patients, 21% were diagnosed with tuberculosis, whereas 3% had a history of lung cancer. (Table 1).

With regard to surgical procedures, video-assisted thoracoscopic surgery (VATS) was performed in 43 cases (47%), whereas 49 patients (53%) underwent non-intubate video assisted thoracoscopic (NIVATS) lung surgery, with one case in this group being converted from VATS. None of patients underwent open thoracotomy first. Most surgeries were performed on the right side (71%), with four patients (4%) undergoing bilateral thoracoscopies due to contralateral pneumothorax. Four patients had a history of lung operations before the data collection period.

We analyzed the final procedures and found that bullectomy was performed in 77 patients (77%). Talc pleurodesis was performed in 75 patients (82%) of surgeries, whereas mechanical pleurodesis was performed in only 17 patients (18%). The median operative time was reported as 30 minutes, with an average blood loss of 10 milliliter. Only 3% of patients required blood transfusions due to underlying and preoperative anemic conditions. Most patients (97.8%) were extubated immediately, with 2.2% requiring postoperative ventilation. The median tube duration was 2 days.

Table 1. Descriptive data of secondary pneumothorax patient whom under lung surgery

Descriptive data	n=92
Age, median (P25 to P75)	52.5 (38.5 to 65)
Sex, n (%)	
Male	76 (82.6%)
Female	16 (17.4%)
Smoking status, n (%)	
Non-smoker	41 (45%)
Smoker	51 (55%)
Underlying disease, n (yes %)	
Dyslipidemia	8 (9.8%)
Diabetes	5 (5.4%)
Hypertension	9 (10.8%)
Cardiovascular disease	4 (4.3%)
Cerebrovascular disease	6 (7.6%)
COPD, n (%)	26 (28.2%)
History of tuberculosis, n (%)	20 (21.7%)
Approach, n (%)	
NIVATS	48 (52.1%)
VATS	43 (46.7%)
VATS and convert to thoracotomy	1 (1.1%)
Laterality, n (%)	
Left side	23 (25%)
Right side	65 (70.6%)
Bilateral	4 (4.4%)
History of malignancy, n (%)	3 (3%)

COPD=Chronic obstructive pulmonary disease; VATS=video assisted thoracoscopic surgery; NIVATS=non-intubated video assisted thoracoscopic surgery

Table 2. Intra- and Post- operative outcome data in secondary pneumothorax patients after lung surgery

Operative	n=92
Lung bullectomy, n (%)	71 (77.1%)
Type of Pleurodesis, n (%)	
Talc pleurodesis	75 (81.5%)
Mechanical pleurodesis	17 (18.4%)
Mesh coverage	1 (1.1%)
Pleurectomy	1 (1.1%)
Operation time, median min (P25 to P75)	30 (30 to 60)
Estimate blood, median ml (P25 to P75)	10 (5 to 20)
Blood transfusion, n (%)	3 (3.2%)
Postoperative ventilator needed, n (%)	2 (2.2%)
Immediate extubation, n (%)	90 (97.8%)
Complication, n (yes %)	
Pneumonia	1 (1.1%)
Prolong air leak	4 (4.3%)
Bleeding	1 (1.1%)
ICU stay, n (yes %)	8 (9.7%)
Hospital stay, median (P25 to P75)	5.5 (4 to 8)
Tube duration, median (P25 to P75)	2 (1 to 3)
Pain score, median (P25 to P75)	
Day 1	3 (3 to 3)
Day 2	0 (0 to 0)
Day 3	0 (0 to 0)

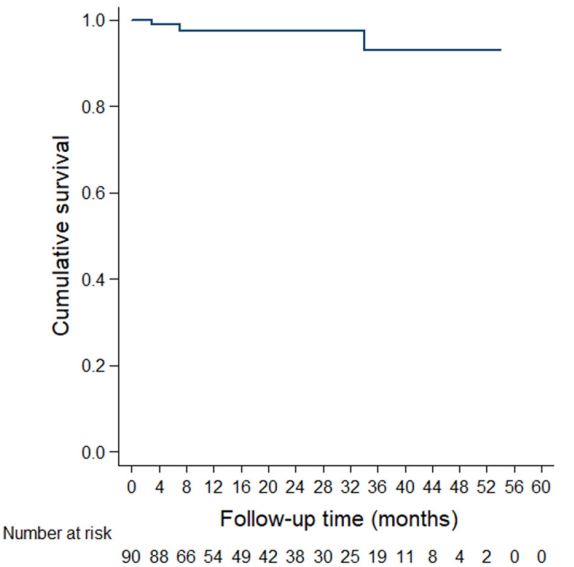

Figure 1. Disease free survival rate after lung surgery in secondary spontaneous pneumothorax.

We collected postoperative data, which showed that 98% of patients did not require postoperative ventilation. Eight patients (9.7%) were transferred to the intensive care unit (ICU) in the early postoperative period, with no reported ICU revisits. Chest drains were removed within 2 day, and the median length of hospital stay was 5.5 days (range, 4 to 8 days), with no reported mortality. With regard to postoperative complications, four patients developed air leaks after surgery and one patient had pneumonia. One patient experienced bleeding due to injury to the subclavian artery in the intraoperative period and required conversion to open thoracotomy (Table 2).

The Re-intervention free survival rates at 12 and 36 months were 97.5% and 93.1%, respectively (Figure 1). Univariate analysis of patient data for survival showed that underlying dyslipidemia, diabetes, and cardiovascular disease were significant risk factors for recurrence of disease with a hazard ratio of nearly 20 and a $p<0.05$ (Table 3).

Discussion

The management of SSP is challenging due to its association with underlying lung diseases and the potential for life-threatening complications. The most common underlying lung disease is usually COPD, which was also the case for the patients in this study. The treatment of SSP

Table 3. Univariate to identify risk of recurrence pneumothorax after lung surgery in secondary spontaneous pneumothorax

	Univariable		
	HR	95% CI	p-value
Age, median (P25 to P75)	1.029	0.960 to 1.104	0.419
Smoking status			
Non-smoker	1.000	Reference	
Smoker	2.267	0.120 to 25.745	0.509
Underlying disease			
Dyslipidemia	19.876	1.802 to 219.240	0.015
Diabetes	20.058	1.243 to 323.738	0.035
Hypertension	3.874	0.349 to 42.986	0.270
Cardiovascular disease	22.557	1.410 to 360.924	0.028
COPD	6.277	0.558 to 70.604	0.137
Approach; VATS vs NIVATS	0.753	0.066 to 8.610	0.820
Laterality; Left Ver Right	1.304	0.118 to 14.383	0.829
Lung bullectomy or none	0.228	0.019 to 2.742	0.244

VATS=video assisted thoracoscopic surgery, NIVATS=non-intubate video assisted thoracoscopic surgery

differs from that of PSP because of its higher mortality and morbidity. However, according to the American College of Chest Physicians' guidelines for secondary pneumothorax, bullectomy and pleurodesis with tensionless technique remain the primary surgical procedures for SSP[12].

Most patients with SSP are elderly and have associated emphysematous lung and marginal pulmonary function. Surgical treatment for these patients can be life-threatening. The morbidity rates of surgical treatment for SSP were reported to be 20% to 35%. Most complications are respiratory system[8]. Although there was no mortality in our study, we observed 6.5% overall morbidity rates, with 5.7% in our study experiencing respiratory complications.

The rate of recurrence after surgical treatment for SSP was reported to be 2% to 16%[6-8]. Isaka et al. conducted a retrospective cohort study and observed a 20.6% morbidity rate and a recurrence rate of 9.3%[8]. Our findings revealed favorable outcomes in 6.9% which is comparable to previous studies. The low incidence of postoperative complications, short hospital stays, and minimal need for postoperative ventilation reflect the effectiveness of surgical treatment. According to a recent study, the recommendation for surgical treatment might play a pivotal role in the prophylaxis of recurrent SSP[9].

The VATS approach is recommended for bullectomy, and bullectomy combined with pleurodesis is associated with a higher success rate to prevent a recurrence. A systematic review by Barker reported a recurrence rate of 5.4% with VATS and 1.1% with open surgery[11]. However, in this study, we found no significant difference in the recurrence rate between those undergoing VATS compare to other studies[11,12]. However, open thoracotomy remains the gold standard of treatment for those who cannot undergo VATS surgery.

In conclusion, patients with SSP who receive surgical treatment show a favorable result. However, several limitations of the present study warrant consideration. The retrospective nature of this study introduced inherent biases and limitations to the data collection. In addition, we conducted the study at a single institution, limiting the generalizability of our findings to other settings. Future research should focus on prospective studies with larger, multicenter cohorts to validate the findings and the impact of underlying comorbidities on surgical outcomes in patients with SSP.

What is already known on this topic?

Secondary spontaneous pneumothorax disease treatment varies from conservative to surgery. However, effect of surgical treatment has been known that could improve disease free recurrence rate than conservative method.

What this study adds?

The present study is claimed to be a first study to report an outcome secondary spontaneous pneumothorax surgery of Thailand. This study is also favorable results and low recurrence rate in secondary patient whom undergoing surgery.

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Conflicts of interest

The authors declare no conflicts of interest.

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