



## Original Article

# Comparative Analysis of the Pleural Vent versus the Intercostal Tube for Managing Spontaneous Pneumothorax

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### Abstract

**Background:** Evidence supporting using pleural venting over traditional intercostal chest drains for managing spontaneous pneumothorax is limited. Therefore, this study aimed to compare using pleural vents and intercostal tubes in managing spontaneous pneumothorax.

**Methods:** In this randomized clinical trial, 61 patients with spontaneous pneumothorax were randomly assigned to two groups. Group I included patients initially managed via intercostal chest tubes (n= 31), and Group II included patients with a pleural vent as the initial management (n= 30). The study outcomes were pain score; the need for nonsteroidal anti-inflammatory medications (NSAIDs) or narcotics; wound infections; pleural effusion; the duration of treatment; the need for surgery; and patient satisfaction and recurrence of pneumothorax at 1, 3, and 6 months after discharge.

**Results:** The baseline data were comparable between the groups, with no differences in the laterality or size of the pneumothorax. The requirements for NSAIDs (77% vs. 13%,  $p<0.001$ ) and narcotics (42% vs. 0%,  $p<0.001$ ) were more frequent in Group I. The duration of treatment was longer in Group 1 ( $3.71\pm 0.78$  vs.  $3.03\pm 0.61$  days;  $p<0.001$ ). Surgery was required more frequently in Group I (61% vs. 0%,  $p<0.001$ ). Recurrence after three months was more common in Group I (11 (35.48%) vs. 1 (3.33%);  $p= 0.003$ ). There was no difference in posttreatment pleural effusion between the groups, whereas wound infection was more common in Group I.

**Conclusions:** Pleural vents for managing spontaneous pneumothorax offer significant advantages over traditional intercostal chest tube placement. Patients managed with pleural vents experienced markedly lower pain levels, reduced reliance on NSAIDs and narcotics, and shorter treatment durations. Additionally, the need for surgical intervention and recurrence rates were substantially lower in the pleural vent group.

### KEYWORDS

Pleural vents;  
Spontaneous pneumothorax;  
Intercostal chest tubes

### Article History

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### Introduction

Spontaneous pneumothorax is a common clinical problem that can be life-threatening with delayed or inappropriate management [1].

Research on the management of spontaneous pneumothorax is still evolving. The optimal management for spontaneous pneumothorax is needed to reduce recurrence rates after



therapeutic intervention and decrease complications and the need for surgical intervention [2]. Several factors govern the choice of management strategy for spontaneous pneumothorax, including the hemodynamic status, number of pneumothorax attacks, size of the pneumothorax, and experience of the treating teams [3].

The management of spontaneous pneumothorax ranges from observation to surgical intervention. Standard management involves the insertion of intercostal chest drains; however, intercostal chest drains have the drawbacks of increased postinsertion pain and prolonged hospital stays [4]. Therefore, the pleural vent has emerged as a treatment option for managing spontaneous pneumothorax [5]. The pleural vent is a minimally invasive device that consists of a small catheter connected to a one-way valve [4]. Compared with intercostal chest drainage, pleural vents may be associated with less pain and shorter hospital stay; however, its efficacy is still questionable [6]. The evidence supporting using pleural venting over chest drains for managing spontaneous pneumothorax is limited. Therefore, this study aimed to compare using pleural vents and intercostal tubes in managing spontaneous pneumothorax.

## Patients and Methods

### Design and patients

*Table 1: Comparison of baseline data between patients who received intercostal chest drains (Group I) and those who received pleural vents (Group II). The data are presented as numbers (%) or medians (Q1-Q3).*

|   | Group I (n= 31) | Group II (n= 30) | p-value |
|---|-----------------|------------------|---------|
| <b>Age (years)</b>  | 35 (26- 42)     | 32 (25- 45)      | 0.991   |
| <b>Male</b>   | 29 (93.55%)     | 23 (76.67%)      | 0.081   |
| <b>BMI (kg/m<sup>2</sup>)</b>                             | 23 (21- 27)     | 25 (22- 27)      | 0.210   |
| <b>Smoking</b>  |                 |                  |         |
| Cigarettes  | 28 (90.32%)     | 24 (80%)         | 0.301   |
| Shisha  | 9 (29.03%)      | 5 (16.67%)       | 0.251   |
| VAP   | 7 (22.58%)      | 11 (36.67%)      | 0.228   |
| <b>Family history of pneumothorax</b>                     | 6 (19.35%)      | 9 (30%)          | 0.334   |
| <b>Previous pneumothorax in surgically unfit patients</b> | 3 (9.68%)       | 2 (6.67%)        | >0.99   |
| <b>Recent weight loss</b>                                 | 7 (22.58%)      | 7 (23.33%)       | 0.944   |
| <b>Previous weight reduction surgery</b>                  | 6 (19.35%)      | 7 (23.22%)       | 0.704   |
| <b>Hypoalbuminemia</b>                                    | 8 (25.81%)      | 8 (26.67%)       | >0.99   |
| <b>Chronic obstructive lung disease</b>                   | 7 (22.58%)      | 11 (36.67%)      | 0.228   |

This clinical trial was conducted between December 2022 and August 2023 in a single tertiary referral center. The study included patients who had spontaneous pneumothorax and were hemodynamically stable at the time of management. Patients were randomized into two groups via blocked randomization with a 1:1 ratio. Group I included patients initially managed via intercostal chest tubes (n= 31), and Group II included patients with a pleural vent as the initial management (n= 30). The study included patients aged > 15 with primary or secondary spontaneous pneumothorax. Children and patients with tension pneumothorax, associated pleural effusion, or large bullae were excluded. Additionally, patients associated with fractured ribs and multiple recurrent attacks of pneumothorax in patients fit for surgery were excluded from the study. One patient was discharged home after randomization on the pleural vent and was excluded. Additionally, patients with tension pneumothorax were excluded.

### Data and endpoints

The data collected included age, sex, body mass index (BMI), smoking status, clinical symptoms, radiological findings on chest X-ray and computed tomography scans (size of the pneumothorax, associated bullae, and pleural effusion), and associated comorbidities, such as chronic obstructive lung disease (COPD).

Table 2: Comparison of the presentation and pneumothorax characteristics between patients who received intercostal chest drains (Group I) and those who received pleural vents (Group II). The data are presented as numbers (%).

|                                       | Group I (n= 31) | Group II (n= 30) | p-value |
|---------------------------------------|-----------------|------------------|---------|
| <b>Presentation</b>                   |                 |                  |         |
| Dyspnea                               | 18 (58.06%)     | 16 (53.33%)      | 0.710   |
| Pain                                  | 13 (41.94%)     | 14 (46.6750)     |         |
| <b>Laterality of the pneumothorax</b> |                 |                  |         |
| Right                                 | 17 (54.84%)     | 18 (60%)         | 0.684   |
| Left                                  | 14 (45.16%)     | 12 (40%)         |         |
| <b>Pneumothorax size on CXR</b>       |                 |                  |         |
| Mild                                  | 7 (22.58%)      | 9 (30%)          | 0.510   |
| Moderate                              | 24 (77.42%)     | 21 (70%)         |         |
| <b>Pneumothorax size on CT</b>        |                 |                  |         |
| Mild                                  | 1 (3.23%)       | 0                | 0.337   |
| Moderate                              | 25 (80.65%)     | 28 (93.33%)      |         |
| Large                                 | 5 (16.13%)      | 2 (6.67%)        |         |
| <b>Associated bullae</b>              |                 |                  |         |
| Small sized                           | 3 (9.68%)       | 3 (10%)          | 0.427   |
| Moderate sized                        | 1 (3.23%)       | 4 (13.33%)       |         |

The study outcomes included the pain score, the need for nonsteroidal anti-inflammatory medications (NSAIDs) or narcotics, the incidence of wound infections, the incidence of pleural effusion, the duration of treatment, the need for surgery, and the recurrence of pneumothorax at 1, 3 and 6 months after discharge. The pain score was assessed via a visual analog score (VAS), which was calculated on a numerical scale from 0 to 10, where 0 indicates no pain, and 10 indicates the worst pain. Additionally, patient satisfaction was evaluated before discharge using self-reported scale as poor, good, or excellent.

### Techniques

Intercostal chest drains were inserted via the 5th intercostal space mid-axillary line. The pleural vent is a new minimally invasive portable device consisting of an 8 French gauge polyurethane catheter mounted on an 18-gauge needle connected to a plastic chamber containing a one-way valve and inserted via the 2nd intercostal space just lateral to midclavicular line with incision less than 5-mm. The Pleural vent was inserted via an incision passed to the pleural cavity while suction to be maintained using syringe 50 ml to ensure the safe entry and suction of free air. Also, a click was heard once the needle passed to the pleural space, and the indicator on the safety needle changed green from red. The needle was

removed, then it was secured with adhesive dressing and sutures. The patency of the device is checked by the movement of the indicator diaphragm during respiration. Both techniques were performed under aseptic conditions and local infiltration anesthesia. Chest X-ray was performed two hours after the procedures to ensure proper drain positioning and monitor improvement. Patients were encouraged to mobilize and use incentive spirometry, and a chest physiotherapist followed them. The drains were removed after full lung expansion and no air leak. Patients were followed up at the outpatient clinic to detect recurrence via chest X-ray.

### Ethical approval

The local ethical committee approved the study, and the patients signed an informed consent before enrollment. The study was conducted in accordance with the Declaration of Helsinki.

### Statistical analysis

Stata 18 was used for data analysis (Stata Corp- College Station- Texas). Categorical data are described as absolute counts and percentages, and the chi-square test or Fisher's exact test was used for comparisons. Continuous data are presented according to the normality distribution as the mean, standard deviation, or median and

25th and 75th percentiles. Comparisons of continuous data were performed via Student's t-test with the Wilcoxon test. A p-value of less than 0.05 was considered statistically significant.

## Results

### Baseline data

Comparisons of baseline data between patients in Group I and those in Group II revealed no significant differences in age, sex, body mass index, smoking status, family history of pneumothorax, recent weight loss, previous weight reduction surgery, hypoalbuminemia or COPD (Table 1).

### Pneumothorax

There were no significant differences in the presenting symptoms between the groups. The most common site for pneumothorax was the right hemithorax. The size of the pneumothorax did not differ significantly between the groups, as measured by chest X-ray and CT. The number of associated bullae and their sizes did not differ significantly between the two treatments (Table 2).

### Outcomes

There was no difference in the development of pleural effusion between the groups. The need for NSAIDs, narcotics, and pain scores were greater in patients with intercostal chest drains. Wound

infection was significantly more common with intercostal chest drains. The duration of treatment was lower in patients with pleural vents. Most patients in Group I reported poor satisfaction with the treatment (52%), whereas most patients in Group II reported excellent satisfaction (80%). Recurrence at three months was greater in Group I, with no difference in recurrence at 1 and 6 months (Table 3).

## Discussion

Spontaneous pneumothorax is a common disease with an incidence of 6/100000 women and 17/100000 men [7]. The British Thoracic Society and the European Respiratory Society recommend needle aspiration as first-line treatment for spontaneous pneumothorax [7,8]; however, the risk of requiring further intervention is still high after aspiration. Therefore, others recommend the intercostal tube as the primary management for spontaneous pneumothorax [9]. The different recommendations for managing pneumothorax and introducing new treatment modalities mandate the performance of new studies comparing different approaches used in managing spontaneous pneumothorax [10]. Evolving the management of spontaneous pneumothorax toward minimally invasive techniques is still needed. We aimed to compare the outcomes of using pleural vents to intercostal chest drains in managing spontaneous pneumothorax.

Table 3: Comparison of treatment outcomes between patients who received intercostal chest drains (Group I) and those who received pleural vents (Group II). The data are presented as numbers (%), mean  $\pm$  SD or medians (Q1-Q3).

|                                     | Group I (n= 31) | Group II (n= 30) | p-value |
|-------------------------------------|-----------------|------------------|---------|
| <b>Pleural effusion</b>             | 3 (9.68%)       | 4 (13.33%)       | 0.707   |
| <b>Need for NSAIDs</b>              | 24 (77.42%)     | 4 (13.33%)       | <0.001  |
| <b>Duration of treatment (days)</b> | 3.71 $\pm$ 0.78 | 3.03 $\pm$ 0.61  | <0.001  |
| <b>Pain score</b>                   | 4 (3- 5)        | 0 (0- 0)         | <0.001  |
| <b>Need for narcotics</b>           | 13 (41.94%)     | 0                | <0.001  |
| <b>Wound infection</b>              | 10 (32.26%)     | 1 (3.33%)        | 0.006   |
| <b>Satisfaction</b>                 |                 |                  |         |
| Poor                                | 16 (51.61%)     | 0                |         |
| Good                                | 14 (45.16%)     | 6 (20%)          | <0.001  |
| Excellent                           | 1 (3.23%)       | 24 (80%)         |         |
| <b>Need for surgery</b>             | 19 (61.29%)     | 0                | <0.001  |
| <b>Recurrence after 1 month</b>     | 7 (22.58%)      | 2 (6.67%)        | 0.147   |
| <b>Recurrence after 3 months</b>    | 11 (35.48%)     | 1 (3.33%)        | 0.003   |
| <b>Recurrence after 6 months</b>    | 6 (19.35%)      | 7 (23.33%)       | 0.704   |

It is hypothesized that a small pleural vent would provide treatment as effectively as a traditional chest drain with lower pain and complication rates. The study demonstrated that compared with intercostal drainage, pleural vents were associated with a shorter duration of treatment, less pain, and less frequent need for surgery. Furthermore, the recurrence rate was lower after three months in patients treated via pleural vents.

There was no difference in BMI and weight reduction between both groups. Previous studies showed that patients with lower BMI had a higher risk of pneumothorax than those in the elevated BMI. Lower BMI affect connective tissue of these patients, so that explained weight reduction was associated with higher rates of spontaneous pneumothorax [11].

The use of a pleural vent for managing spontaneous pneumothorax was evaluated in a systematic review, which revealed an overall success rate of 85% in the 18 included studies, with a low complication rate [12]. Early reports have shown a high success rate of pleural vents in managing large secondary pneumothorax [13]. Knight and colleagues reported the safety of pleural vents in 26 patients and reported that pleural vents can be used with low complication rates [14]. Tsuchiya and associates reported lower medical expenses using a pleural vent, with no difference in complication rates compared to the conventional chest tube insertion [15]. However, large studies comparing the pleural vent to traditional treatment are limited. Roggla and colleagues reported no difference in the rates of lung expansion or complications between pleural vent drain and intercostal chest drain [16]. Walker and associates randomized 20 patients with secondary spontaneous pneumothorax to receive pleural vents and 20 to traditional chest drains [17]. The study reported no difference in the length of stay between the two groups; however, the pleural vents had early failure rates. This finding differs from what was reported in our study, where the duration of treatment and the need for surgical intervention were lower with the pleural vents compared to the chest tubes. Hillifax and colleagues conducted an open-label

randomized trial comparing ambulatory care (n=117) and standard care (n=119) for primary spontaneous pneumothorax [18]. They reported shorter hospitalization in patients with ambulatory care; however, these patients had more adverse events, including leakage, dislodgement, and enlarged pneumothorax. The main cause of the difference in our results compared with these studies was that we hospitalized the patients during the entire treatment period, and the management was under the healthcare provider's supervision.

The current study reported a high recurrence rate, especially in patients who received intercostal chest drains. The recurrence rate of spontaneous pneumothorax ranged between 20% and 55% during a 2-year follow-up period [19]. The high recurrence rate in our series could be attributed to the high prevalence of associated bullae and lung diseases. Furthermore, early recurrence may not present a true recurrence but rather a healing process [20,21]. Several factors could have affected recurrence, including the educational level of the patients, associated risk factors of these patients, recurrence occurring during chest tube removal, infected gaped wound, and associated bullae and lung disease. Patients with recurrence were smokers, with family history of pneumothorax, thin and inoperable. Those patients were managed medically because of their general conditions and the associated comorbidities. Similar to our study, Olesen and colleagues reported a high recurrence of pneumothorax after conservative management and intercostal chest tube insertion [22]. Therefore, risk scoring for detecting patients at high risk of recurrence could be used to select patients who can benefit from early intervention [10].

Patients in Group I required surgery more frequently. The indications of surgery were recurrent pneumothorax, empyema with thick pleural peel, failure of lung to expand after incentive physiotherapy and continuous air leak and deterioration of the general condition of the patient with development of surgical emphysema.

## Implications

The findings suggest that pleural vents may be a preferable first-line treatment for spontaneous pneumothorax, given the lower pain levels and reduced need for medications. With lower rates of surgery and recurrence, pleural vents could increase patient satisfaction and overall outcomes, potentially reducing healthcare costs associated with longer hospital stays and surgical interventions. This study could inform clinical guidelines and protocols for managing spontaneous pneumothorax, emphasizing pleural vents as a viable alternative. The results can serve as a basis for larger, multicenter studies to further validate the benefits of pleural vents in diverse populations.

## Study Limitation:

This study's relatively small sample size limits the generalizability of the findings. Larger studies are needed to confirm these results. Although outcomes were assessed at 1, 3, and 6 months, longer-term effects and complications were not evaluated, which could affect recurrence rates. Conducting the study in a single center may introduce bias and limit the applicability of the results to broader populations. Random assignment to groups does not eliminate potential biases in patient selection or treatment adherence, which could affect outcomes. The lack of blinding could have introduced subjective bias in pain reporting and patient satisfaction. The management of spontaneous pneumothorax may vary across institutions; thus, the findings may not apply to all clinical settings or regions.

## Conclusion

This study demonstrated that pleural vents for spontaneous pneumothorax offer significant advantages over traditional intercostal chest tube placement. Patients managed with pleural vents experienced markedly lower pain levels, reduced reliance on NSAIDs and narcotics, and shorter treatment durations. Additionally, the need for surgical intervention and recurrence rates were substantially lower in the pleural vent group. Therefore pleural vents may be a safer and more effective option for managing spontaneous pneumothorax, highlighting the need for further research to confirm these benefits.

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