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# Is Chest Tube Omission Safe for Patients with Primary Spontaneous Pneumothorax Scheduled for VATS?

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**Abstract:** Primary spontaneous pneumothorax (PSP) is a pleural disease that abruptly affects healthy adolescents and young adults, representing a common thoracic disorder in this age group. This study aimed to investigate the necessity of preoperative chest tube insertion in patients with PSP and to re-evaluate current clinical treatment approaches. A retrospective review of medical records was conducted for children and young adults aged 14–30 years, diagnosed with PSP and who underwent Video-assisted thoracoscopic surgery (VATS) between January 2016 and December 2022 at Wonju Severance Christian Hospital. Patients were retrospectively divided into two groups based on their initial treatment: chest tube insertion and non-chest tube insertion. Clinical data including demographics, treatment details, and outcomes were collected and compared. Total 128 cases of PSP were included in the study. The total length of hospital stay was significantly shorter in the non-chest tube group (p=0.000), which was attributed to the omission of pre-operative chest tube insertions. No significant differences were observed between the two groups in terms of postoperative complications or recurrence rates. In cases of young patients with PSP, omitting pre-operative chest tube insertion may be a viable option if the patient is scheduled for VATS.

**Keywords:** pneumothorax; chest tube; video-assisted thoracoscopic surgery; recurrence

## 1. Introduction

Primary spontaneous pneumothorax (PSP) is a pleural disease that abruptly affects healthy adolescents and young adults, representing a common thoracic disorder in this age group, with an incidence rate of 22.7 per 100,000 and 3.3-fold higher prevalence in males [1]. PSP is well known for its high recurrence rate, and recurrence rates among patients treated non-surgically vary among researchers, ranging from a minimum of 32% to a maximum of 54% [2–6]. However, the recurrence rates reduced after surgical treatment for PSP, ranging from 1.16% to 17%, with various surgical techniques such as bullectomy, pleurodesis, pleural abrasion, and parietal pleurectomy being utilized [7–10]. Video-assisted thoracoscopic surgery (VATS) is preferred over thoracotomy. According to the British Thoracic Society (BTS) and the American College of Chest Physicians (ACCP) guidelines, chest tube insertion is recommended for PSP with a symptom [11,12]. However, there are currently no established guidelines advocating the omission of chest tubes in PSP patients undergoing VATS.

Chest tube insertion can result in complications. According to Vilkvil et al. [13], the overall complication rate of chest tube insertion was 19.9%, and the rate of complications specific to patients with PSP was 14.2%. Chan et al. reported an overall complication rate of 18.2%, with 15.1% of the patients having unresolved PSP [14]. While rare, serious complications like lung parenchymal and heart and esophagus injuries, and subcutaneous tube misplacement can occur. Also, it could contribute to increased analgesic use due to pain at the insertion site [15]. Many complications in PSP arise from chest tube insertion performed by inexperienced physicians in emergency settings [14]. Furthermore, when a skilled physician's chest tube insertion cannot be guaranteed, an alternative

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approach for hemodynamically stable PSP patients predict for VATS might be to omission pre-operative chest tube insertion proceed directly to VATS. Therefore, in cases where VATS is predicted for pneumothorax according to the guideline, and the patient is hemodynamically stable, we analyzed pre- and post-operative data for two groups: one without a chest tube and the other with a chest tube.

## 2. Materials and Methods

*Inclusion and exclusion criteria of study*

After obtaining approval from the Ethics Committee of Wonju Severance Christian Hospital, we retrospectively reviewed the medical records of children and young adults (aged 14–30 years) diagnosed with PSP, who underwent VATS between January 2016 and December 2022. Inclusion criteria were hemodynamic stable patients with asymptomatic or symptomatic PSP with an apical or lateral length less than 2 cm relative to pleural line in chest X-ray. Additionally, all patients consented to VATS. The exclusion criteria for the study included patients who fell into the following categories:

1. Bilateral PSP in the initial chest X-ray,
2. Tension PSP with mediastinal shifting,
3. Definitive bulla was not visible on CT scans,
4. History of previous surgery on the ipsilateral thorax,
5. Underlying lung diseases such as emphysema or chronic obstructive lung disease,
6. Patients who did not consent to surgery,
7. Referred from other hospitals with inserted chest tubes,
8. Inadequate medical or radiographic records.

Patients were divided into two groups according to their initial treatment approach: those who underwent drainage procedures in the emergency department or upon admission (chest tube group), and those who received conservative care upon admission or in the outpatient clinic before their surgical interventions (non-chest tube group). Demographic and clinical data, including age, sex, weight, height, history of smoking, side and associated diagnoses of PSP, and comorbidities, were collected.

Chest computed tomography (CT) scans were conducted before VATS, with decisions based on confirmed bullae or blebs presence. All VATSs were performed under general anesthesia and single-lung ventilation was achieved using double-lumen endotracheal tubes. Outcome measures such as postoperative pleurodesis, chest tube removal day after VATS, lung collapse after chest tube removal, length of stay after VATS, and total hospitalization days were collected from the electronic medical records. Recurrence was defined as a subsequent PSP, confirmed through chest radiography or chest CT, occurring more than 7 days after discharge with no PSP. This study was approved by the institutional review board of Wonju Severance Christian Hospital, which waived the requirement for informed consent (IRB approval no. CR323150).

*Statistical analysis*

Data are reported as medians (interquartile ranges) for continuous variables and as frequencies (percentages) for categorical variables. Statistical analyses were performed using SPSS Statistics for Windows (version 22.0; IBM Corp., Armonk, NY, USA). Individual measures were compared using the Mann–Whitney U test and Chi-squared test, as appropriate, and statistical significance was set at $P < 0.05$.

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## 3. Results

Between January 2016 and December 2022, 281 VATS were performed on 243 patients with PSP. Of these, 128 VATS that did not meet the exclusion criteria were included in the study. Among these, 42 cases with pneumothorax size less than 2 cm from the pleural line, 18 cases of tension pneumothorax, 7 cases of no definite bulla on chest CT, 28 cases where patients did not consent to surgery or study participation, 10 cases with existing lung disease, 6 cases with previous ipsilateral thoracic surgery, 5 cases of bilateral pneumothorax, 13 cases with inadequate medical records, and 24 cases where a chest tube had been inserted at another hospital, a total of 153 cases were excluded from the study.

*Clinical characteristics of patients according to chest tube*

The study's demographic and clinical characteristics are presented in Table 1. A total of 128 patients were analyzed, divided into two groups: 87 patients underwent initial chest tube insertion, while 41 patients did not receive pre-operative chest tube insertion. Analysis of demographic data revealed no significant differences between these groups in terms of age, gender, pneumothorax side, height, weight, BMI, smoking history, or history of ipsilateral PSP ($P<0.05$ for all).

**Table 1.** Pre-operative characteristics of the non-chest tube insertion and chest tube insertion groups.

| | Non-chest tube insertion (n=41) | Chest tube insertion (n=87) | P-value |
|---|---|---|---|
| Age | 19.17+3.94 | 19.33+3.75 | 0.859 |
| Male | 39 (95.1%) | 82 (94.3%) | 0.840 |
| Pneumothorax side | | | 0.389 |
| Left | 16 (39.0%) | 41 (47.1%) | |
| Right | 25 (61.0%) | 46 (52.9%) | |
| Height (meters) | 1.75+0.06 | 1.74+0.07 | 0.957 |
| Weight (kilograms) | 58.93+7.63 | 57.52+8.49 | 0.367 |
| Body mass index | 19.02+2.41 | 18.85+2.25 | 0.561 |
| History of smoking | 4 (9.8%) | 16 (18.4%) | 0.209 |
| History of ipsilateral PSP | 17 (41.5%) | 28 (32.2%) | 0.305 |

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

A closer examination of the non-chest tube group showed that 78.0% (32/41) were admitted on the day of diagnosis, and the remaining 22.0% (9/41) were admitted for video-assisted thoracoscopic surgery (VATS) later. Of those admitted on the day of diagnosis, 71.9% (23/32) underwent VATS within two days. In contrast, among the later admitted patients, 33.3% (3/9) opted for VATS during their first outpatient visit, while the rest chose VATS after multiple outpatient observations. In the chest tube group, 56.3% (49/87) underwent VATS within two days of admission, and a smaller proportion, 8.0% (7/87), underwent VATS more than five days after the onset of air leakage. Intraoperative data, detailed in Table 2, revealed no significant differences between the groups in terms of operative time, number of wedge resections, or pleurodesis. However, the usage of a single port was significantly higher in the non-chest tube group ($P=0.001$).

**Table 2.** Intra-operative data of the non-chest tube insertion and chest tube insertion groups.

| | Non-chest tube insertion (n=41) | Chest tube insertion (n=87) | P-value |
|---|---|---|---|
| Op time (min) | 40.32+16.17 | 36.77+19.16 | 0.307 |
| Single port | 13 (31.7%) | 8 (9.2%) | 0.001* |
| Number of wedge resection | 1.54+0.78 | 1.40+0.81 | 0.286 |

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| | | | |
|---|---|---|---|
| Mechanical pleurodesis | 1 (2.4%) | 3 (3.4%) | 0.759 |

Values are presented as mean ± standard deviation or number (%). *p < 0.05.

Postoperative outcomes, as shown in Table 3, indicated a significantly shorter total hospitalization period in the non-chest tube group (P=0.000). No significant differences were observed in other postoperative variables, including lung collapse after chest tube removal, post-operation hospitalization days, and pneumothorax recurrence rates. Furthermore, the study reported no deaths or significant complications during the VATS procedures in either group, underscoring the safety and efficacy of the surgical approaches employed in the management of pneumothorax in this patient population.

**Table 3.** Univariate analysis for risk factors of occult pneumothorax.

| | **Non-chest tube insertion (n=41)** | **Chest tube insertion (n=87)** | **P-value** |
|---|---|---|---|
| Post operation pleurodesis | 1(2.4%) | 3(3.4%) | 0.759 |
| Chest tube remove(day) | 1.41+0.77 | 1.55+0.86 | 0.387 |
| Lung collapse after chest tube removal | 1(2.4%) | 0(0%) | 0.144 |
| Post-operation hospitalization(day) | 2.59+1.09 | 2.85+1.27 | 0.253 |
| Total hospitalization(day) | 4.05+1.26 | 5.26+1.83 | 0.000 |
| Pneumothorax recurrence | 2(4.9%) | 5(5.7%) | 0.840 |

Values are presented as mean ± standard deviation or number (%). *p <0.05.

## 4. Discussion

This study explored the implications of chest tube insertion in patients diagnosed with PSP who were scheduled for VATS. The research primarily focused on comparing the outcomes between two distinct groups: patients who underwent chest tube insertion and those who did not. The findings revealed that, aside from the total duration of hospi-tal stay, there were no statistically significant differences across various clinical parame-ters between the two groups. This key outcome underscores the nuanced role of chest tube insertion in the management of PSP prior to VATS.

In the cohort of 41 patients who did not receive chest tube insertion initially, 32 were promptly admitted and received oxygen therapy, followed by VATS. The remaining 9 pa-tients chose VATS after a period of outpatient observation. Notably, none of the patients in this study underwent chest tube insertion before VATS, and there were no cases with he-modynamically significant symptoms. This observation is pivotal, as it highlights the po-tential for managing certain PSP cases without immediate chest tube insertion, thus pos-sibly reducing hospital stay and associated healthcare costs.

A deeper analysis into the lengthier hospital stay for the chest tube group reveals that this may be linked to the strategy of opting for surgical treatment only after confirming prolonged air leakage, a scenario not typically encountered in the non-chest tube group. Soler et al. [5] have emphasized the importance of educating both patients and their fami-lies about the recurrent nature of PSP and advocating for surgical intervention in such cases. In this context, our study observed that among the 41 patients in the non-chest tube group, 24, who had no prior history of PSP, chose surgical intervention for their initial ep-isode. This decision-making process varied: 17 opted for immediate surgical treatment upon their initial consultation, two after confirming a surgical schedule post-admission, and five after one or more outpatient follow-ups. This finding contributes to the ongoing debate regarding the appropriateness of surgical intervention for a first PSP episode, par-ticularly in cases with a clear presence of bullae.

Interestingly, the non-chest tube group exhibited a higher tendency towards sin-gle-port VATS procedures. Single-port VATS, a technique pioneered by Rocco et al. in 2004, has gained widespread recognition for its effectiveness and stability [16–18]. However, the focus of this study is not on the surgical technique per se but rather on the comparative analysis of pre-operative, intra-operative,

and post-operative outcomes in relation to the omission or inclusion of preoperative chest tube. It is important to note that the choice of using preoperative chest tube insertion may be influenced by the surgeon's preference, which can be a variable in different clinical settings.The results of this study imply that performing VATS immediately without pre-operative chest tube insertion in hemodynamically stable patients, even those presenting with symptoms like chest pain, does not exacerbate the risk of additional pain or compli-cations. The significance of this study lies in its demonstration that such a strategy can be effectively and safely imple-mented in a clinical setting.

However, the limitations of this study are noteworthy. The study's small patient population, its single-center nature, and the retrospective design may affect the generali-zability of the findings. While the results are promising, they should be interpreted with caution. The study provides valuable insights, but larger scale, multi-center studies are needed in the future to establish more definitive guidelines and to validate these findings in a broader clinical context.

## 5. Conclusions

In cases of PSP, the absence of significant complications without preoperative chest tube insertion suggests that omitting this procedure may be a viable option, especially for patients slated for surgical treatment or already scheduled for VATS.

**Supplementary Materials:** The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Table S1: Trauma team activation criteria.

**Author Contributions:** Conceptualization, CSB. and CWK.; methodology, CWK.; formal analysis, CWK.; investigation, IHP.; resources, IHP, CSB, CWK.; data curation, CSB.; writing—original draft preparation, CWK.; writing—review and editing, CSB.; supervision, CSB. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement: Informed Consent Statement:** The study was approved by the Institutional Review Board for Human Research of Yonsei University Wonju Severance Christian Hospital (CR-323150).

**Informed Consent Statement:** Informed consent was waived, due to the retrospective nature of the research. In addition, only de-identified data extracted from medical records prior to analysis were used in the study.

**Data Availability Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Conflicts of Interest:** The authors declare no conflict of interest.

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