Observational Study

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Intrathoracic gas effusions in patients with COVID-19

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Abstract

Current evidence suggests that intrathoracic gas effusions (pneumomediastinum and pneumothorax) may be observed among COVID-19 patients even without mechanical ventilation. Here, we report 9 patients who developed spontaneous intrathoracic gas effusions in the absence of mechanical ventilation. The incidence of spontaneous intrathoracic gas effusions is low at 0.5% in hospitalized COVID-19 patients in the absence of respiratory support. Two patients (22.2%) had spontaneous pneumomediastinum, with or without subcutaneous emphysema. Three patients (33.3%) had pneumomediastinum associated with pneumothorax, with or without subcutaneous emphysema, and 4 patients (44.4%) had spontaneous pneumothorax. The Pneumothorax was unilateral in 66.6% of cases (6/9) but without location preference. Five of our patients were smokers, of whom 80% had isolated spontaneous pneumothorax. Other comorbidities included pulmonary tuberculosis in a single patient, diabetes in 2 patients and arterial hypertension in 1 patient. None of the patients had respiratory comorbidities. All of our patients were male. The average duration of hospital stay was 10 days (±6.63). All patients required oxygen therapy. Three patients (33.3%) with spontaneous pneumothorax required chest drainage. The evolution was favorable in 6 patients (66.7%) and worse in 3 cases (33.3%). The respiratory manifestations of COVID-19 have been stereotyped. Intrathoracic effusions may also be signs of COVID-19 with varying prognoses, or even the only presentation of the disease. This should be considered in clinical practice, and doctors are encouraged to request a SARS-CoV-2 test in this situation. Further investigations with a larger sample size are needed to identify the prognostic factors in COVID-19 patients with gas effusions.

Abbreviations: CT = computed tomography.

Keywords: COVID-19, intrathoracic gas effusions, Morocco, pneumomediastinum, pneumothorax

1. Introduction

During the COVID-19 pandemic, several complications have been reported, including, thromboembolic, cardiac, renal, and neurological. Intrathoracic gaseous effusions (spontaneous pneumothorax and pneumomediastinum) have also been described as complications linked to SARS-CoV-2. A systematic review reported that 0.3% of COVID-19 patients developed pneumothorax,[1] whereas this incidence is more elevated in patients on mechanical ventilation with a poor prognosis.[2]

Here, we report 9 patients who developed spontaneous intrathoracic gas effusions in the absence of mechanical ventilation.

2. Patients and Methods

We present a case series of 9 patients with COVID-19 admitted to the COVID-19 intensive care unit at the University Hospital Center of Tangier between July 2020 and January 2021. We cared for 1700 patients in this period. The diagnosis of COVID-19 was confirmed by reverse transcription-polymerase chain reaction (RT-PCR) and/or computed tomography (CT) chest scan with a COVID-19 Reporting and Data System (CORADS) score of 5. These patients developed spontaneous pneumothorax with or without spontaneous pneumomediastinum associated with or without subcutaneous emphysema in the absence of mechanical ventilation. Demographic, clinical, biological, and imaging data were collected from the medical records.

3. Results

All our patients were men. The average age was 58.33 years, 44 to 73 years (Table 1). Two patients (22.2%) had spontaneous pneumomediastinum, with or without subcutaneous emphysema. Three patients (33.3%) had pneumomediastinum associated with pneumothorax with or without subcutaneous emphysema, and 4 patients (44.4%) had isolated spontaneous pneumothorax (Table 2). Gas effusions associated with lesions suggestive of COVID-19 (peripheral, bilateral, and basal ground glass opacities) were present on the chest CT scan at admission in 8 patients (88.9%). One patient (11.1%) developed

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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Table 1

Demographic and clinical characteristics of patients.

Variable	Patients (N = 9)
-**Age** (Average)	58.3 (44–73)
-**Sex, n** (%)	
Male	9 (100)
Female	0
-**BMI** (n = 7) Average **(%)**	22.28 (17.2–27.47)
-**Tobacco, n** (%)	
Smokers	4(44.4)
No-smokers	4(44.4)
Ex- smokers	1(11.1)
-**Comorbidity, n** (%)	
Asthma	0
COPD	0
AHT	1(11.1)
Diabetes	2(22.2)
Tuberculosis history	1(11.1)
-**Average time between onset of gas effusion and onset of symptoms** (d)	10.11 (2–21)
-**Symptoms, n (%)**	
Dyspnea	8(88.9)
Dry cough	7(77.8)
chest pain	3(33.3)
Anosmia	2(22.2)
Fever	4(44.4)
Headache	3(33.3)
Myalgia	2(22.2)
- **Vital Parameters, Average**	
Initial SpO2 (%)	83 (68–91)
Initial respiratory rate (cycles/min)	29.33(20–45)
Cardiac frequence (bat/min)	105.56 (98–122)
Systolic blood pressure (mm Hg)	120 (100–140)
Diastolic blood pressure (mm Hg)	77.22(60–90)
Initial temperature	36.82 (36–39)

AHT = arterial hypertension, BMI = body mass index, COPD = chronic obstructive pulmonary disease.

Table 2

Distribution of intrathoracic gas effusions in our series.

Symptoms	Patients (n)
IsolatedPneumomediastinum	1
Pneumomediastinum + Left Pneumothorax + Subcutaneous emphysema	1
Pneumomediastinum + Left Pneumothorax	1
Pneumomediastinum + Subcutaneous emphysema	1
Pneumomediastinum + Bilateral Pneumothorax + Subcutaneous emphysema	1
Right Pneumothorax	3
Left Pneumothorax	1

gas effusion 3 days after his hospitalization. The average size of the lesions was 36.67% (15%–80%). A CORADS score 5 was found in 55.6% of patients, and a CORADS score 6 was detected in 44.4% patients. A diffuse honeycomb in bilateral lower lobe lung was also observed (11.1%). Bubbles of emphysema were noted in 44.4% of our patients. The Pneumothorax was right-sided in 33.3%, left-sided in 33.3%, and bilateral in 11.1% of cases. The scanographic sections of our patients are shown in Figures 1, 2. Nasopharyngeal swab tests were positive in 4 patients, negative in 2 patients, and not performed in 3 patients. Five of our patients were smokers, 80% had isolated spontaneous pneumothorax. One patient had a history of pulmonary tuberculosis, 2 patients presented with diabetes, and 1 patient had arterial hypertension. Respiratory comorbidities were not observed. Dyspnea was the most common symptom (88.9%), followed by dry cough (77.8%), fever (44.4%), and chest pain (33.3%). The average time between the onset of gas effusion and the symptoms was 10.11 days (±6.5). In all patients, gas effusion was present before invasive or noninvasive mechanical ventilation. Due to worse evolution, chest CT angiography was performed in 5 patients, of whom 2 presented with pulmonary embolism. The majority of patients (77.8%) received a combination of (azithromycin, hydroxychloroquine) and systemic corticosteroid therapy, whereas azithromycin alone was administered in 22.2% of our cases. All the patients required oxygen therapy. The average flow rate of oxygen therapy in all patients was 10 L/minutes (5 to 15 liters), where 33.3% of cases received oxygen with nasal cannula and 66.7% received a high-concentration mask. Our patients with spontaneous pneumomediastinum associated or not with pneumothorax were treated with oxygen therapy. Three patients (33.3%) with spontaneous pneumothorax required chest drainage. noninvasive ventilation (spontaneous mode + pressure support + positive expiratory pressure) was administered for 24 hours in 33.3% of patients, followed by oxygen therapy in 66.6%, and intubation with mechanical ventilation in 33.3 % of cases due to respiratory distress. The average duration of hospital stay was 10 days (±6.63). Chest CT scan performed during follow-up showed that the gas effusions regressed in 6 patients (66.7%). Three patients (33.3%) died (2 on D8 and D10 of hospitalization due to cardiorespiratory arrest of undetermined cause and 1 patient on D17 of hospitalization due to hypoglycemia) (Table 3).

4. Discussion

Published data showed that the incidence of pneumothorax during COVID-19 viral pneumonia increases up to 24% in patients on mechanical ventilation.[2] Several case reports of spontaneous pneumomediastinum associated with or without spontaneous pneumothorax with or without subcutaneous

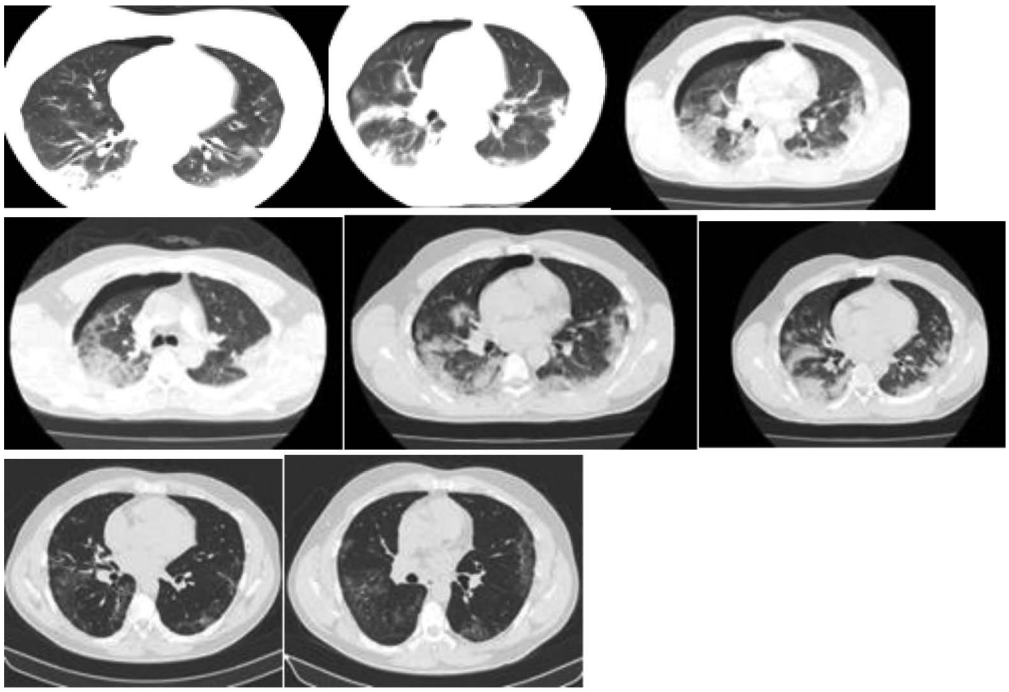

Figure 1. Axial section of 1 patient showing a right low abundance pneumothorax with peripheral bilateral ground-glass opacities associated with condensations.

emphysema have been reported in COVID-19 patients, even without a related cause, invasive, and noninvasive mechanical ventilation.[3,4] However, the incidence of spontaneous pneumothorax and pneumomediastinum in these patients remains unknown.[5] In our series, the incidence of spontaneous intrathoracic gas effusions is low at 0.5% in hospitalized COVID-19 patients in the absence of respiratory support.

The pathophysiological mechanism of spontaneous pneumothorax and/or pneumomediastinum remains poorly understood. The most reported mechanism is the so-called "Macklin effect," which consists of intra-alveolar hyperpressure leading to rupture of the alveolar wall with propagation of air in the interstitial spaces along the bronchovascular sheaths.[6] This suggests that the mechanism most likely involved in our series is alveolar rupture caused by diffuse lung damage related to COVID-19 pneumonia, increased alveolar pressure during coughing episodes, and rupture of emphysema bubbles.[7–9]

Many risk factors are involved in the development of intrathoracic gas effusions, including tobacco, drug addiction (cocaine), persistent cough, asthma, chronic obstructive pulmonary disease, and mechanical ventilation.[10–12] In our patients, the occurrence of gas effusions was spontaneous in the absence of any invasive or noninvasive mechanical ventilation. Cough related to COVID-19 pneumonia and smoking (77.8% and 55.5%, respectively) were the most frequent risk factors in our study. In contrast, Miro et al observed that nonsmokers had a 5.46-fold increased risk of developing spontaneous pneumothorax in patients with COVID-19 pneumonia compared to patients with pneumothorax and not infected with SARS-CoV-2. According to this study, there was no association between the development of spontaneous pneumothorax and smoking in patients with COVID-19 pneumonia.[13]

A review by Quincho-Lopez et al showed that the majority of cases of intrathoracic gas effusions occurring in patients with SARS-COV-2 pneumonia were male.[3] Similarly, we described a male predominance in our series, which may be explained by the fact that men are generally more frequently affected by COVID-19 pneumonia.[14] This is correlated with the epidemiological profile of COVID-19 in our country, showing a predominance of males (M/F ratio = 1.28).[15]

Our patients presented with symptoms of COVID-19 pneumonia. Dyspnea was the most common symptom (88.9%), followed by dry cough (77.8%), fever (44.4%), and chest pain (33.3%). This is in accordance with a study by Miro et al[13] These symptoms are not specific to COVID-19 disease.[13] The average time between onset of gas effusion and onset of symptoms was 10.11 days (±6.5). This is in agreement with the data from a study by Ding et al[16] However, a study from Hong Kong during the SARS CoV-1 pandemic in 2002-2003 reported more important delays between the development of pneumomediastinum and the onset of symptoms (19.6 days ± 4.6).[17]

The Pneumothorax was unilateral in 66.6% (6/9) of cases, but without location preference, which is in contrast to findings from Miro et al, which reported a predominance of spontaneous pneumothorax in the right lung (81%).[13]

In summary, based on our findings, the severity of lesions, the presence of comorbidity, and an underlying fibrotic lesion may be prognostic factors for intrathoracic gas effusions in our series.

5. Conclusion

Intrathoracic gas effusion is a possible complication of COVID-19 pneumonia. This is probably due to the mechanism of alveolar wall rupture secondary to extensive lung damage and/or by an increase in alveolar pressure during coughing episodes, and also by rupture of an emphysema bubble. The most important risk factors in our study were cough and smoking. The severity of lesions, the presence of comorbidity, and an underlying fibrotic lesion may be prognostic factors for intrathoracic gas effusions. Further investigations with a larger sample size are needed to identify the prognostic factors in COVID-19 patients with gas effusions.

Author contributions

Data curation: Fatima El Bozouiki, Mohamed Moumkin, Jihane El Melhaoui.
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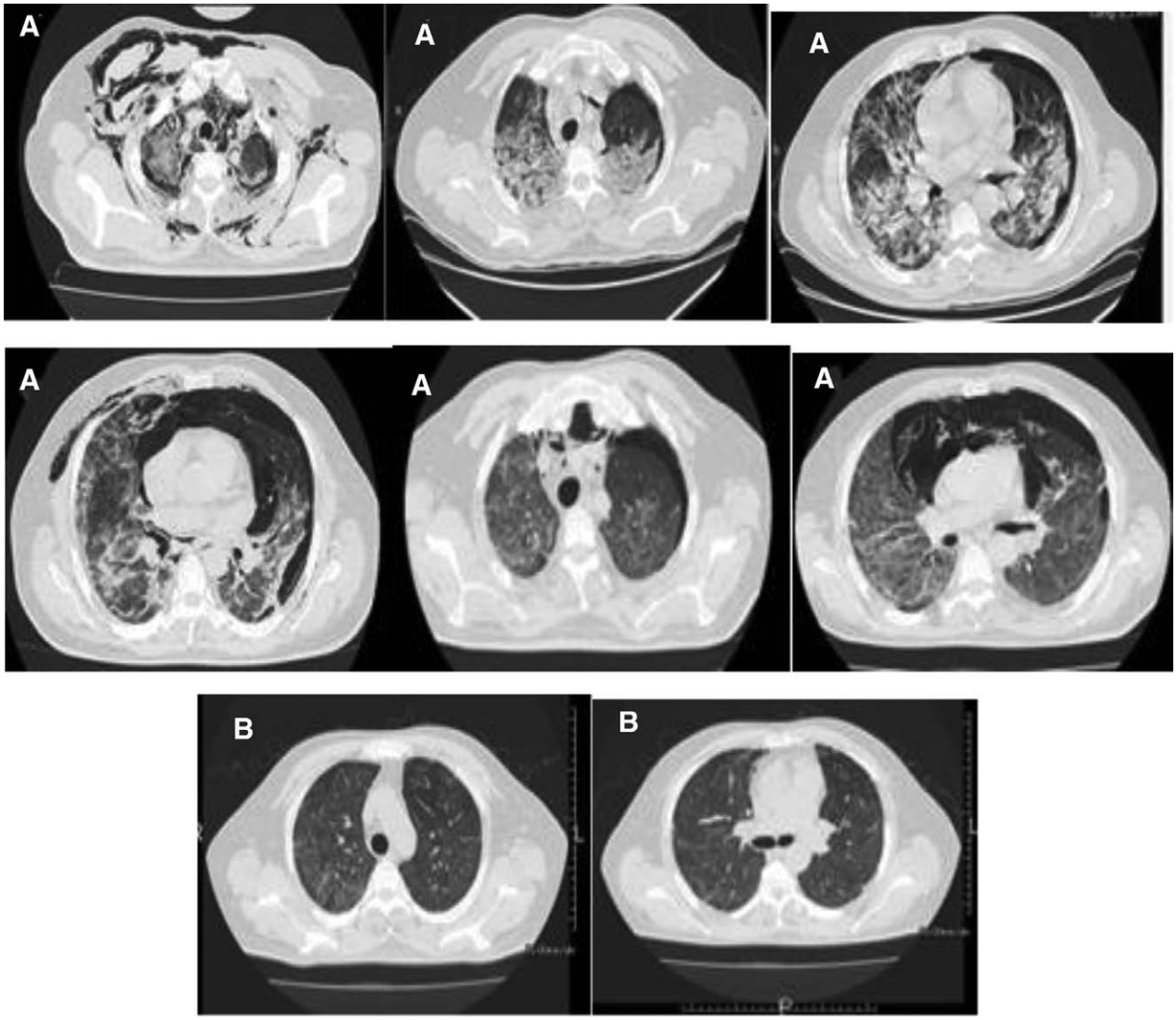

Figure 2. A. Axial sections of 1 patient showing left low abundance pneumomediastinum and pneumothorax and subcutaneous emphysema with bilateral ground-glass opacities. B. Axial sections showing the persistence of bilateral diffuse ground-glass foci associated with some basal reticulations after 3 months.

Table 3

Patient evolution.

	Favorable Evolution (%)	Worse Evolution (%)
Oxygen therapy	66.6	33.3
Non invasive Ventilation	11.1	22.2
Intubation	0	11.1

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