Outcomes of using pleural vent for managing spontaneous pneumothorax

Ayman M. Shaalan[a,b], Abdulkareem Alhuthaifi[a,c], Eman E. Elwakeel[d], Tamer H. Ezeldin[b]

[a]Dallah Hospital, Cardiac Center, Riyadh, Saudi Arabia, Departments of [b]Cardiothoracic Department, Benha faculty of medicine, Benha, Egypt, [d]Anatomy and Embryology, Faculty of Medicine, Benha University, Benha, Egypt, [c]Department of Cardiology, Cardiac Center, Al Thawra Hospital, Sana, Yamen

Correspondence to Ayman M. Shaalan, MD, Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Benha, Egypt. E-mail: shalaanayman@yahoo.com

Received: 19 December 2022
Accepted: 1 January 2023
Published: 28 April 2023

The Egyptian Journal of Surgery 2023, 41:1707–1715

Background
The pleural vent is a minimally invasive, small-sized portable device that has been used successfully for management of spontaneous pneumothorax (SP). The use of pleural vent in such cases is still limited compared to the use of routine large chest tube connected to underwater seal.

Aim
To evaluate the long-term outcome and complications of using a pleural vent for the treatment of cases with SP.

Patients and methods
This was a 2-year retrospective cohort study that enrolled all patients who had pleural vents inserted either as an initial treatment after admission or after a period of observation.

Results
This study included 53 patients with SP who were managed by inserting pleural vent as a portable device. All patients completed their 2-year follow-up period. The outcomes comprised a significantly low recurrence rate within 6 months (7.5 vs. 92.5%), after 1 year (3.8 vs. 96.2%), and after 2 years (17.0 vs. 83.0%). Four (7.5%) patients required a change to the chest tube, and a significantly low percentage (5.7%) developed wound infections ($P<0.001$). The frequency of the use of narcotics (7.5%) analgesia was significantly low. Moreover, patient satisfaction was excellent.

Conclusions
The use of pleural vents for management of primary and secondary SP is well tolerated and safe and had low incidence of complications. Follow-up for 2 years after the pleural vent use showed low recurrence rates and better patient satisfaction.

Keywords:
complications, pleural vent, pneumothorax, recurrence

Egyptian J Surgery 41:1707–1715

1110-1121

Introduction

Pneumothorax involves accumulation of air in the pleural space and is categorized as traumatic, spontaneous, or iatrogenic. Spontaneous pneumothorax (SP) occurs without any injury (blunt or penetrating), medical intervention, or apparent precipitating factors. These kinds of patients may be primary or secondary. Primary spontaneous pneumothorax (PSP), typically occurs in young patients without known lung disease, whereas secondary spontaneous pneumothorax (SSP) is associated with preexisting lung diseases [1,2].

SSP is a critical medical illness, especially in cases with moderate to large pneumothorax where the underlying collapsed lungs had chronic lung disease including chronic obstructive pulmonary disease, interstitial lung disease, lung infections, lung cancer, and endometriosis [3]. SSP is more common than PSP, with worse outcomes involving a higher recurrence rate and frequent hospitalization, as well as higher morbidity and mortality [4,5].

There are various factors affecting the initial management of SP such as the patient's hemodynamic stability, size of pneumothorax, and possibility of recurrence. The management can be either conservative or definitive treatment that targets the resolution of manifestations and decrease the incidence of recurrences. The management includes needle aspiration, chest tube drainage connected to underwater seal, or surgical intervention [6]. Definitive surgical management in cases with PSP is indicated if there is persistent air leak

 DOI: 10.4103/ejs.ejs_314_22

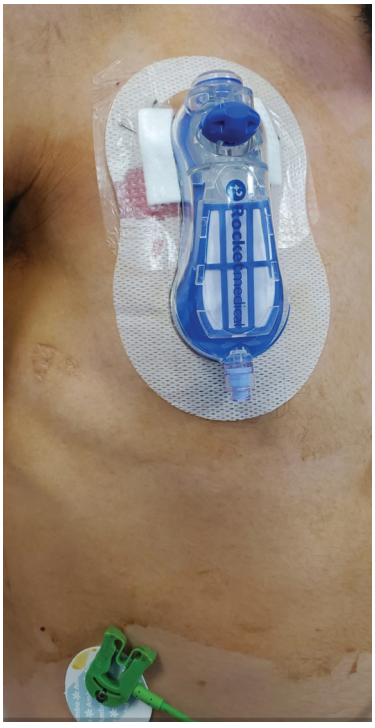
for more than 3–5 days or associated with surgical bleeding [7,8].

The standard insertion of a large chest tube connected to underwater seal requires regular inpatient admission and limited mobility as it usually has pain, which needs regular doses of analgesia. Because of all mentioned disadvantages, this technique has become less popular for treating PSP. Regarding other less-invasive techniques, ambulatory management can be achieved through insertion of a drainage catheter size (8 Fr) connected to a one-way flutter valve at the external end, in which the patient can mobilize freely without the need for large underwater seal chambers [9].

Earlier randomized clinical trials of portable devices in PSP have proved to decrease lengths of hospital stay [10,11]. Furthermore, successful ambulatory portable management modality for SSP has been also reported to reduce the hospital stay than the standard chest tube drainage [12,13].

Recently, the pleural vent has been reported as an option for ambulatory management of SP (Fig. 1). It is a minimally invasive, small-sized portable device that has been used successfully in several hospitals, with related economic benefits for the patients and hospitals [10,14,15]. However, few reports have addressed the long-term effectiveness and safety of the pleural vent.

Figure 1



Portable pleural vent inserted in second intercostal space.

Therefore, this study aimed to investigate the long-term therapeutic efficacy and complications of using a pleural vent for the treatment of PSP and secondary spontaneous pneumothorax (SSP).

Patients and methods

This study was a 2-year retrospective cohort study. Data of eligible patients presenting between the August 2019 and August 2021 were collected from patients' documents in the hospital. This study was carried out according to the approval of the Research Ethics Committee. Consent forms were signed by the participants, and the confidentiality of patients' data was preserved. We enrolled all patients who were managed through the insertion of a pleural vent either as an initial treatment after admission or after a period of observation when the amount of pneumothorax was diagnosed or increased to moderate. The study excluded children younger than 15 years old as well as patients with large to tension pneumothorax (defined by radiographic evidence of significantly increased intrapleural pressure causing hemodynamic compromise), moderate to large pleural effusion, hemodynamic instability, large lung bullae, trauma, or associated fracture ribs. Moreover, cases with multiple recurrent SPs, as well as cases discharged home with the vent for close observation were excluded. The patient's data were collected and recorded on a specially designed sheet. The collected data included demographic data; risk factors of pneumothorax; clinical presentation; radiological findings, including chest radiograph and computed tomography (CT) regarding the grade of pneumothorax and the presence of lung bullae, any lung disease, and the grade of pleural effusion; the patient's hemodynamics; and the primary management either conservative followed by a plural vent or initial management by the plural vent.

Follow-up data consisted of recurrence of pneumothorax within 6 months, after 1 year, and after 2 years; the need for chest tube insertion because of failure in lung inflation; the development of wound infection; postinsertion pain score that was assessed by the numerical 0–10 pain scale; the need for analgesia either NSAIDs and/or narcotics analgesics; and patient satisfaction, which ranged from poor, moderate, or excellent. Finally, the duration of the pleural vent (days) was calculated and recorded.

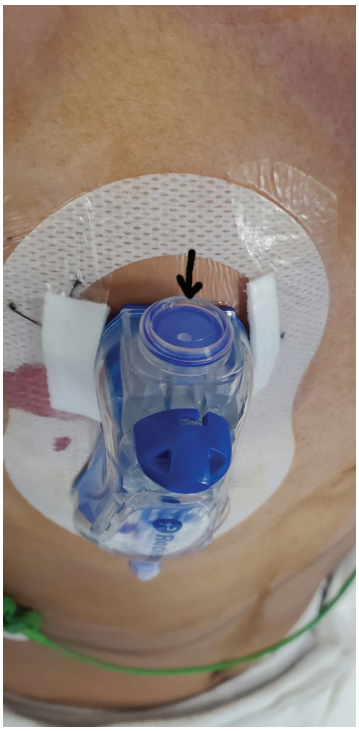
Surgical technique for insertion

The pleural vent is a new minimally invasive portable device consisting of an 8-Fr gauge polyurethane

catheter mounted on an 18-G needle connected to a plastic chamber containing a one-way valve. After consent was taken under complete aseptic technique, the patient was draped with exposure of the chest.

Less than 5-mm incision was made into the second intercostal space just lateral to the mid-clavicular line under local infiltration anesthesia. The pleural vent was inserted via an incision passed to the pleural cavity while suction to be maintained using a syringe 50 ml to ensure the safe entry and suction of free air. Moreover, 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, and then it was secured with adhesive dressing and sutures. The patency of the device was checked by the movement of the indicator diaphragm during respiration (Fig. 2). A chest radiograph was done 2 h to assess the improvement or any complications, as well plain CT chest to clarify the detailed anatomical findings (Figs 3 and 4). Follow-up was arranged and chest physiotherapy and the use of incentive spirometer were advised as the patient tolerated. Chest radiograph and plain CT chest were done to confirm full lung expansion and to assess the recurrence of pneumothorax during hospital visits.

Figure 2



Diaphragm denoting the air is going out (black arrow).

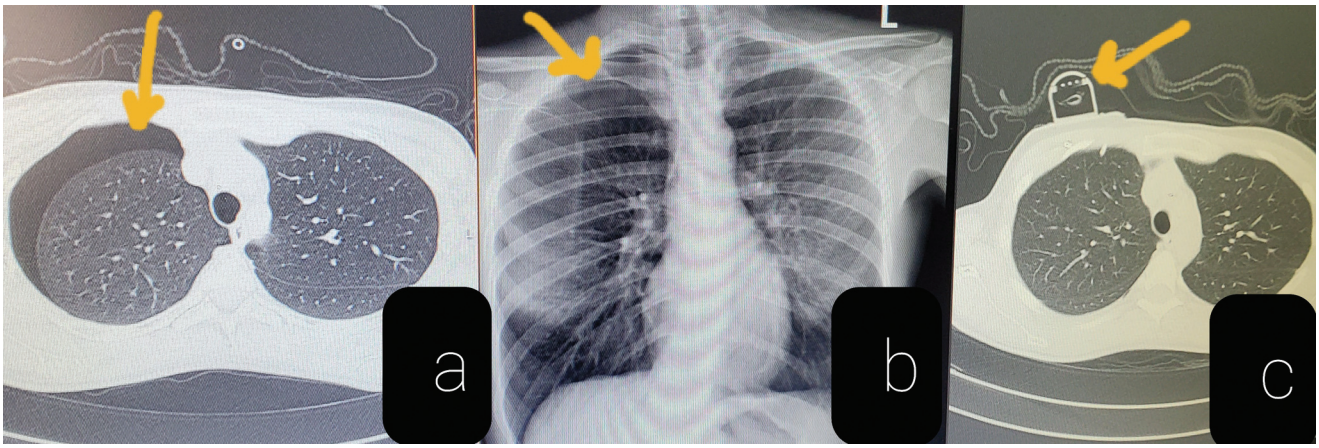
Statistical analysis

Analysis and presentation of data were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, Version 22.0. (SPSS Inc., Chicago, Illinois, USA). Categorical data were presented as numbers and percentages, whereas continuous data were tested for normality by the Shapiro–Wilk test. They were normally distributed and were expressed as mean±SD. The nonparametric χ^2 goodness-of-fit test was applied to find out any significant differences between the observed and the expected outcomes of using the plural vent. P value less than 0.05 was considered statistically significant.

Results

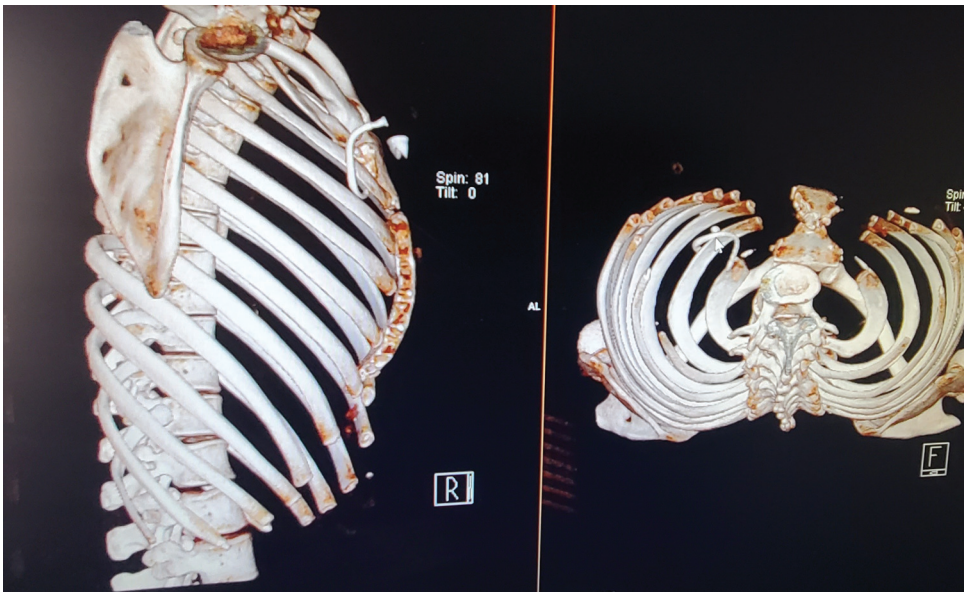
This study included 53 patients with a SP who were managed by inserting a pleural vent as a portable device. All patients completed their follow-up over a

Figure 3



(a) Plain CT chest showed moderate right side pneumothorax. (b) Chest radiograph for the same case with mild right-side pneumothorax. (c) Plain CT chest arrow denotes the devise and full lung expansion. CT, computed tomography.

Figure 4



Bone reconstruction images in lateral and caudal views showing the vent catheter passing in the second intercostal space.

period of 2 years (Fig. 1). Most of the patients (83.0%) were males, their mean of their age was 33.4±9.9 years, and their mean BMI was 24.8±6.5 kg/m^2 (Table 1).

Table 2 shows that four (7.5%) patients recorded a history of SP that resolved with conservative management, and 13 (24.5%) gave a positive family history of SP. Most (84.9%) of the patients were cigarette smokers, whereas 30.2 and 20.8% were vape and shisha smokers, respectively. A total of 13 (24.5%) patients undertook weight reduction surgery. Hypoalbuminemia and low vitamin D were recorded in 30.2 and 24.5%, respectively. Associated comorbidities included diabetes mellitus (15.1%), cardiac diseases (7.5%), and renal disorders (3.8%).

Concerning the characteristics of pneumothorax in the studied patients, patients either presented with dyspnea (56.6%) or pain (43.4%), and the right side of the chest was affected in 60.4% of the cases. Chest radiograph revealed either mild (26.4%) or moderate pneumothorax (73.6%), whereas the CT chest grade was more informative as it showed moderate pneumothorax in a higher percentage of patients (88.7%) and large in six (11.3%). Radiologic investigations revealed small and moderate lung bullae in five (9.4%) patients each and mild pleural effusion in six (11.3%) patients. A total of 34 (64.2%) cases had primary pneumothorax, whereas 35.8% had chronic obstructive pulmonary disease (secondary pneumothorax), which was documented through pulmonary function tests during hospital admission.

Table 1 Demographic characteristics of the studied patients

		N=53
Sex	Female [*n* (%)]	9 (17.0)
	Male [*n* (%)]	44 (83.0)
Age (years)	Minimum–maximum	15.0–51.0
	Mean±SD	33.4±9.9
BMI (kg/m^2)	Minimum–maximum	12.3–49.9
	Mean±SD	24.8±6.5

All patients (100.0%) were hemodynamically stable, and they were managed by inserting a pleural vent either as the first step (79.2%) or after a period of observation (20.8%) when the amount of pneumothorax increased to moderate instead of improving (Table 3).

The duration of the pleural vent ranged from 2 to 10 days till its removal, with a median of 3.0 [interquartile range (IQR): 3.0–4.0]. The outcomes comprised a significantly low recurrence rate within 6 months (7.5%), after 1 year (3.8%), and after 2 years (17.0%). Only four (7.5%) patients required chest tube insertion after failure of lung expansion after the pleural vent was inserted with a significant difference ($P<0.001$), and a significantly low percentage (5.7%) developed wound infections ($P<0.001$). Assessment of pain score after the vent insertion showed a median of 0.0 (IQR: 0–0), and the frequency of the need for NSAIDs was seen in nine (17%) cases and the need for narcotics analgesia in 7.5%,which was significantly low. Patient satisfaction

Table 2 Distribution of risk factors for pneumothorax among the studied patients

	N=53 [*n* (%)]
History of spontaneous pneumothorax	
No	49 (92.5)
Yes	4 (7.5)
Family history	
No	40 (75.5)
Yes	13 (24.5)
Cigarette smoking	
No	8 (15.1)
Yes	45 (84.9)
Shisha smoking	
No	42 (79.2)
Yes	11 (20.8)
Vape smoking	
No	37 (69.8)
Yes	16 (30.2)
Weight loss	
No	40 (75.5)
Yes	13 (24.5)
Weight reduction surgery	
No	40 (75.5)
Yes	13 (24.5)
Hypoalbuminemia	
No	37 (69.8)
Yes	16 (30.2)
Low vitamin D	
No	40 (75.5)
Yes	13 (24.5)
Other illness	
No	39 (73.6)
Diabetic	8 (15.1)
Cardiac	4 (7.5)
Renal	2 (3.8)

Table 3 Characteristics of pneumothorax in the studied patients

	N=53 [*n* (%)]
Presentation	
Dyspnea	30 (56.6)
Pain	23 (43.4)
Chest side affected	
Right	32 (60.4)
Left	21 (39.6)
Chest radiographevaluation	
Mild	14 (26.4)
Moderate	39 (73.6)
CT chest evaluation	
Large	6 (11.3)
Moderate	47 (88.7)
Lung bullae(presence)	
No	43 (81.1)
Small	5 (9.4)
Moderate	5 (9.4)
COPD	
No	34 (64.2)
Yes	19 (35.8)
Mild pleural effusion	
No	47 (88.7)
Yes	6 (11.3)
Hemodynamics	
Stable	53 (100.0)
Primary management	
Observation first then insertion of pleural vent	11 (20.8)
Pleural vent t as the first presentation	42 (79.2)

COPD, chronic obstructive pulmonary disease; CT, computed tomography.

was excellent in 75.5%, good in 17.0%, and poor in 7.5%, with a significant difference ($P<0.001$) (Table 4 and Figs 5 and 6).

Table 5 shows the frequency of recurrence and change to chest tube after using the pleural vent according to the radiologic grade using CT scan and according to the type of SP either primary or secondary. Patients with moderate pneumothorax displayed a significantly low incidence of recurrence within 6 months (8.5%), after 1 year (2.1%), and after 2 years (14.9%) as well as a significantly low incidence of the need to change the vent to chest tube connected to underwater seal (6.4%). Regarding patients with a large pneumothorax, they showed no recurrence within 6 months, recurrence in one (16.7%) case after 1 year, and recurrence in two (33.3%) cases after 2 years, and only one (16.7%) patient of large pneumothorax required to change the portable devise to a routinely used chest tube. Regarding the type of pneumothorax, the recurrence rates within 6 months, after 1 year, and after 2 years, and the rates of change to a chest tube were significantly low among this group (5.9, 2.9, 17.6, and 5.9%, respectively) as well as patients with secondary pneumothorax (10.5, 5.3, 15.8, and 10.5%, respectively).

Discussion

Pneumothorax is a common respiratory disorder, with an incidence of nearly 40.7 in men and 15.6 in women per 100 000 [12]. Nevertheless, there are considerable differences in the guidelines for treating pneumothorax, with no clear agreement for optimum management. Consequently, there is an observed geographical variation in clinical practice [16].

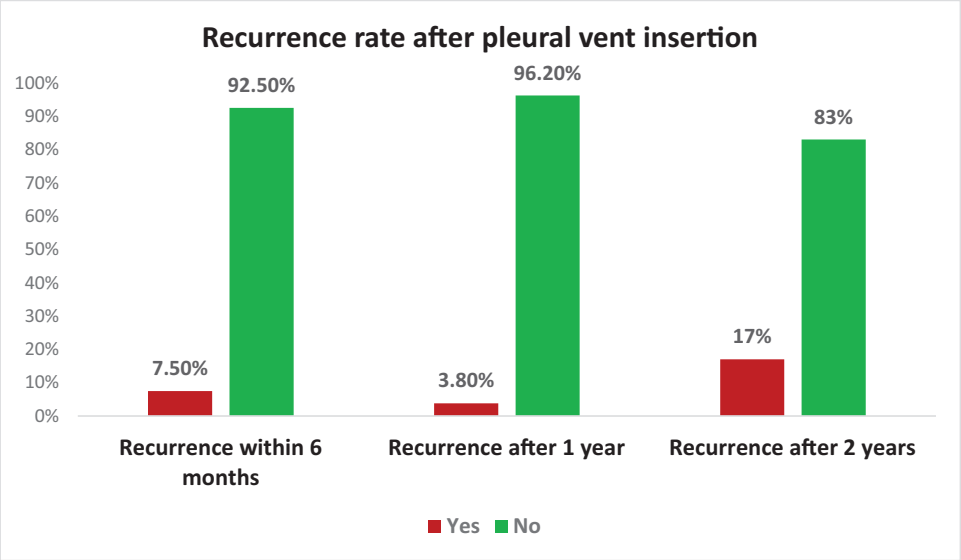
Ambulatory device for pneumothorax management has been described for 40 years and recommended in the 2010 British Society pleural guidelines. There is some evidence to support the use of ambulatory portable devices in PSP. However, the evidence to treat SSP in

Table 4 Outcomes of using a pleural vent for managing spontaneous pneumothorax

	N=53 [*n* (%)]	The χ^2 goodness-of-fit test *P* value
Recurrence within 6 months		
No	49 (92.5)	<0.001*
Yes	4 (7.5)	
Recurrence after 1 year		
No	51 (96.2)	<0.001*
Yes	2 (3.8)	
Recurrence after 2 years		
No	44 (83.0)	<0.001*
Yes	9 (17.0)	
Change to chest tube after the first vent was inserted		
No	49 (92.5)	<0.001*
Yes	4 (7.5)	
Wound infection		
No	50 (94.3)	<0.001*
Yes	3 (5.7)	
Need for NSAIDs		
No	44 (83.0)	<0.001*
Yes	9 (17.0)	
Need for narcotics		
No	49 (92.5)	<0.001*
Yes	4 (7.5)	
Pain score postinsertion		
Minimum–maximum	0.0–0.6	–
Median (IQR)	0.0 (0.0–0.0)	
Duration of pleural vent/days		
Minimum–maximum	2.0–10.0	–
Median (IQR)	3.0 (3.0–4.0)	
Patient satisfaction		
Excellent	40 (75.5)	<0.001*
Good	9 (17.0)	
Poor	4 (7.5)	

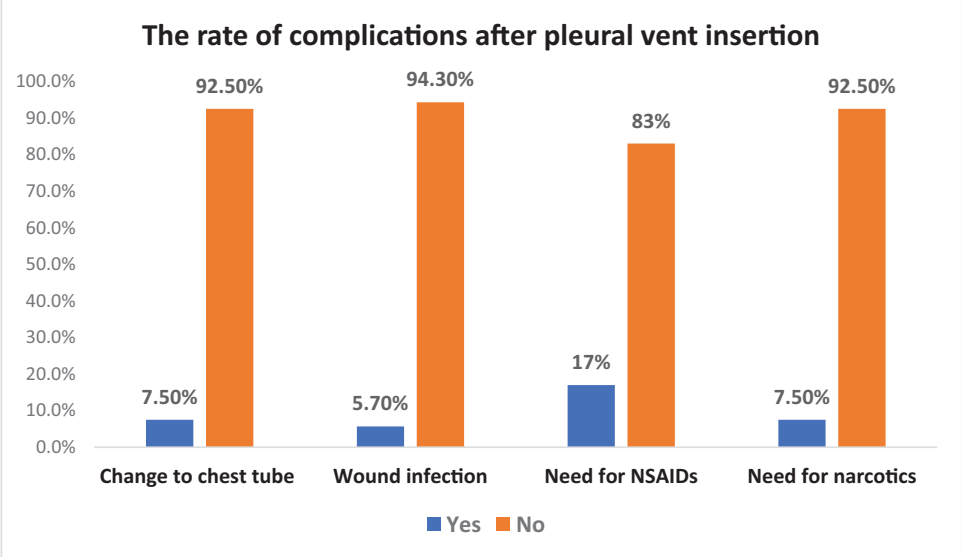
IQR, interquartile range. *Significant at *P* value less than 0.05.

Figure 5



The recurrence rates within 6 months, after 1 year, and after 2 years of follow-up.

Figure 6



The incidence of complications after pleural vent insertion.

Table 5 The frequency of recurrence and change to chest tube after using the pleural vent according to the radiologic grade and the type of spontaneous pneumothorax

	Recurrence within 6 months		Recurrence after 1 year		Recurrence after 2 years		Change to chest tube	
	No	Yes	No	Yes	No	Yes	No	Yes
Radiologic grade (CT)								
Moderate (*N*=47) [*n* (%)]	43 (91.5)	4a* (8.5)	46 (97.9)	1a* (2.1)	40 (85.1)	7a* (14.9)	44 (93.6)	3a* (6.4)
Large (*N*=6) [*n* (%)]	6 (100.0)	0[NA]	5 (83.3)	1b (16.7)	4 (66.7)	2 [b] (33.3)	5 (83.3)	1b (16.7)
Type of pneumothorax								
Primary (*N*=34) [*n* (%)]	32 (94.1)	2a* (5.9)	33 (97.1)	1a* (2.9)	28 (82.4)	6a* (17.6)	32 (94.1)	2a* (5.9)
Secondary (*N*=19) [*n* (%)]	17 (89.5)	2c* (10.5)	18 (94.7)	1a* (5.3)	16 (84.2)	3c* (15.8)	17 (89.5)	2c* (10.5)

CT, computed tomography. [a]*P* value less than 0.001. [b]*P* value more than 0.05. [c]*P* value=0.001. *Significant at *P* value less than 0.05.

end-stage lung disease with ambulatory devices is limited [12,17].

The pleural vent is a thoracic decompression device that has the advantages of lightweight, having a self-contained drain and valve, and lacking the lengthy tubing and underwater seal systems. The use of pleural vent allows patients to be managed on an outpatient basis with reduced hospital stays and the associated health care costs. Moreover, it enables early mobilization and patient comfort.

The current study described the local experience of using the pleural vent for the treatment of SSP and PSP for future generalizable applicability. This study showed the long-term efficacy of pleural vents for managing patients with primary and secondary pneumothorax of either moderate or large grade. The use of plural vent was associated with a significantly low recurrence rate within 6 months, after 1 year, and after 2 years from the initial discharge (7.5, 3.8, and 17.0%, respectively), and only four (7.5%) patients required a change to the chest tube after the first vent was inserted. There was also a low incidence of complications in the form of wound infections (5.7%). Furthermore, the device was well tolerated with a median postinsertion pain score of 0.0 (IQR: 0–0), and the frequency of using the NSAIDs (17.0%) and the narcotics (7.5%) analgesia was significantly low. Hence, a high percentage of the studied patients showed excellent (75.5%) and good (17.0%) satisfaction, whereas 7.5% showed poor satisfaction.

Previous research showed that the pleural vent was effective with full lung re-expansion in 90% of 10 patients (four were PSP and six were SSP) who were treated with a pleural vent. The device was blocked in only one case that required conversion to a chest drain insertion [18]. Furthermore, Masih *et al.*

[19] reported the successful use of the plural vent for managing two cases having secondary pneumothorax with full lung expansion and healing of the air leak that persisted despite the initial conventional treatment with chest drain has been reported. A 2-year audit into the management of pleural disease supported the use of pleural vents in the management of spontaneous and iatrogenic pneumothorax of less than 5 cm [20]. Ball *et al*. [21] recently concluded that the pleural vent is a safe and effective compared with routinely inserted chest tube for the management of CT-guided biopsy-related pneumothorax.

An open-label multicenter randomized clinical trial study has shown successful management of PSP with an ambulatory device with significantly short hospitalization days and recurrence rate, but there was a higher rate of treatment-related serious adverse events in the ambulatory device group than the standard aspiration or chest tube drainage group (55 vs. 39%, *P*=0.013). These adverse events included enlarging pneumothorax, asymptomatic pulmonary edema, and the device malfunctioning, leaking, or dislodging [22].

The duration of the pleural vent in the present study ranged from 2 to 10 days, with a median of 3 days. A corresponding study that retrospectively analyzed the outcomes of 49 patients with pneumothorax treated with the pleural vent revealed a mean duration of pleural vent in situ in all patients of 5.6 days and a complication rate of 18.3% [23].

In the present study, the recurrence rate was much higher after 2 years from the initial resolution of pneumothorax (17.0%), but this is lower than the previously reported recurrence rates for SP that ranged between 21 and 54% with 1–2 years [24]. It has been reported that the risk of recurrence is increased with the persistent conservative treatment of the subsequent pneumothorax incidents, and therefore, invasive interventions for pneumothorax are highly recommended after the first recurrence [25]. Moreover, risk stratification at presentation could help to manage cases at a higher risk of recurrence and who could benefit from early intervention to avoid recurrence [26].The recurrence rate within 6 months in this study was significantly low (7.5%). The occurrence of pneumothorax within 30 days should not be a true recurrence as it can be a healing process [27]. Furthermore, Brophy *et al*. [28] have proved that cases with postoperative recurrence within 30 days showed a better prognosis than cases with delayed recurrent episodes.

The studied cohort showed a high prevalence of cigarette (84.9%), vape (30.2%), and shisha (20.8%) smoking. Essentially, several risk factors as well the prevalence of weight loss and associated malnutritional status with hypovitaminosis D all were risks for developing SP; however, smoking was the one most strongly associated [29].

Limitations

The present study is limited by being retrospective, which carries selection bias, with no control arm representing the local standard conventional interventions for pneumothorax. The small number of cases is another limitation that is attributed to the current surgeon's preference for chest tube insertion and the insufficient orientation of the promising role of the pleural vent in suitable patients. Cases that were discharged home with the devise were not included in this study. We recommend a prospective trial to compare the pleural vent treatment with other treatment options.

Conclusion

The use of pleural vents for management of PSP and SSP is well tolerated, is safe, has low pain score, and is associated with a low incidence of complications. Follow-up for 2 years after the pleural vent use showed low recurrence rates with excellent patient satisfaction.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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