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Pneumomediastinum: Experience with 87 Patients

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Abstract

Objective. The aim of the present series was first to present our experience in the management of 37 patients with spontaneous pneumomediastinum (SPM), and further to indicate the necessity of identifying true SPM cases as they are currently inadequately defined. **Methods.** This is a single-center, retrospective study, conducted in a university hospital. Consecutive adult patients with pneumomediastinum (PM) between January 2009 and March 2020 were involved in the series. The data about age, gender, symptoms, signs, treatment, length of hospital stay (LOS), and in-hospital mortality were evaluated. **Results.** In total, 87 cases with pneumomediastinum (37 with spontaneous and 50 with secondary PM) were analyzed. Patients in both groups were of similar ages (P=0.4). Sufferers with secondary PM were more likely to have: an associated pneumothorax (19% vs 58%, P<0.05), a chest tube placed (18.9% vs 58%, P<0.05), an associated pleural effusion (0% vs 18%, P<0.05). They presented with a longer LOS (3.9 vs 5.3 days, P<0.05), and were more likely to die (0% vs 10%, P<0.05). Additionally they showed a higher prevalence of radiologic subcutaneous emphysema (49% vs 74%, P<0.05). **Conclusion.** Spontaneous pneumomediastinum is an onset of clinical importance with a low mortality rate, short LOS and good longterm prognosis. It often presents with chest pain, dyspnea and/or subcutaneous emphysema. However, secondary causes of mediastinal air must be ruled out, due to their potential devastating outcome if not diagnosed promptly. A consensus aimed at an update of the classification guidelines is more than indispensable.

Key Words: Pneumomediastinum ▪ Spontaneous vs Secondary ▪ Classification ▪ Treatment ▪ Outcomes.

Introduction

Pneumomediastinum (PM) is defined as the presence of air in the mediastinal cavity, and can be a potentially catastrophic complication. According to the pathological cause, it is further divided into two entities: spontaneous pneumomediastinum (SPM), without any obvious primary cause, and secondary pneumomediastinum, with a specific responsible pathological event, such as trauma, intrathoracic infections, or violation of the aerodigestive track.

SPM was originally described by Louis Hamman in 1939 (1) and is generally described as a benign condition, presenting mainly in young adults exposed to a sudden pressure change within the intrathoracic cavity. The pathogenesis of SPM is characterized by a sudden increase in intrathoracic pressure, along with intraalveolar pressure (2). The difference in pressure created within the pulmonary parenchyma leads to alveolar rupture, with further leakage of air throughout the interstitium and bronchovascular tissue toward the mediastinum. In fact, SPM usually occurs after several precipitating events, triggering a strong Valsalva maneuver (2, 3).

On the other hand, secondary pneumomediastinum (secondary PM) is found in the majority of patients with pneumomediastinum. In most cases, there is a precipitating event, such as a penetrating

or blunt trauma, rupture of a hollow viscus, esophagus or trachea, tissue dissection originating from a spontaneous pneumothorax, or pulmonary or mediastinal infection by gas-forming organisms (4). Despite the rare incidence of SPM, we report here one of the largest series of PMs available in the literature, to the best of our knowledge (5, 6).

The purpose of the present study was on the one hand to present our experience in the management of 37 individuals with SPM, and on the other to point out the importance of recognizing true spontaneous pneumomediastinum cases as long as they are poorly defined in the current literature. Their clinical presentation, diagnostic evaluation, radiologic findings, and clinical outcomes were analyzed and compared with those from 50 patients suffering from secondary PM.

Materials and Methods

Patients Selection

The present study is a single-center, retrospective analysis incorporating patient data from all consecutive patients diagnosed either with SPM or secondary PM, treated in our hospital from January 2009 to March 2020. The search was conducted covering the aforementioned time period in databases of the Departments of Radiology, Thoracic and Cardiovascular Surgery, and Accident and Emergency, using the following keywords and their combinations in the documented diagnoses: "Pneumothorax", "Pneumomediastinum", "Pneumopericardium", and "Subcutaneous Emphysema".

Since definitions of primary and/ or spontaneous PM are interchangeably and arbitrary used, we followed the widely accepted "common" practice and classified as SPM all these "otherwise healthy" cases in which SPM occurred in the absence of clinically apparent underlying lung disease, penetrating or blunt trauma, iatrogenic causes, or complications due to surgery and mechanical ventilation.

Primary and Secondary Endpoints

All data regarding baseline characteristics, pathological characteristics, along with imaging and the hospital course, were prospectively collected. The parameters evaluated for comparison between the two groups included: age, sex, diagnostic chest radiograph, associated pneumothorax, pleural effusions, atelectasis, subcutaneous emphysema, length of stay (LOS), and in-hospital mortality. In-hospital mortality was the primary endpoint and LOS was the secondary endpoint.

Laboratory and Radiologic Analyses

All patients underwent laboratory blood tests for hematocrit, hemoglobin, white blood cells, neutrophils, electrolytes, urea, creatinine, and c-reactive protein. Radiology images upon admission included chest radiograph in 95% of patients (35 of 37) and chest CT-scan in 81% (30 of 37).

Statistical Analysis

The results were analyzed using GraphPad Prism 8.4.3 for Mac (GraphPad Software, San Diego, CA). Normal distribution of the continuous data was tested by application of the D'Agostino and Pearson Omnibus normality tests. Comparisons of continuous variables were performed with the two-tailed unpaired t-test for parametric data and the Mann-Whitney U-test for nonparametric data. The categorical outcomes were tabulated in 2x2 tables and were assessed by performing the Chi square test. Differences were deemed significant with a $P \leq 0.05$.

Results

Baseline Characteristics

A total of 87 patients were included (SPM group: 37 patients; secondary PM group: 50 patients). SPM patients' baseline characteristics are presented in Table 1. Regarding the SPM group, the most frequently reported symptom was chest pain in 38% (14 of 37), followed by dyspnea in 35% (13 out of 37) and cough in 30% (11 out of 37). Pneumothorax was present in 19% (7 out of 37) upon admission and atelectasis in 14% of the cases

(5 out of 37). The pneumothoraces were small and evident only on the chest CT scan. No pathological lung abnormality (eg, bleb, cavity, bullae) was identified as the etiology of the pneumothorax. Laboratory analysis included complete cell count, electrolytes, and arterial blood gases. The white blood cell count was elevated in 43% of patients (16 out of 37). The remainder of the laboratory work performed was otherwise unremarkable. Radiology images upon admission included chest radiograph in 95% of cases (35 out of 37) and chest CT-scan in 81% (30 out of 37). The chest x-ray (CXR) revealed mediastinal air in 57% (21 out of 37) and subcutaneous air in 38% (14 out of 37). Chest CT scan revealed mediastinal air in 100% (30 out of 30 performed scans) and subcutaneous air in 60% (18 of 30) of the examinations.

Medical history predisposing to the development of SPM included smoking in 22% (8 out of 37), asthma in 16% (6 out of 37), idiopathic pulmonary fibrosis in 5% (2 out of 37), and chronic obstructive pulmonary disease in 14% (5 out of 37) of the patients. Twenty-four cases (64.9%) appeared without any comorbidities (Table 1).

Table 1. Patient Baseline Characteristics and Clinical Findings of SPM* Patients

Demographics	SPM* group (N=37)
Female (N; %)	13 (35.4)
Mean age (years) (SD)	54.6 (25.5)
Presenting symptom (N; %)	
Chest pain	14 (38)
Dyspnea	13 (35)
Cough	11 (30)
Neck pain	4 (10.8)
Precipating event (N; %)	
Cough/URI†	14 (38)
Vomitting	12 (32)
Physical activites	2 (5.4)
Inhalational drugs	0 (0)
No triggering factor	6 (16.2)
Not known/ missing	3 (8.1)
Comorbidities (N; %)	
Asthma	6 (17)
IPF‡	2 (5.4)
COPD	5 (14)
No comorbidities	24 (64.9)
Lifestyle	
Smoking (N; %)	8 (22)

*Spontaneous pneumomediastinum; †Upper Respiratory Infection; ‡Idiopathic Pulmonary Fibrosis; §Chronic Obstructive Pulmonary Disease.

Among the suspected triggering factors in the origin of SPM, cough and upper respiratory infection were noted to be the predominant precipitating events in 38% of patients (14 out of 37). Asthma exacerbation was seen in 16% (6 out of 37) and vomiting in 32% (12 out of 37). Further triggering events observed were physical activity and panic attacks. Inhalational drugs, a well-established precipitating event for SPM, were not recorded (0%) in our cohort. There was no apparent triggering factor for mediastinal air in 6 cases (16%).

The majority of the cases were admitted to the hospital, placed on oxygen and treated expectantly. Eight (22%) of those underwent drainage through chest tube insertion. The mean length of hospital stay was 3.9 (SD=1.8) days and there were no in-hospital deaths.

The second cohort included patients (N:50) in whom pneumomediastinum developed as a result of blunt thoracic trauma in 44% (22 out of 50), barotrauma in 36% (18 out of 50), esophageal perforation in 8% (4 out of 50), surgical intervention (tracheostomy in 10% [N:5] and thyroidectomy in 2% [N:1]). This group of 50 sufferers with secondary PM was compared with the original cohort with SPM. Comparing the two groups (SPM vs secondary PM)showed that: individuals were of similar age (P=0.4), while secondary PM cases were more likely to have an associated pneumothorax (19% vs 58%, P<0.05), a chest tube placed (18.9% vs 58%, P<0.05), and an associated pleural effusion (0% vs 18%, P<0.05). Additionally, they presented a higher prevalence of radiologic subcutaneous emphysema (49% vs 74%, P<0.05) (Table 2).

Regarding outcomes, they presented longer LOS (3.9 vs 5.3 days, P<0.05) (Figure 1), and higher in-hospital mortality (0% vs 10%; P<0.05) (Table 2).

Table 2. Spontaneous Pneumomediastinum Compared with Secondary Pneumomediastinum

Clinical parameters	SPM (N=37)	Secondary PM (N=50)	P-value
Age, mean (SD)	54.6 (25.5)	50.3 (21.3)	0.40
Females, n (%)	13 (35.4)	9 (18)	0.07
Diagnostic chest radiograph, N (%)*	21 (56.7)	22 (44)	0.46
Associated pneumothorax, N (%)	7 (18.9)	29 (58)	<0.01
Associated pleural effusions, N (%)	0 (0)	9 (18)	0.01
Associated atelectasis, N (%)	5 (13.5)	16 (32)	0.05
Subcutaneous emphysema, N (%)	18 (48.7)	37 (74)	0.02
Chest tube placement, N (%)	8 (21.6)	30 (60)	<0.01
LOS, mean (SD)	3.9 (1.8)	5.3 (1.9)	<0.01
In-hospital Mortality, N (%)	0 (0)	5 (10)	0.048

SPM=Spontaneous pneumomediastinum; PM=Pneumomediastinum; *The diagnosis of pneumomediastinum was made based on the Chest X-ray.

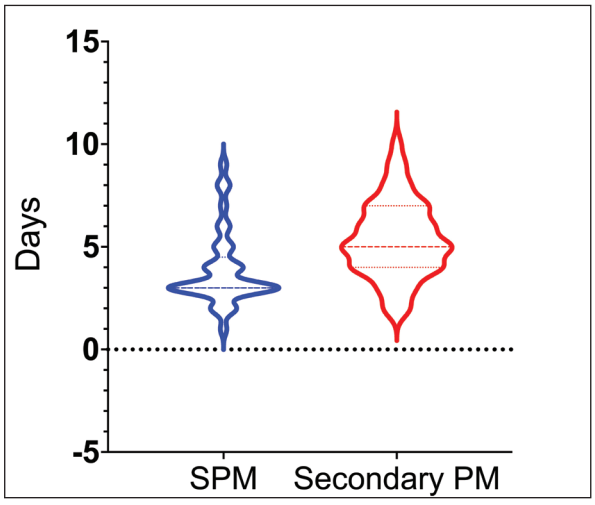

Figure 1. Comparison of length of stay (LOS).

Discussion

Analyzing the data on the SPM cohort, we found that most affected patients were adults of younger age, which correlates with many other reviews (7–9). Nonetheless, there was no significant difference regarding age and gender distribution compared to the secondary PM group. The evaluation revealed that underlying lung diseases, mainly COPD and asthma, were frequent comorbidities among SPM individuals. This is not surprising, given the pathophysiology of the entity. In addition, we observed several precipitating factors similar to other case series (7, 10).

Concerning the clinical presentation, it was similar to other reports (10–12). In fact, most of the sufferers complained of chest pain, shortness of breath, and subcutaneous emphysema. In addition, we found an exceptionally low incidence of atelectasis, subcutaneous emphysema and pleural effusion on imaging studies, as these features are more common in cases of secondary pneumomediastinum.

Regarding diagnostic radiological tools, thoracic-CT compared to chest x-ray was more accurate in our series in establishing the diagnosis of pneumomediastinum in the SPM group (100% vs 60% of the performed scans respectively). In fact, Kaneki et al. (5) stated that up to 30% of patients with SPM present with a normal chest x-ray. Our analysis revealed that a chest radiograph is an appropriate initial study that might pose the diagnosis (in 60% of the examinations performed), while a CT scan is complementary, which is in accordance with a previous study (6). This might be explained by the fact that the patients in our series who underwent CT had more severe symptoms, typically pain, which prompted the test and hospital admission thereafter. To date there is no evidence defining which PM cases should undergo a scan. Summarizing, usually the diagnosis of SPM is established with a clinical examination and a simple chest X-ray. Nevertheless, as many as 50% of all cases might remain undiagnosed if only a posteroanterior chest x-ray is taken, a lateral view is recommended to identify the presence of air (3). However, if the diagnosis of SPM is still unclear,

or if there is a suspicion of secondary pneumomediastinum, a CT scan should be added to ensure the diagnosis. In general, the data reported in the literature underline that a high level of suspicion, supported by an individual case by case evaluation by a physician, including the close interdisciplinary collaboration of various specialties such as Emergency Medicine physicians and Thoracic Surgeons, remain the cornerstone of establishing the diagnosis.

Even so, if the diagnosis of SPM is definitely confirmed, the optimal therapeutic approach still remains under debate. Conservative management, including rest, analgesia, and close observation, is the mainstay of treatment. In approximately 10% of these cases, small concurrent pneumothoraces are present. In cases of concurrent pneumothorax, management should follow the same principles as in primary spontaneous pneumothorax sufferers.

Regarding morbidity and outcomes, the hospital course of the SPM group was benign. No death was reported and the LOS was relatively short. The chance of recurrence is small, approximately 1% (13). Few reported PM recurrences confirm its benign entity. Due to the extremely low recurrence incidence, no long-term follow-up is required, unless otherwise indicated (14).

Although SPM represents, as shown, a rare benign condition, it should be always differentiated from secondary PM, which has an ominous onset with potentially catastrophic complications. Free air in the mediastinum is a finding which may raise the concern regarding potentially devastating conditions such as abscess formation or esophageal perforation, with subsequent mediastinitis, accompanied by high morbidity and mortality rates. This was partially confirmed through the comparison in our study of the SPM and secondary PM cohorts, where the second group showed significant higher morbidity, mortality and LOS.

According to the current literature and common practice in classification, "spontaneous", or "primary" PM are considered any pneumomediastinum without any apparent precipitating clinical factor or lung disease ('sine causa'), which is not traumatic, or that develops as a complication of surgery. Nevertheless, as patients with SPM are usually found to have subtle undiagnosed pulmonary abnormalities, accompanied or not by triggering factors, the distinction between secondary PM and SPM becomes increasingly cloudy. In our series, up to 20% of the SPM had either a triggering event, or a predisposing, preexisting comorbidity for a sudden increase in intrathoracic pressure.

Asthma, one of the most commonly reported factors, was present in our study in 17% of the cases. Following the previously mentioned line of reasoning, asthmatic patients should actually be considered as having secondary PM. However, in the medical literature they are included in the SPM cohorts. In this context, although both the precipitating trigger and predisposing factors of SPM have been extensively analyzed, no distinction has been made between them, despite the fact that they are not the same. On the other hand, in our series 24 patients presented without any predisposing pulmonary disease and only 6 without any triggering factor. These would correspond to 27.5% and 6.9% respectively of the total population of PM patients, meaning that, "true" SPM cases (without any predisposing and precipitating factors!!) are extremely rare. Summarizing, the current definitions for SPM and secondary PM, as well the common practice in distinguishing between the subgroups, create confusion and cause conceptual difficulty. The question arises whether it is time for a consensus for a change of classification, introducing among others the term "idiopathic" PM, as proposed by some groups (15, 16). This would lead to greater accuracy in order to achieve appropriate diagnosis, treatment or management, and reliable prognosis estimation.

Limitations of Study

This retrospective non-randomized series refers to a single-center regional experience; thus, the results may not be generalizable to the entire population, since there are significant differences between institutions and countries. Additionally, the relatively small size of 87 cases may have limited the power for comparison between spontaneous and secondary PM.

Conclusions

Spontaneous pneumomediastinum is a benign and self-limiting onset of clinical importance with good prognosis, as shown by the extremely low mortality, as well as the relative short LOS in our case series. In the absence of significant pathology, the treatment focuses on symptom relief. The entity often presents with chest pain, dyspnea and/or subcutaneous emphysema. Due to its clinical presentation, mimicking many other respiratory pathologies and clouding the differential diagnosis, it is often under-diagnosed. Therefore diagnosis requires a high level of suspicion given that a significant proportion of patients present without any precipitating factor, or it may be missed on a plain chest radiograph. However secondary causes of mediastinal air must be ruled out, because they may have a devastating outcome if not diagnosed promptly. A consensus targeting an update of the classification guidelines is more than necessary. This would enable more accurate diagnosis resulting in appropriate treatment and reliable prognosis estimation.

What Is Already Known on This Topic:

Pneumomediastinum (PM) is in general a self-limiting condition with good outcomes. Its presenting clinical signs are nonspecific, thus the identification of predisposing risk factors is essential for better management and prognosis. If there is no significant pathology, the treatment focuses on symptom relief. The entity is further divided into two groups: spontaneous pneumomediastinum (SPM), without any obvious primary source, and secondary PM, with a specific responsible pathologic event, such as trauma, intrathoracic infections, or violation of the aerodigestive track. SPM usually presents with chest pain, dyspnea and/or subcutaneous emphysema. However secondary causes of mediastinal air must always be ruled out, in order to prevent complications with devastating outcome.

What This Study Adds:

Despite the rare incidence of SPM, our study represents one of the largest series of PM available in the literature. The comparison of SPM patients with secondary PM cases revealed findings similar to those reported by other authors. However, the series underlines, on the one hand, the necessity of a high level of suspicion in establishing the SPM diagnosis as many cases present without any precipitating factors, or may be missed on plain chest radiograph, and on the other hand it illustrates that the current PM classification into spontaneous and secondary PM may create confusion and cause conceptual difficulty. The question arises whether it is time for a consensus to seek amendment of the classification for the sake of greater accuracy.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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