

# Aetiology, clinical profile and management outcome of pneumothorax patients: A prospective study from Central India

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## ABSTRACT

**Background:** Pneumothorax (PT) is defined as the presence of air in the pleural cavity. Primary spontaneous pneumothorax (PSP) arises in an otherwise healthy person without any underlying lung disease. PSP occurs in people aged 20 to 30 years, with a peak incidence in the early twenties. The recurrence rate in spontaneous PT patients is approximately 10%–20%. In the present study, 50 cases of spontaneous PT were undertaken with an aim to analyse aetiology, clinical profile and management outcome of PT patients. **Materials and Methods:** The present study was conducted for a period of 12 months, among 50 patients presenting with unilateral PT. The therapeutic interventions were indicated when there was a loss of volume of lungs of 32% or more, and this loss of volume was calculated using Collins method. The association between the side of PT, smoking status and size of PT were found using the Chi-square test, and the association between variables were considered significant if the *P* value was <0.05. **Results:** In the present study, the male patients were 92.0% and only 8.0% of patients were females. The further history-taking of patients had shown that the mode of onset of PT was sudden in 72.0% of patients. Although the success rate of Intracath procedure was lower in comparison with the intercostal drainage (ICD) procedure, the complication rate of Intracath was lower when compared with extensive subcutaneous. **Conclusion:** PSP is less common than secondary spontaneous PT. Smoking is an independent risk factor for PT, and it delays its resorption.

**Keywords:** Chest pain, iatrogenic, pneumothorax, smoking, spontaneous

## Introduction

Pneumothorax (PT) is characterised by the presence of air in the pleural cavity, which normally contains a small amount of lubricating fluid. The clinical manifestations of PT depend on the extent of lung collapse on the affected side, ranging from mild chest pain to severe breathlessness.<sup>[1]</sup>

Primary spontaneous pneumothorax (PSP) occurs in otherwise healthy individuals without underlying lung disease, typically affecting people between the ages of 20 and 30, with a peak incidence in the early twenties. The occurrence of PSP in individuals older than 40 years is rare. The age-adjusted incidence of PSP is 7.4 cases per 100,000 persons per year in men and 1.2 cases per 100,000 persons per year in women.<sup>[2,3]</sup>

On the other hand, secondary spontaneous pneumothorax (SSP) occurs in individuals with underlying lung disease. In some cases, the air accumulation in the chest increases significantly due to the formation of a one-way valve by damaged tissue, leading

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to tension PT. The incidence of SSP after adjusting for age is 6.3 cases per 100,000 persons per year in men and 2.0 cases per 100,000 persons per year in women.<sup>[4,5]</sup>

Although PT can resolve spontaneously, it often requires intervention such as needle aspiration or intercostal tube drainage. The recurrence rate in patients with spontaneous PT is approximately 10%–20%.<sup>[6]</sup> It is important to investigate any underlying causes of spontaneous PT to prevent recurrence.

Primary care physicians play a crucial role in the early recognition, diagnosis and management of various medical conditions, including PT. Understanding the aetiology, clinical profile and management outcomes of PT patients is essential for primary care physicians, as it allows for timely diagnosis, appropriate referral and effective coordination of care with specialists. In this study, we aim to provide valuable insights into the management of PT patients, thereby enhancing the knowledge and practice of primary care physicians and family physicians. In the present series, a study on 50 cases of spontaneous PT was undertaken with an aim to analyse the aetiology, clinical profile and management outcome of PT patients.

## Materials and Methods

### Study design and study subjects

The present study was hospital-based prospective study, which was conducted for a period of 12 months from July 2019 to June 2020, among 50 patients (>14 years of age) presenting with unilateral PT (both spontaneous and traumatic) in the emergency ward or outpatient department (OPD) of Respiratory Medicine Department of Government Hospital. This study was prior approved by the Institutional Ethical Review Board of our hospital (Approval Letter No. IERC/MIMS/2019/03/212). Patients who were pregnant were excluded from the study.

### Procedure

The therapeutic interventions were indicated when there was a loss of volume of lungs of 32% or more, and this loss of volume was calculated using the Collins method [ $\% = 4.2 + 4.7(A + B + C)$ ], where A is apex to apex lung, B is midpoint upper half, C is midpoint lower half and this is where the sum of the intrapleural distance (A + B + C) is greater than 6 cm and corresponds to a loss of volume of 32% or more.<sup>[6]</sup> Among them, patients with loss of volume <32% were treated conservatively (simple observation and avoidance of strenuous activities or supplementation of oxygen) and for patients with loss of volume of 32% or more, therapeutic interventions were used [Intracath insertion with underwater seal or Chest tube drainage (Valve/Under water seal)]. The patients were followed up for any complications and were treated accordingly.

### Data collection

A predesigned and pretested study questionnaire used for the data collection included sociodemographic details (gender,

age and smoking status), clinical symptoms and characteristics of PT (mode of onset, type, side involved, activity at time of onset and repetition). The radiological and microbiological investigations were done to find the aetiology of spontaneous PT. The severity of PT was defined using British Thoracic Society (BTS) guidelines (2010) where if the distance measured from chest wall to lung edge at the level of the hilum is <2 cm then PT is of small size and  $\geq 2$  cm then PT is of large size.

### Statistical analysis

The collected data was entered in the MS Excel sheet and analysis of data was carried out using the same. The qualitative data was presented as mean and standard deviation (SD) and qualitative data was presented as frequency and percentage (%). The association between side of PT, smoking status and size of PT were found using the Chi-square test, and the association between variables were considered significant if the *P* value was <0.05.

### Ethical consideration

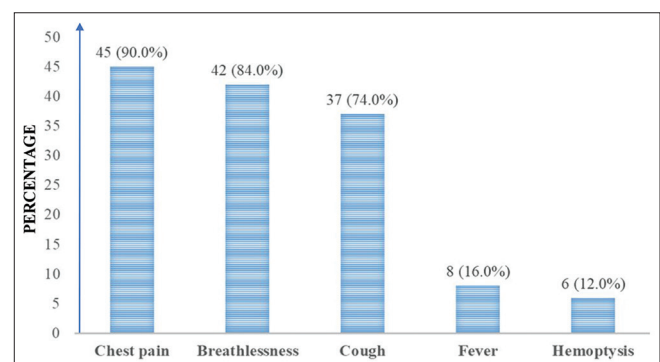
Ethical approval was obtained from the Mahaveer Institute of Medical Sciences Institutional Ethical Committee, Bhopal (Approval Letter No. MIS/IEC/27/2019). Written informed consent from the elderly was obtained and anonymity and confidentiality of the participants was maintained throughout the study.

## Results

In present study, the male patients were 92.0% and only 8.0% of patients were females. The peak incidence of PT was in the 3<sup>rd</sup> (22.0%) and 4<sup>th</sup> (22.0%) decade of life. The youngest case was 18-year-old male patient while the oldest case was a 78-year-old male patient. Furthermore, 60.0% of patients were smokers [Table 1].

Chest pain was the most common presenting complaint or symptoms among patients with PT (90.0%), followed by breathlessness (84.0%) and cough (74.0%). Among 12.0% of patients, the hemoptysis was presenting complaint [Figure 1].

The further history taking of patients had shown that the mode of onset of PT was sudden in 72.0% of patients. Among 26.0%



**Figure 1:** Clinical symptoms among subjects with pneumothorax (*n*=50)

of patient the PT was primary in origin and in 10.0% of patients the PT was traumatic in nature. The side of PT was right in 56.0% of patients. In addition, 56.0% patient said that they were resting at the time of onset of PT and 16.0% of patients were doing hard work at the time of onset of PT. The history of recurrence of PT was observed in 4.0% of subjects [Table 2].

The further investigations for aetiology of spontaneous PT of secondary in nature showed that among 15.6% of patients, the PT was due to smear positive active Pulmonary Tuberculosis (PTB), among 53.1% of patients the chronic obstructive pulmonary disease (COPD) including emphysema was the cause for secondary PT [Figure 2].

The radiological quantification of PT showed that among 16.0% of patients, the PT was of small size and among 84.0% of patients, the PT was of large size. The contralateral shift of mediastinum was observed among 62.0% of patients [Table 3].

In total, Intracath insertion with underwater seal procedure was indicated in 44 patients with PT, but such procedure was successful in improving the condition among 29.5% of patients (13/44). Similarly, in total, the intercostal drainage [ICD] (Valve/Underwater seal) was indicated among those the Intracath insertion with underwater seal procedure was unsuccessful and the ICD procedure was successful in improving the patient condition among 94.6% (35/37) [Figure 3].

Further analysis showed that among patients with PSP, the size of PT was small and large in 15.4% and 84.6% of patients, respectively, and among all those patients (100.0%), the Intracath insertion with underwater seal was attempted and among those not responding, the ICD (Valve/Underwater seal) was attempted, i.e., 69.2% of patients. Similarly, among patients with SSP due to active PTB, the size of PT was small and large in 16.7% and 83.3% of patients, respectively, and among all those patients (100.0%), the Intracath insertion with underwater seal was attempted and among those not responding, the ICD (Valve/Underwater seal) was attempted, i.e., 66.7% of patients [Table 4].

Although the success rate of Intracath procedure was lower in comparison with ICD procedure, but the complication rate

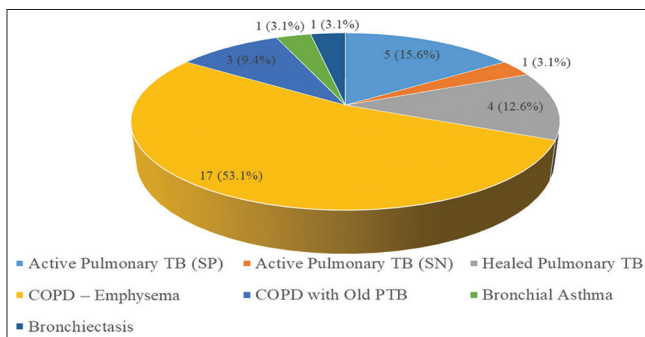
of Intracath (extensive subcutaneous emphysema: 2.3% and nil cases for hydropneumothorax) was lower when compared with ICD extensive subcutaneous emphysema: 2.3% and hydropneumothorax: 13.5%). The reason behind this could be

**Table 1: Baseline characteristics of the study subjects (n=50)**

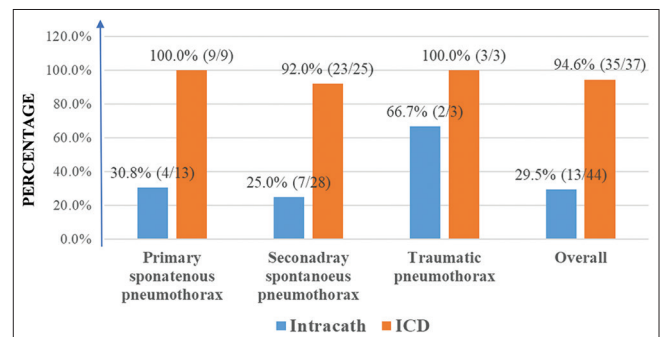
Variables	Frequency	Percentage
Age (in years)		
11–20	02	4.0
21–30	10	20.0
31–40	11	22.0
41–50	11	22.0
51–60	09	18.0
61–70	06	12.0
71–80	01	2.0
Gender		
Male	46	92.0
Female	04	8.0
Smoking		
Smoker	30	60.0
Nonsmoker	20	40.0

**Table 2: Aetiological characteristics of the pneumothorax among study subjects (n=50)**

Variables	Frequency	Percentage
Mode of onset		
Sudden	36	72.0
Insidious	14	28.0
Type of pneumothorax		
Primary spontaneous	13	26.0
Secondary spontaneous	32	64.0
Traumatic	5	10.0
Side of pneumothorax		
Right	28	56.0
Left	22	44.0
Activity at time of onset		
Rest	28	56.0
Light Work	14	28.0
Heavy Work	08	16.0
Repetition of pneumothorax		
1 <sup>st</sup> time	48	96.0
Recurrence	02	4.0



**Figure 2: Aetiology of secondary spontaneous pneumothorax among study subjects (n = 32)**



**Figure 3: Success rate for the procedures performed for various types of pneumothorax among subjects**

as ICD procedure was successful in improving patient condition, so was sustained for longer period while Intracath was used successful in lesser number of patients so was sustained for lesser duration or period [Figure 4].

Although the large sized PT was noticed on right side (54.8%) as compared with left side (45.2%), and more among smokers (59.5%) as compared with nonsmokers (40.5%), during Chi-square analysis such association between size of PT and side or smoking status was found to be nonsignificant ( $P > 0.05$ ) [Table 5].

### Discussion

In our study, the peak incidence of spontaneous PT was in the age group of 31–50 years (44.0%), but in studies by Boghani *et al.*, (42.0%) and Janmeja *et al.*, (42.0%) they reported highest occurrence in 21–30 years of age group, whereas in the study by Khan *et al.* (37.0%), it was in 11–20 years of group.<sup>[7-9]</sup>

In our study, the incidence of spontaneous PT was more in male (92.0%) as compared with female (8.0%), which was similar to the studies by Faruqi *et al.*, Gupta *et al.* and Khan *et al.*, where affected males were 96.0%, 84.0% and 64.0%, respectively.<sup>[10-12]</sup> But, in the study by Bobbio *et al.*, there was no statistical difference between men and women with PT.<sup>[13]</sup>

In our study, the common presenting symptoms was chest pain (90.0%), which is similar with studies by Faruqi *et al.*, Gupta *et al.* and Sousa *et al.*, 93.0%, 83.0% and 90.0% patients had chest pain respectively.<sup>[10,11,14]</sup> In present study, 84.0% of patients had breathlessness which is similar with studies by

Faruqi *et al.*, Gupta *et al.* and Sousa *et al.*, where 84.0%, 91.0% and 81.0% of patients had breathlessness, respectively.<sup>[10,11,14]</sup> But, in the study by Gayatrivedi *et al.*, dyspnoea was the most common symptom seen in 90% patients followed by pleuritic chest pain (86%).<sup>[15]</sup>

In present study, the onset of PT was sudden in 72.0%, whereas in 28.0% it was insidious, whereas it was 77.0%, 51.0% and 89.0% in studies of Boghani *et al.*, Sousa *et al.* and Mendis *et al.*, respectively.<sup>[7,14,16]</sup>

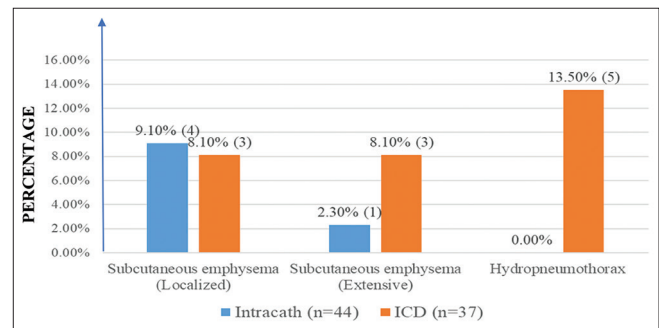
In present study, PT was more common in smoker (60.0%) than nonsmoker (40.0%). Other studies of Gupta *et al.*, (52.0%) Mendis *et al.*, (66.0%) and Noppen *et al.*, (71.0%) also revealed higher incidence of PT in smokers.<sup>[11,16,17]</sup> Cigarette smoking is associated with the pathophysiological consequences of extensive respiratory bronchiolitis, which had a significant impact on the incidence rates of spontaneous PT.<sup>[18,19]</sup>

In present study, PT was more common on right side (56.0%), which was similar to the studies of Khan *et al.*, Gupta *et al.* and Noppen *et al.*, where 56.0%, 60.0% and 62.0% of patients had right-sided, respectively.<sup>[9,11,17]</sup>

In present study, on radiological quantification, large-size PT (84.0%) was more common than small-size PT (16.0%), whereas in Khan *et al.* and Sharma *et al.*, studies the large size PT were 49.0% and 65.0%, respectively.<sup>[9,20]</sup>

**Table 3: Radiological characteristics of the pneumothorax among study subjects (n=50)**

Chest X-ray findings	Frequency	Percentage
Radiological quantification of pneumothorax		
Small	08	16.0
Large	42	84.0
Contralateral mediastinal shift		
Present	31	62.0
Absent	19	38.0



**Figure 4: Complications related to procedures performed for the pneumothorax among subjects**

**Table 4: Severity of pneumothorax and treatment procedure performed based on aetiology of pneumothorax (n=50)**

Type of pneumothorax	Frequency (%)			
	Size of pneumothorax		Procedure used	
	Small (n=8)	Large (n=42)	Intracath (n=44)	ICD (n=37)
Primary Spontaneous (n=13)	2 (15.4)	11 (84.6)	13 (100.0)	09 (69.2)
Active Pulmonary TB (n=6)	1 (16.7)	5 (83.3)	6 (100.0)	4 (66.7)
Healed Pulmonary TB (n=4)	1 (25.0)	3 (75.0)	4 (100.0)	3 (75.0)
COPD-Emphysema (n=17)	1 (5.9)	16 (94.1)	15 (88.2)	14 (82.4)
COPD with Old PTB (n=3)	0 (0.0)	3 (100.0)	1 (33.3)	3 (100.0)
Bronchial Asthma (n=1)	1 (100.0)	0 (0.0)	1 (100.0)	0 (0.0)
Bronchiectasis (n=1)	0 (0.0)	1 (100.0)	1 (100.0)	1 (100.0)
Traumatic Iatrogenic (n=3)	2 (66.7)	1 (33.3)	3 (100.0)	1 (33.3)
Traumatic Noniatrogenic (n=2)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)

**Table 5: Association of severity of pneumothorax with the baseline characteristics of the subject (n=50)**

Variables	Size of pneumothorax frequency (%)		P
	Small (n=8)	Large (n=42)	
Side			
Right (n=28)	5 (62.5)	23 (54.8)	0.686
Left (n=22)	3 (37.5)	19 (45.2)	
Smoking			
Yes (n=30)	5 (62.5)	25 (59.5)	0.874

In present study, 26.0% patients had PSP, which is similar to the studies by Janmeja *et al.*, Khan *et al.* and Khan *et al.*, where 34.0%, 20.0% and 22.0% patients had PSP, respectively.<sup>[8,9,12]</sup>

In present study, 64.0% patients had SSP, which is similar to the studies by Janmeja *et al.*, Khan *et al.* and Khan *et al.*, where 66.0%, 68.0% and 64.0% of patients had SSP, respectively.<sup>[8,9,12]</sup> In present study, incidence of traumatic PT was 10.0%, whereas in studies by Khan *et al.* and Khan *et al.*, it was 12.0% and 14.0%, respectively.<sup>[9,12]</sup>

In present study, COPD-emphysema (53.1%) and pulmonary TB (31.3%) were the most common underlying aetiology for PT, whereas studies by Janmeja *et al.*, Khan *et al.* and Gupta *et al.*, demonstrated pulmonary tuberculosis as a dominant aetiology among 36.0%, 37.0% and 42.0% of patients, respectively.<sup>[8,11,12]</sup> Studies by Janmeja *et al.*, Khan *et al.* and Gupta *et al.*, demonstrated pneumonia as a second common aetiology among 16.0%, 14.0% and 25.0% of patients, respectively.<sup>[8,11,12]</sup> In countries where TB is prevalent and HIV is growing, spontaneous PT will become an increasingly common pathological condition and a cause of respiratory distress.<sup>[21]</sup>

In present study, cumulative success rate of intracath insertion was 29.5%, whereas in studies by Faruqi *et al.*, Gupta *et al.* and Parlak *et al.*, it was 62.9%, 90.0% and 68.0%, respectively.<sup>[10,11,22]</sup> In present study, cumulative success rate of ICD insertion was 94.5%, which is similar to the studies by Faruqi *et al.*, Gupta *et al.* and Parlak *et al.*, it was 84.2%, 93.75% and 80.6%, respectively.<sup>[10,11,22]</sup> Studies have shown that, conservative management resulted in a lower risk of serious adverse events or PT recurrence than interventional management.<sup>[23,24]</sup>

In our study, interventional procedure (both ICD and Intracath)-related subcutaneous emphysema (localised and extensive) occurred in 32% patients, that is similar to the study done by Gupta *et al.*, where interventional procedure-related subcutaneous emphysema was 28.0%, whereas study by Janmeja *et al.*, has reported its incidence as 8.0%.<sup>[8,11]</sup>

Pathophysiological mechanisms underlying PT are now better understood and this may have implications for clinical management.<sup>[25]</sup> Risk stratification of patients at baseline could help to identify subgroups at higher risk of recurrent PT who would benefit from early intervention to prevent recurrence.<sup>[26,27]</sup>

Further research into the roles of conservative management, Heimlich valves, digital air-leak monitoring and pleurodesis at first presentation might lead to an increase in their use in the future.<sup>[28-30]</sup>

By being aware of the different aetiologies, such as spontaneous PT, traumatic PT and iatrogenic PT, primary care physicians can better assess patients' medical history, guide preventive measures and provide appropriate counselling. Familiarity with the clinical profile of PT, including associated signs, symptoms and physical examination findings, enables primary care physicians to promptly recognise and differentiate PT from other respiratory conditions. This knowledge aids in the accurate triaging of patients and facilitates timely referrals to specialists. Although the immediate management of PT often involves chest tube placement or other invasive procedures performed by specialists, primary care physicians play a vital role in the long-term management and follow-up of PT patients. Understanding the different treatment options, including observation, aspiration and surgical intervention, allows primary care physicians to engage in shared decision-making discussions with patients, ensuring informed choices aligned with patients' preferences and clinical indications. Moreover, primary care physicians can play a pivotal role in posttreatment surveillance, addressing patient concerns and facilitating appropriate referrals for rehabilitation or pulmonary rehabilitation services.

## Limitations

Although our study was prospective in nature but due to limited duration of study (1 year), we were not able to do long-term follow-up, so the recurrence rate of PT among operated cases can be derived and can be considered as the limitation of the study. Also, we have not included cases with bilateral PT, so outcomes of unilateral cases with PT could be not be generalised.

## Conclusion

PSP is less common than SSP. Smoking is an independent risk factor for PT, and it delays its resorption. Large size PT is found to have in smoker patients. Complications of Intracath insertion and ICD intervention are mild and mostly self-limiting. Intracath insertion with under water seal is an efficient PT relieving intervention, especially for primary spontaneous and iatrogenic PT. Duration of interventional aspirating measures is longer for SSP. Speedy resolution of PT mostly found with small size as compared with large size PT. As frontline healthcare providers, primary care physicians and family physicians play a vital role in the recognition, diagnosis and management of PT. This paper provides valuable insights into the aetiology, clinical profile and management outcomes of PT patients, with implications for primary care practice. By incorporating these findings into their clinical decision-making, primary care physicians can enhance patient care, improve diagnostic accuracy and optimise referral and management strategies, ultimately leading to better patient outcomes.

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## Conflicts of interest

There are no conflicts of interest.

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