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Clinical characteristics of spontaneous pneumomediastinum: a retrospective study

Hasan Emre Yildirim[1*], Süleyman Emre Akin[1], Cem Dogan[1], Hasan Ekrem Camas[1], Isa Dongel[1] and Rasih Yazkan[1]

Abstract

Background and aim The mediastinum is an anatomical compartment that contains all thoracic organs and tissues except the lungs. Spontaneous pneumomediastinum (SPM) is a rare condition characterized by the presence of air in this space without any identifiable underlying cause. This study aimed to investigate the clinical characteristics and seasonal distribution of SPM cases, and to evaluate potential meteorological influences on its occurrence.

Methods This retrospective study included 23 patients diagnosed with SPM at our institution between 2020 and 2025. Inclusion criteria were: age between 18 and 90 years, complete medical records, and absence of trauma-, surgery-, infection-, or iatrogenic-related pneumomediastinum. Demographic data, clinical symptoms, laboratory parameters [C- reactive protein (CRP), white blood cell (WBC)], hospitalization duration, and seasonal distribution were analyzed. Statistical analysis was performed using IBM SPSS Statistics version 22.0. Numerical data were expressed as mean ± standard deviation (SD). The chi-square test was used for categorical comparisons, and the Spearman correlation coefficient was used to evaluate associations between variables. A p-value of < 0.05 was considered statistically significant.

Results Of the 23 patients, 78.3% were male, with a mean age of 23.6 ± 7.9 years. The highest incidence occurred in autumn (47.8%), followed by spring (26.1%), and the lowest in summer (4.3%). The mean length of hospital stay was 3.9 ± 2.2 days, and relapse was observed in 8.7% of cases. CRP and WBC levels showed weak, non-significant positive correlations with the length of hospital stay ($p > 0.05$).

Conclusion Although SPM cases tended to increase during transitional seasons such as autumn and spring, this seasonal relationship was not statistically significant. The relatively high recurrence rate observed in this study may be associated with sample size, individual risk factors, or follow-up duration. Given the study's small, single-center design, these findings should be interpreted with caution. Larger multicenter studies are required to better elucidate potential seasonal and environmental influences on SPM incidence.

Keywords Mediastinal emphysema, Spontaneous pneumomediastinum, Seasonal, Pneumothorax

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Introduction

The mediastinum is the space between the pleural sacs of the lungs, bounded by the sternum anteriorly, vertebrae posteriorly, mediastinal pleura laterally, and the thoracic inlet superiorly. It is divided into superior and inferior parts and contains all thoracic organs and tissues except the lungs [1]. Therefore, this space holds significant physiological and anatomical importance. Pneumomediastinum refers to the abnormal accumulation of air in this space. It is divided into two types: spontaneous and secondary. In secondary pneumomediastinum, underlying pathological factors such as surgical, iatrogenic, traumatic, and infectious causes are present, whereas in spontaneous pneumomediastinum (SPM), there is no underlying pathology [2].

SPM was first described by Hamman in 1939 as a benign condition that occurs in young adults due to increased intrathoracic pressure [3]. The Hamman sign is a characteristic auscultatory finding observed in conditions such as pneumomediastinum. It presents as a crunching sound synchronized with the cardiac apex beat [4]. A severe Valsalva maneuver often plays a triggering role [5]. In SPM, benign predisposing factors such as asthma, smoking, coughing, vomiting, physical exertion, and food impaction in the throat can be observed [6].

Although the exact pathophysiology of SPM is not completely understood, it is believed to involve alveolar rupture and air leakage along bronchovascular sheaths into the mediastinum, known as the Macklin effect [7, 8]. Furthermore, certain environmental and seasonal factors may contribute to the occurrence of SPM. Sudden changes in atmospheric pressure, temperature fluctuations, and an increased prevalence of respiratory tract infections during transitional seasons such as autumn and spring could play a triggering role. These influences, which have been more extensively studied in spontaneous pneumothorax, may also be relevant to SPM, yet this relationship has not been adequately explored in the literature [8].

The main symptoms include chest pain, cough, dyspnea, dysphonia, neck pain, and difficulty swallowing. These symptoms generally resolve spontaneously. Diagnosis is usually based on clinical findings and confirmed by chest radiography and computed tomography (CT) [8]. In the treatment of SPM, conservative management is usually sufficient. This treatment includes bed rest, oxygen therapy, and pain control. Invasive interventions are rarely required [9].

Although the factors we discussed in the pathophysiology of SPM are considered, the condition has not been fully elucidated. There are studies in the literature regarding the seasonal effects of spontaneous pneumothorax [10, 12]. There may also be a relationship between similar mechanisms and the development of SPM.

In our study, we aimed to investigate the potential relationship between spontaneous pneumomediastinum and seasonal characteristics; however, we emphasize that any findings regarding this relationship are based solely on the observed distribution and should be interpreted with caution when generalizing to broader populations. Additionally, we examined the association between this condition and certain clinical features and laboratory parameters. The purpose of the study is to describe the observed seasonal distribution of SPM presentations and to evaluate accompanying clinical requirements, without asserting a definitive claim of seasonal causality.

Materials methods

Type of study, population, and sample selection

In our study, we retrospectively and single center examined 40 patients diagnosed with spontaneous pneumomediastinum who were followed and treated in the Department of Thoracic Surgery at our hospital between 2020 and 2025. However, after considering the exclusion criteria, we included 23 patients in the study. The data were obtained from the hospital's electronic medical records and archive system. We investigated the relationship of this condition with seasonal factors and other clinical parameters. Our aim was to elucidate the seasonal relationship of this condition.

The patients' age, sex, clinical condition, presenting complaints, length of hospital stay, date of admission, whether they were admitted to the general ward or intensive care unit, whether any additional invasive procedures were performed, and laboratory parameters including CRP and WBC levels at the time of initial application were analyzed. The reference ranges used in our hospital laboratory were CRP: 0–5 mg/L and WBC: $3.6–11.2 \times 10^9$/L. The study evaluated the seasonal distribution of spontaneous pneumomediastinum cases based on the study period. Observations regarding the frequency of cases across different seasons were used to assess potential seasonal patterns. No direct meteorological or atmospheric data (temperature, humidity, wind speed, or pressure) were collected or analyzed.

The inclusion criteria for the study were patients aged between 18 and 90 years who were diagnosed with spontaneous pneumomediastinum and had complete data in their medical records while being followed and treated at our hospital. The exclusion criteria were defined in detail as follows: patients with pneumomediastinum secondary to trauma, thoracic or cervical surgery, endoscopic procedures, mechanical ventilation, infection, or barotrauma related to mechanical causes were excluded. In addition, patients younger than 18 years or older than 90 years, as well as those with incomplete medical records or

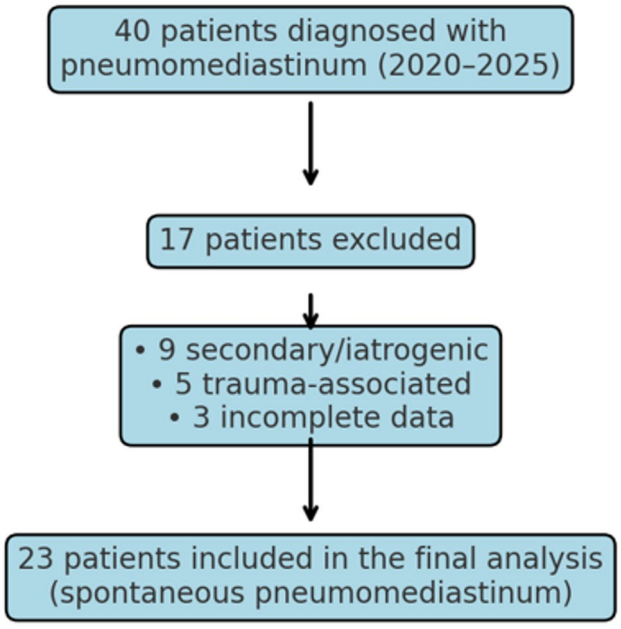


Fig. 1 Flow diagram illustrating the patient selection process. A total of 40 patients diagnosed with pneumomediastinum between 2020 and 2025 were initially identified. After applying the exclusion criteria, 17 patients were excluded (9 secondary or iatrogenic, 5 trauma-associated, and 3 with incomplete clinical data), resulting in 23 patients included in the final analysis with a diagnosis of spontaneous pneumomediastinum

uncertain radiological findings, were not included in the final analysis. Among the initially identified 40 cases, 17 patients were excluded 9 due to secondary or iatrogenic causes, 5 due to trauma-associated pneumomediastinum, and 3 due to incomplete clinical data resulting in a final study population of 23 patients diagnosed with spontaneous pneumomediastinum (Fig. 1).

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA, 2013). Numerical values were expressed as mean ± standard deviation (mean ± SD). The Kolmogorov-Smirnov test was used to assess the normal distribution of the parameters. For the comparison of parameters that did not show a normal distribution, the chi-square test and Spearman correlation analysis were used. A significance level of $p < 0.05$ was accepted for all analyses. In the results section, statistical analysis results were presented by reporting the exact p-values. Only when the p-value was less than 0.001, it was expressed as $p < 0.001$. In our study, the length of hospital stay was categorized as ≤ 3 days and > 3 days based on the median hospitalization duration observed in the study population, to enable comparison between patients with shorter and longer clinical courses and to identify factors associated with prolonged hospitalization.

Table 1 Distribution of patients by descriptive characteristics ($n = 23$)

Charecteristics	*n*	%
Gender		
Man	18	78,3
Woman	5	21,7
Place of hospitalization		
General ward	21	91,3
Intensive Care Unit	2	8,7
Oral intake stopped?		
Yes	11	47,8
No	12	52,2
Marijuana use		
Yes	1	4,3
No	22	95,7
Diagnosed season		
Winter	5	21,7
Spring	6	26,1
Summer	1	4,3
Autumn	11	47,8
Relapse		
Yes	2	8,7
No	21	91,3
Total	23	100,0

Ethical approval and study permission

The study was initiated after the ethics committee approval from **** **** Health Sciences Ethics Committee (Date: 12.05.2025, No: 96/50). This research received no external funding. This study was carried out in compliance with the principles of the Declaration of Helsinki (1964) and its subsequent revisions.

Use of AI for writing assistance

The authors declared that ChatGPT-4 (OpenAI, 2024) used exclusively for grammar correction and enhancing clarity. The final manuscript was thoroughly reviewed and approved by the authors to ensure its accuracy and originality.

Results

The study was completed with a total of 23 patients diagnosed with pneumomediastinum, of whom 78.3% were male. Among the participants, 91.3% were followed in the general ward, and 8.7% were monitored in the intensive care unit. During the follow-up period, continued oral intake during hospitalization in 52.2% of the patients. Hospital admissions occurred most frequently in autumn (47.8%), followed by spring (26.1%), and winter (21.7%). No relapses were observed in 91.3% of the participants. The mean age of the patients was 23.6 ± 7.9 years; the mean CRP was 18.7 ± 28.5; the mean WBC was 11.1 ± 3.6; and the mean length of hospital stay was 3.9 ± 2.2 days. The descriptive characteristics of the participants are shown in Tables 1 and 2.

Table 2 Distribution of patients by age and blood values ($n=23$)

Charecteristics	Min-Max	Mean ± SD
Age	18–58	23,6 ± 7,9
CRP (mg/L)	1-131	18,7 ± 28,5
WBC(x10^9/L)	6,2–19,1	11,1 ± 3,6
Hospitalization (Day)	1–9	3,9 ± 2,2

Min Minimum, *Maks* Maximum, *SD* Standart Deviation, *CRP* C- reactive protein, *WBC* White blood cell

Table 3 Distribution of patients by symptoms and invasive procedures ($n=23$)

	n	%*
Symptoms		
Dyspnea	12	52,2
Chest Pain	17	73,9
Cough	3	9,4
Diarrhea	1	4,3
Throat Pain	1	4,3
İnvasive Procedure		
No	19	82,6
Bronchoscopy	1	4,3
Fasciotomy	1	4,3
Endoscopy	2	8,7

* Patients could present with more than one symptom

Table 4 Comparison of length of hospital stay with descriptive variables (n=23)

	Hospitalition Dayn		p
	3 days and less	>3 day	
Gender			
Man	10	8	0,538
Woman	2	3	
Diagnosed Season			
Autumn and Winter	9	7	0,554
Spring and Summer	3	4	
Oral intake stopped?			
Yes	1	10	<0,001
No	11	1	
CRP (mg/L)			
Normal (5 and less)	5	5	0,855
High (>5)	7	6	
WBC (x10^9/L)			
Normal (3,6-11,2)	9	4	0,042
High (>11,2)	3	7	
İnvasive Procedure			
No	11	8	0,231
Yes	1	3	

CRP C- reactive protein, *WBC* White blood cell

The most common symptom among the patients was chest pain, observed in 73.9% of cases. This was followed by dyspnea (52.2%), cough (9.4%), sore throat (4.3%), and diarrhea (4.3%). No invasive procedures were performed in 82.6% of the patients. Endoscopy was performed in 8.7% of patients, bronchoscopy in 4.3%, and fasciotomy in 4.3%. The distribution of symptoms and invasive procedures among the patients is shown in Table 3.

Table 5 Correlation of length of hospital stay with age, CRP, and WBC levels ($n=23$)

		Hospitalition	Age	CRP	WBC
Hospitalization (Day)	rho	1			
	p				
Age	rho	-0,144	1		
	p	0,512			
CRP (mg/L)	rho	0,045	0,478	1	
	p	0,838	0,021		
WBC (x10^9/L)	rho	0,065	-0,307	0,403	1
	p	0,767	0,155	0,056	

rho: Spearman correlation coefficient, *CRP* C- reactive protein, *WBC* White blood cell

The length of hospital stay was longer in males compared to females; however, this difference was not statistically significant ($p=0.538$). Among pneumomediastinum patients who had oral intake discontinued, the length of hospital stay was significantly longer ($p<0.001$). Patients with higher CRP levels and those who underwent invasive procedures had longer hospital stays, but the differences were not statistically significant ($p=0.855$ and 0.231, respectively). The length of hospital stay was significantly longer in patients with higher WBC levels ($p=0.042$). The distribution of variables related to the length of hospital stay is shown in Table 4.

The length of hospital stay was weakly negatively correlated with the patients' age (rho: -0.144). CRP and WBC levels were mildly elevated but showed no statistically significant correlation with the length of hospital stay (rho: 0.045 and rho: 0.065, respectively). The results of the correlation analysis are presented in Table 5.

Discussion

When we look at the literature, there are numerous studies examining the relationship between primary spontaneous pneumothorax (PSP) and meteorological conditions and seasons, whereas studies investigating this relationship in SPM are rare. One study reported that PSP increases during winter, attributing this to variable temperatures and high atmospheric pressure [10]. However, Canavar et al. did not find a seasonal association with PSP, but reported an increase related to elevated NO2 levels due to air pollution [11]. Another study noted an increase in PSP during transitional seasons such as spring, linking this to climatic changes during these periods [12]. In the study by Daş et al., it was found that PSP increased due to cold weather and sudden temperature changes [13].

When examining the seasonal relationship of SPM, Kim et al.'s study found that nearly half of the patients presented during the summer, but no clear link to weather conditions was established. Instead, they attributed SPM

to direct increases in intrathoracic pressure from actions such as vomiting and coughing [9]. Another publication also indicated that incidence of SPM tends to rise in the summer months [14]. However, in our study, contrary to these two studies, only one of our patients presented during the summer. When considering the distribution, the highest rate of presentations occurred in autumn at 47.8%, followed by spring at 26.1%, and winter at 21.7%. Month-wise, 26% of the patients presented in October. However, other potential explanations for this seasonal clustering should also be considered. Moreover, the discussion regarding the impact of meteorological variables on SPM remains limited in our study. Detailed meteorological data such as average temperatures, wind speeds, and regional atmospheric differences were not available for analysis, which may have influenced our interpretation of seasonal variation. Future studies incorporating these environmental parameters could provide a more comprehensive understanding of the relationship between weather conditions and SPM occurrence. From a mechanistic perspective, it can be hypothesized that seasonal transitions characterized by sudden temperature changes and cold weather conditions might contribute to the development of spontaneous pneumomediastinum. These environmental factors could potentially lead to increased atmospheric pressure variations and airway bronchospasm, which have been suggested in the literature as possible triggers for both SPM and PSP [12, 15]. However, since our study did not directly analyze meteorological or atmospheric parameters, this interpretation remains speculative. Future studies incorporating environmental and physiological measurements are needed to clarify the potential role of these factors in the pathogenesis of SPM.

Clinically, as previously mentioned, the main symptoms are non-specific findings such as chest pain, cough, dyspnea, dysphonia, neck pain, and difficulty swallowing. In two studies, the most common symptoms were chest pain and neck-throat pain [9, 16], whereas in another study, the most frequent symptoms were chest pain, shortness of breath, and cough in descending order [17]. In our study, the most common symptoms were chest pain and dyspnea, while throat pain was observed in only one patient. In Yamairi et al.'s study of 71 patients, a slight increase in WBC was detected, and no significant rise in CRP levels was noted. They suggested that WBC and CRP levels could be mildly elevated in SPM patients, and emphasized the need to investigate any underlying infection in such cases [16]. In another study, no significant difference was found between WBC and CRP levels and the severity of SPM, but it was noted that these levels could be slightly elevated [9]. In our study, both CRP and WBC levels showed weak and statistically insignificant correlations with the length of hospital stay ($p > 0.05$). Therefore, no meaningful relationship could be established between these laboratory parameters and hospitalization duration. These findings are consistent with previous studies reporting that inflammatory markers may show mild, non-specific elevations in SPM without a clear prognostic implication.

SPM typically occurs in young males aged 18–30 years. In the study by Kim et al., the mean age was 18.5 years, while in Yamairi et al., it was 19.3 years [9, 18]. Another study reported a mean age of 22.4 years [20]. Regarding gender distribution, the literature generally indicates a male predominance. In three different publications, the proportion of male patients was reported as 79.7%, 72.8%, and 71.7%, respectively [9, 17, 18]. According to our findings, the mean age at presentation was 23.6 years, and the proportion of male patients was 78.3%. Our results are consistent with many studies in the literature. Additionally, in our study, the length of hospital stay was weakly negatively correlated with age. Studies have shown that the average hospital stay for SPM can range between 3 and 10 days. In the study by Macia et al., the average length of stay was 3.2 days, while in the study by Kim et al., it was found to be 4.59 days [9, 19]. Another study reported a higher average length of stay at 10.5 days [20]. According to our findings, the mean length of hospital stay was 3.9 days.

The diagnosis of SPM is established through imaging modalities following clinical suspicion. For this purpose, chest X-ray and CT scans are used. Radiologic findings typically include mediastinal air densities, particularly linear shadows extending toward the neck, and subcutaneous emphysema. Air is especially prominent around the trachea and bronchi. Thoracic CT has a very high sensitivity and a diagnostic accuracy approaching 100% (10). One study reported that 70% of SPM cases were diagnosed with direct radiography and 30% with CT [21]. In our cases, we suspected SPM based on chest radiography, but the diagnosis was always confirmed with thoracic and neck CT (Fig. 2). Additionally, in one of our patients, unlike previously reported cases, air was observed within the spinal cord of most thoracic vertebrae (Fig. 3). Takada et al. noted that diagnostic procedures such as bronchoscopy and endoscopy are generally unnecessary [22]. While these procedures have been performed in some studies, most did not reveal any abnormal findings. Kim et al. recommended that endoscopy and bronchoscopy should be reserved for suspected esophageal or tracheal ruptures [9]. In our study, we performed bronchoscopy in two patients and endoscopy in one patient due to suspected rupture, but no pathology was detected. A review of the literature shows that conservative treatments such as rest, analgesia, inhaler therapy, and antibiotics are used in nearly all cases, and unnecessary diagnostic and therapeutic procedures may be performed due to a

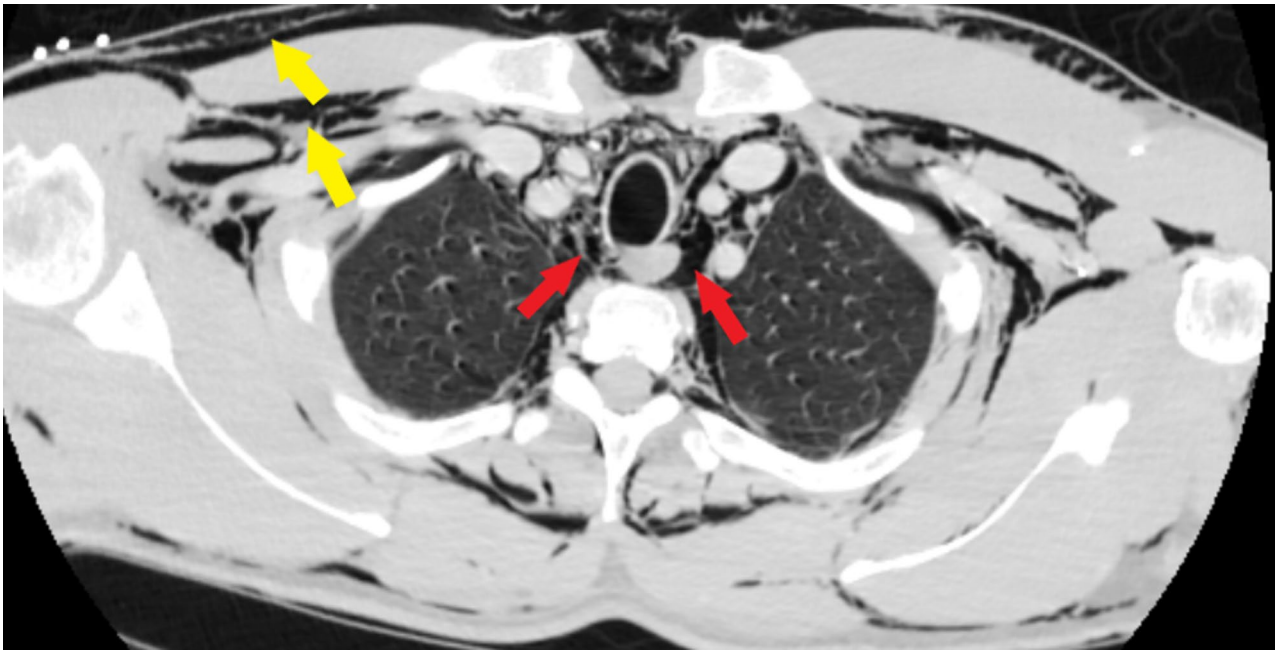


Fig. 2 On the thoracic CT scan, increased mediastinal and peribronchial air densities are clearly demonstrated (indicated by the red arrows), consistent with pneumomediastinum. Additionally, subcutaneous emphysema is visualized in the anterior chest wall and neck regions (highlighted by the yellow arrows), representing air extension into the subcutaneous tissues

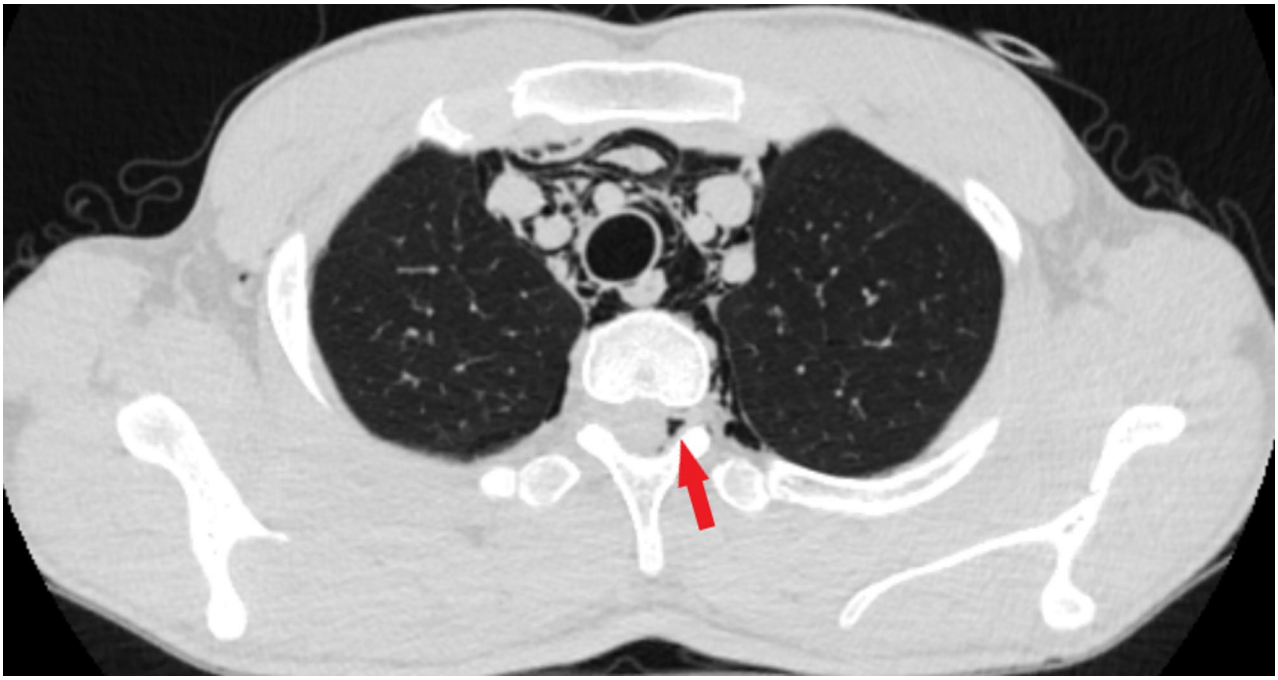


Fig. 3 On the thoracic CT scan, the presence of air is observed within the spinal canal along the thoracic vertebral column (indicated by the red arrow), consistent with pneumorrhachis, which represents the extension of mediastinal air into the epidural space

lack of information [23]. Some studies have suggested that oral intake should be restricted [24]. In our cases, we generally opted for conservative treatment; however, we restricted oral intake in 11 patients and performed fasciotomy in 1 patient due to extensive subcutaneous emphysema. Additionally, our analysis showed that the length of hospital stay was longer in patients for whom we restricted oral intake.

Delayed diagnosis and failure to identify primary causes can lead to life-threatening complications such as

mediastinitis and tension pneumothorax due to tracheal and esophageal rupture [24, 25]. In a study involving 339 patients, 5.6% of the patients died during hospitalization; however, these deaths were attributed not directly to SPM but to other underlying conditions [18]. According to the literature, the mortality rate in SPM is extremely rare and is generally attributed to underlying pathologies. In the studies by Yamairi et al. and Dionisio et al., no deaths or cases of mediastinitis were reported [16, 20]. Consistent with these findings, no deaths or mediastinitis were observed in our patients. Regarding recurrence rates, relapse is very rare, occurring at a rate of 1.2% [22]. In our study, the relapse rate was 8.7%, which was higher than that reported in the literature. This relatively higher recurrence rate may be related to the small sample size of our study and possible individual differences in predisposing factors such as undiagnosed pulmonary conditions, repeated Valsalva maneuvers, or lifestyle factors including smoking and cannabis use. Additionally, differences in follow-up duration and diagnostic sensitivity among studies may have contributed to this variation. Additionally, one of our patients was a chronic cannabis user, and we believe the SPM in this case was related to that factor. According to the literature, this condition has been linked to intrathoracic pressure changes caused by severe vomiting and Valsalva maneuvers [26]. However, unlike the literature, our cases did not involve any vomiting episodes.

This study has several limitations. First, it was conducted in a single center with a relatively small sample size, which may limit the generalizability of the findings. Second, detailed meteorological and air pollution data such as PM_{10}, NO_2, and ozone concentrations were not directly analyzed, which might have influenced the assessment of environmental effects. Additionally, the retrospective design may have introduced selection bias, and some clinical or environmental variables could not be fully controlled. Therefore, the results should be interpreted with caution, and further multicenter prospective studies with larger cohorts are needed to validate these findings.

Conclusion

In conclusion, SPM is a generally benign and self-limiting condition that often resolves spontaneously with conservative management, and invasive interventions are rarely required. In our study, although the results did not reach statistical significance, a seasonal trend was observed, with higher incidence rates during transitional periods such as autumn and spring, suggesting a potential influence of meteorological variations. The findings highlight the need to consider environmental and seasonal factors as possible contributors to SPM occurrence. This study adds to the limited body of evidence exploring these associations and provides a preliminary framework for further investigation. However, the study's small sample size and single-center retrospective design limit the generalizability of the results. Future multicenter studies with larger cohorts and integrated meteorological and pollution data are required to confirm these findings and better define the underlying mechanisms.

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Previous presentation of data at meetings or in abstract form
None.

Clinical Trial Number
Not applicable.

Use of AI for Writing Assistance
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Authors' contributions
All authors have participated equally in conceiving and initiating the manuscript. All authors read and approved the final manuscript.

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Data availability
The data of the study results are available from the corresponding author upon request.

Code Availability
Not applicable.

Declarations

Ethics approval and consent to participate
The study was initiated after the ethics committee approval from ********* Health Sciences Ethics Committee (Date: 12.05.2025, No: 96/50). This research received no external funding.

Consent for publication
Signed consent was obtained for the use and publication of the patient's data.

Competing interests
The authors declare no competing interests.

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References

1. Carter BW, Tomiyama N, Bhora FY, de Christenson MLR, Nakajima J, Boiselle PM, Marom EM (2014) A modern definition of mediastinal compartments. J Thorac Oncol 9(9 Suppl):S97–S101
2. Magouliotis DE, Sgantzou I, Salemis NS, Rountas C, Samara A, Zotos PA et al (2023) Pneumomediastinum: experience with 87 patients. Acta Med Acad 52(2):88

3. Ito S, Takada Y, Tanaka A, Ozeki N, Yazaki Y (1989) A case of spontaneous pneumomediastinum in a trombonist [in Japanese]. Kokyu Junkan 37(12):1359–1362
4. Talwar A, Rajeev A, Rachapudi S, Khan S, Singh V, Talwar A (2024) Spontaneous pneumomediastinum: a comprehensive review of diagnosis and management. Intractable Rare Dis Res 13(3):138–147
5. Spiliopoulos K, Tsantsaridou A, Magouliotis DE, Charisi E, Kimpouri K, Salemis NS (2020) Spontaneous pneumomediastinum in a teenager after physical exercise: a benign and rare, but sometimes challenging, entity. Med Arch 74(4):315–317. https://doi.org/10.5455/medarh.2020.74.315-317
6. Song IH, Lee SY, Lee SJ, Choi WS (2017) Diagnosis and treatment of spontaneous pneumomediastinum: experience at a single institution for 10 years. Gen Thorac Cardiovasc Surg 65:280–284
7. Nair SM, Pinto V, Hirebile VK, Maroli R (2015) Spontaneous pneumomediastinum and subcutaneous emphysema in asthma exacerbation: an unusual presentation. Saudi J Med Med Sci 3(1):58–60
8. Baburao A, Das R, Shyamsunder S (2021) Pneumomediastinum, pneumopericardium, and subcutaneous emphysema—a rare complication in COVID-19 infection. Egypt J Bronchol 15(1):35
9. Kim KS, Jeon HW, Moon Y, Kim YD, Ahn MI, Park JK, Jo KH (2015) Clinical experience of spontaneous pneumomediastinum: diagnosis and treatment. J Thorac Dis 7(10):1817–1824
10. Lee SH, Seo YW, Kwak SG (2022) Influence of meteorological factors on development of spontaneous pneumothorax. Med (Baltim) 101(45):e31488
11. Canavar A, Erk M, Seyrek Y, Akçıl AM, Cansever N, Bedirhan MA, Cansever L (2024) Do atmospheric pressure and air pollution affect the incidence of primary spontaneous pneumothorax? Curr Thorac Surg 9(2):72–77
12. Kaneko Y, Utsushikawa Y, Deguchi H, Tomoyasu M, Kudo S, Shigeeda W et al (2021) Correlation with spontaneous pneumothorax and weather change, especially warm front approaching. J Thorac Dis 13(3):1584–1590
13. Daş M, Alar T, Delice O, Gedik İE, Bardakci O, Akman C et al (2021) The effect of meteorological variables on spontaneous pneumothorax in two regions with different altitudes. Int J Biometeorol 65(4):503–511
14. Liu YW, Chang YT, Kao CN, Chang PC, Chou SH (2023) Seasonal impact and risk factors of concurrent spontaneous pneumomediastinum and Pneumorrhachis in adolescents. ISEE Conf Abstr 2023(1):45–46
15. Smit HJ, Devillé WL, Schramel FM, Schreurs AJ, Sutedja TG, Postmus PE (1999) Atmospheric pressure changes and outdoor temperature changes in relation to spontaneous pneumothorax. Chest 116(3):676–681
16. Yamairi K, Yoshimatsu Y, Shimazu H, Kakuno S, Sawa N, Mizukubo Y et al (2021) Clinical analysis of 71 spontaneous pneumomediastinum cases: an observational study from a tertiary care hospital in Japan. Respir Investig 59(4):530–534
17. Wald L, Yergin C, Petroze R, Larson S, Islam S (2024) The unnecessary workups and admissions of adolescents and young adults with spontaneous pneumomediastinum. Sci Rep 14(1):4501
18. Alemu BN, Yeheyis ET, Tiruneh AG (2021) Spontaneous primary pneumomediastinum: is it always benign? J Med Case Rep 15:1–8
19. Freixinet J, García F, Rodríguez PM, Santana NB, Quintero CO, Hussein M (2005) Spontaneous pneumomediastinum long-term follow-up. Respir Med 99(9):1160–1163
20. Dionísio P, Martins L, Moreira S, Manique A, Macedo R, Caeiro F et al (2017) Spontaneous pneumomediastinum: experience in 18 patients during the last 12 years. J Bras Pneumol 43(2):101–105
21. Kaneki T, Kubo K, Kawashima A, Koizumi T, Sekiguchi M, Sone S (2000) Spontaneous pneumomediastinum in 33 patients: yield of chest computed tomography for the diagnosis of the mild type. Respiration 67(4):408–411
22. Takada K, Matsumoto S, Hiramatsu T, Kojima E, Shizu M, Okachi S et al (2009) Spontaneous pneumomediastinum: an algorithm for diagnosis and management. Ther Adv Respir Dis 3(6):301–307
23. Al-Mufarrej F, Badar J, Gharagozloo F, Tempesta B, Strother E, Margolis M (2008) Spontaneous pneumomediastinum: diagnostic and therapeutic interventions. J Cardiothorac Surg 3:1–4
24. Iyer VN, Joshi AY, Ryu JH (2009) Spontaneous pneumomediastinum: analysis of 62 consecutive adult patients. Mayo Clin Proc 84(5):417–21
25. Perna V, Vilà E, Guelbenzu JJ, Amat I (2010) Pneumomediastinum: is this really a benign entity? When it can be considered as spontaneous? Our experience in 47 adult patients. Eur J Cardiothorac Surg 37(3):573–575
26. Motes A, Laoveeravat P, Thongtan T, Nugent K, Islam S, Islam E (2021) Marijuana use–induced spontaneous pneumomediastinum. Bayl Univ Med Cent Proc 34(2):274–275

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