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Case report

Case report: Spontaneous pneumothorax in resolved, uncomplicated COVID-19 Pneumonia-A literature review

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ABSTRACT

As the global COVID-19 pandemic has progressed, awareness of uncommon presentations and complications has increased. The actual incidence of spontaneous pneumothorax was found to be 0.66%, or six patients out of 902 who tested positive in recently published literature of 3368 patients (Zantah M, Dominguez Castillo E, Townsend R, Dikengil F, Criner GJ. Pneumothorax in COVID-19 disease-incidence and clinical characteristics. Respir Res. 2020 Sep 16; 21 (1):236.). Of those six patients, only two (0.22%) were not associated with mechanical ventilation barotrauma or comorbid lung disease such as COPD. Here, we present a spontaneous pneumothorax and pneumomediastinum in a patient four days after he had been discharged from hospitalization due to uncomplicated COVID-19 pneumonia.

1. Introduction

Since the first outbreak in Wuhan, China in December of 2019, coronavirus (COVID-19) due to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has swept the globe causing a massive pandemic. Common symptoms that have been identified include fever, cough, dyspnea, headache, abdominal pain, nausea/vomiting, myalgia, diarrhea, pharyngitis, rhinorrhea, fatigue, and loss of smell and/or taste [2]; although some of those infected can be asymptomatic [3]. There have also been fairly common complications of COVID-19 pneumonia that have been recognized which include but are not limited to: respiratory failure/acute respiratory distress syndrome, pulmonary fibrosis, arrhythmias, acute cardiac injury, shock, thromboembolic events, and inflammatory complications [4]. Consequently, many COVID-19 patients have been treated with invasive ventilation. It is well established that mechanical ventilation can cause barotrauma and resultant pneumothorax or pneumomediastinum. Consequently, many mechanically ventilated COVID-19 infected patients have suffered from these complications. However, reports of spontaneous pneumothorax, tension pneumothorax, or pneumomediastinum as a result of COVID-19, in the absence of underlying lung disease or barotrauma due to mechanical ventilation are rare. Therefore, we describe a case of secondary spontaneous pneumothorax and pneumomediastinum in a patient with resolved, uncomplicated COVID-19 pneumonia.

2. Narrative

A 72-year-old male with a past medical history of coronary artery disease, coronary artery bypass graft surgery, hypertension, and prediabetes presented to the emergency room with seven days of progressively worsening malaise, fatigue, weakness, fever, sore throat, cough, and dyspnea. He was never a smoker and was never diagnosed with chronic lung disease. Chest x-ray (CXR) was significant for mild scattered patchy opacities bilaterally, and computed tomography (CT) was significant for patchy ground-glass opacities bilaterally (Fig. 1A and B). He was found to be COVID-19 positive but was stable with an oxygen saturation (O2 SAT) of 95% on room air. He was subsequently discharged home on standard COVID-19 precautions. Two days later, he returned to the emergency room with worsening dyspnea and cough, productive of whitish sputum; he was in acute hypoxic respiratory failure with an O2 SAT of 86% on room air. CXR was notable for passive atelectasis in the lung bases due to a poor inspiratory effort as well as foci of increased interstitial change in the right mid-lung zone and lateral left base which could also have been due to atelectasis or pneumonitis. The patient was admitted to the intermediate care unit with telemetry under COVID-19 precautions and started on supplemental

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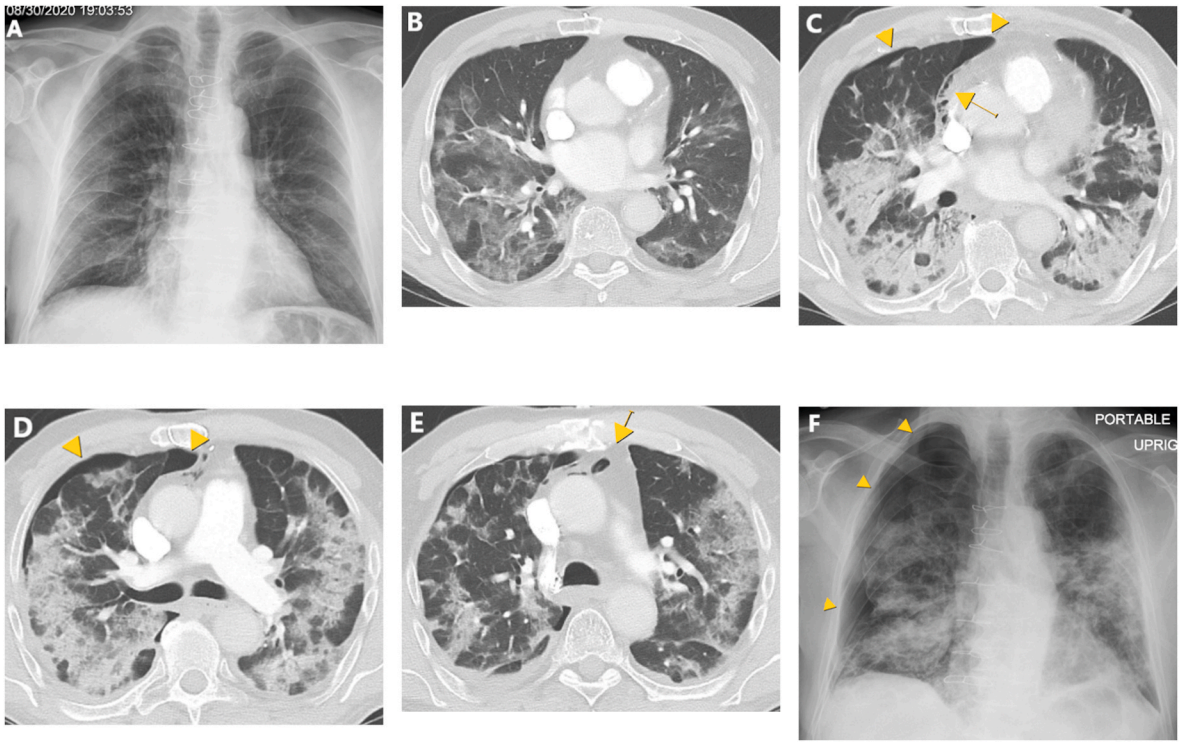

Fig. 1. CXR (A) from first admission demonstrating mild scattered patchy opacity bilaterally and CT (B) with patchy ground-glass opacities bilaterally; no evidence of pneumothorax or pneumomediastinum. CT images (C,D,E) from the second admission date demonstrating anterior-lateral pneumothorax (yellow arrowheads) and small pneumomediastinum (yellow arrows). Portable CXR (F) prior to chest tube placement demonstrating the pneumothorax enlarged to approximately 30% (yellow arrowheads). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

oxygen, enoxaparin, intravenous (IV) dexamethasone as well as remdesivir. The following day, he was given two units of COVID-19 convalescent plasma and placed on 2 L oxygen (O2) to maintain an O2 SAT of 95%. However, the patient deteriorated over the next 24 hours requiring 35 L of high flow nasal cannula with fraction of inspired oxygen (FiO2) of 50% to maintain an O2 SAT of 86%. Awake prone positioning was initiated for as often as the patient could tolerate. Over the next nine days, the patient's status slowly improved, although CXR remained unchanged. By day 14 after admission, the patient was maintaining an O2 SAT above 90% on room air, was afebrile, stable, and subsequently discharged.

Four days after discharge, the patient again returned to the emergency room with complaints of dyspnea, cough, and pleuritic type chest pain. He was hypoxic with an O2 SAT in the mid 80's on room air. He was otherwise hemodynamically stable and afebrile. Laboratory evaluation did not reveal any leukocytosis or significant derangements on his complete blood count (CBC) or basic metabolic panel (BMP). His procalcitonin and lactic acid were both normal at 0.09 ng/ml and 1.4 mmol/L respectively. However, his D-dimer, ferritin, and fibrinogen were each elevated at 0.93 mcg/mL, 515 ng/mL, and 520 mg/dL respectively. Additionally, C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) were both elevated. He was sent for a chest CT that did not show evidence of pulmonary embolism, although he continued to demonstrate ground-glass and consolidative opacities predominantly involving the mid to lower lung zones with scattered peripheral ground-glass opacities in the upper lobes bilaterally. Additionally, there was a small, 1 cm right anterior-lateral pneumothorax and small pneumomediastinum identified (Fig. 1C and D,E). The patient was once again admitted in order to monitor the pneumothorax, systemic inflammatory response syndrome, and to begin IV cefepime and azithromycin for possible superimposed bacterial pneumonia with recent COVID-19 infection. He was placed on 5 L nasal cannula supplemental oxygen and given breathing treatments of albuterol, metered-dose inhaler, as needed. Following infectious disease consultation, the patient's antibiotic regimen was changed from azithromycin to vancomycin. Over the course of the next five days, the pneumothorax progressively enlarged to approximately 30% (Fig. 1 F). At its largest size, the apical portion measured 3.7 cm from the upper chest wall and 3.1 cm from the lateral chest wall. General surgery was consulted for chest tube placement, and follow-up imaging demonstrated satisfactory position with near complete resolution of the pneumothorax. During the five days following the chest tube placement, the patient required 13 L of Optiflow and received dexamethasone and enoxaparin. He improved steadily until he became hemodynamically stable with an O2 SAT of 92% on 7 L of O2 by nasal cannula. The pneumothorax resolved, the chest tube was removed, and he was weaned down to 3 L of O2 by nasal cannula gradually over the course of the next two weeks. He was subsequently discharged home on hospital day 25 with supplemental oxygen.

3. Discussion

COVID-19 infection has been shown to rarely cause spontaneous pneumothorax, with an incidence of <1% although this may be underreported [5]. Additionally, these patients are often treated with invasive ventilation leading to barotrauma or have multiple pre-existing cardiopulmonary comorbidities [6]. However, we report a patient who had no prior lung injury, was never a smoker, and did not receive invasive ventilation. While the mechanism of spontaneous pneumothorax is frequently secondary to complications of cystic lung lesions, the mechanism in COVID-19 infection is less well understood. Known risk factors for spontaneous pneumothorax include male sex, thin and tall body habitus, smoking, trauma, and infection [7]. In COVID-19 infections, it is thought that the inflammatory response and ischemic damage within the lung parenchyma predisposes to cell adhesion between type I and type II pneumocytes, alveolar damage, and subsequent rupture [8].

Table 1
Literature review of COVID-19-associated pneumothorax in patients without history of mechanical ventilation or prior lung disease.

Serial Number	Author/published Year/country	Number of relevant cases/total cases	Age (years)	Gender	Comorbidities	Diagnosis	Treatment/ Intervention	Outcome
1.	Sun R et al. [21], March 2020, Wuhan, China	1	38	Male	Nil	Left pneumothorax	Conservative	Recovered
2.	Wang W et al. [25], August 2020, Zhejiang, China	1	62	Male	Nil	Right pneumothorax, pneumomediastinum, subcutaneous emphysema	Conservative	Recovered
3.	Wang J et al. [10], March 2020, Guangzhou, China	1	36	Male	Nil	Pneumomediastinum	Conservative	Expired
4.	Rohailla S et al. [11], May 2020, Toronto, Canada	1	26	Male	Nil	Right pneumothorax	Chest tube	Recovered and discharged
5.	Ucpinar BA et al. [12], May 2020, Istanbul, Turkey	1	82	Female	Nil	Left pneumothorax, pneumomediastinum, subcutaneous emphysema (neck, post. thoracic wall)	Chest tube	Recovered and discharged
6.	Quincho-Lopez A et al. [13], July 2020, Lima, Peru	1/2	31	Male	Chronic gastritis, hypercholesterolemia	Pneumomediastinum	Conservative	Recovered and discharged
7.	Lopez Vega JM et al. [14], June 2020, Madrid, Spain	3	84 67 73	Female Male Male	Hypertension, prosthetic heart valve, chronic kidney disease, and congestive cardiac failure Not reported Basal cell epithelioma, OSA, depression	Right hydropneumothorax Bilateral pneumothorax, pneumomediastinum Pneumomediastinum	Conservative Chest tube CPAP	Expired Expired Expired
8.	Hollingshead C et al. [15]., June 2020, Ohio, USA	1	50	Male	Nil	Right posterior pneumothorax	Chest tube	Not reported
9.	Eperiesiova B et al. [16], July 2020, Michigan, USA	4/7	54 Not Reported Not Reported Not Reported	Female Not Reported Not Reported Not Reported	Hypertension Not Reported Not Reported Not Reported	Pneumomediastinum, subcutaneous emphysema Left pneumothorax, Pneumomediastinum Right pneumothorax Right pneumothorax	Conservative Chest Tube Chest Tube Chest Tube	Recovered and discharged Not Reported Not Reported Not Reported Not Reported
10.	Mallick T et al. [17], July 2020, New York, USA	3/3	40 68 58	Male Male Female	Smoker Nil Hypertension	Right pneumothorax Bilateral pneumothorax, pneumomediastinum, subcutaneous emphysema Right pneumothorax, Pneumomediastinum, subcutaneous emphysema	Chest tube Chest tubes Pleural cavity decompression	Expired Recovered and discharged Recovered and discharged
11.	Ferreira JG et al. [18], August 2020, Rio de Janiero, Brazil	1	45	Male	Nil	Left tension pneumothorax	Chest tube	Recovered and discharged
12.	Spiro JE et al. [2], June 2020, Munich, Germany	1	47	Male	Nil	Right tension pneumothorax	Chest tube	Recovered and discharged
13.	Khurram R et al. [19], August 2020, London, United Kingdom	1	64	Male	Nil	Right tension pneumothorax	Chest tube	Recovered and discharged
14.	Martinelli AW et al. [20], September 2020, Cambridge, United Kingdom	18/62	Varies[a]	Varies[a]	Varies[a]	Varies[a]	Varies[a]	Varies[a]
15.	Chen X et al. [5], September 2020, Wuhan, China	1	66	Male	Nil	Left pneumothorax	Chest tube	Recovered and discharged
16.	Fan Q et al. [22], September 2020, Wuhan, China	1	32	Male	Nil	Left pneumothorax, subpleural bulla	Chest tube	Recovered and discharged
17.	Alhakeem A et al. [3], July 2020, Doha, Qatar	1	49	Male	Nil	Bilateral pneumothorax	Chest tubes	Stable
18.		1	73	Female	Breast cancer	Left pneumothorax	Conservative	

(*continued on next page*)

Table 1 (*continued*)

Serial Number	Author/published Year/country	Number of relevant cases/total cases	Age (years)	Gender	Comorbidities	Diagnosis	Treatment/ Intervention	Outcome
	Borghesi A et al. [23], July 2020, Brescia, Italy							Recovered and discharged
19.	Gurkan O et al. [24], June 2020, Istanbul, Turkey	1	24	Male	Nil	Left pneumothorax	Conservative	Recovered and discharged
20.	Zantah M et al. [1], September 2020, Pennsylvania, USA	2/6	49 81	Male Female	Nil Not reported	Left pneumothorax Bilateral pneumothorax	Chest tube Chest tubes	Expired Expired
21.	Ahluwalia AS et al. [26], September 2020, New York, USA	1	31	Male	Nil	Left tension pneumothorax, right pneumothorax, pneumomediastinum, pneumopericardium	Chest tube	Recovered and discharged
22.	Janssen ML et al. [27], August 2020, Rotterdam, the Netherlands	1/3	63	Male	Nil	Right pneumothorax	Chest tube	Recovered and discharged
23.	Gonzalez-Pacheco et al. [9], July 2020, Mexico City, Mexico	1	45	Male	Nil	Bilateral pneumothorax	Chest tubes	Recovered and discharged
24.	Al-Shokri SD et al. [28], July 2020, Doha, Qatar	1/3	50	Male	Not reported	Right tension pneumothorax	Chest tube	Recovered and transferred
25.	Sahu KK et al. [29], August 2020, Massachusetts, USA	1	61	Male	Hypertension	Pneumomediastinum, pneumopericardium, subcutaneous emphysema	Intubation	Expired
26.	Yasukawa K et al. [30], July 2020, Washington DC, USA	1	37	Male	Nil	Right tension pneumothorax, right bulla	Chest tube	Recovered and discharged
27.	Carvalho do Lago VC et al. [6], July 2020, Sao Paulo, Brazil	2	34 62	Male Male	Nil Ex-smoker	Left pneumothorax Right pneumothorax	Chest tube Chest tube	Stable Stable
28.	Lei P et al. [31], April 2020, Guiyang, China	1	64	Male	Nil	Pneumomediastinum	Conservative	Recovered
29.	Zhou et al. [32], April 2020, Hangzhou, Zhejiang, China	1	38	Male	Not reported	Pneumomediastinum, subcutaneous emphysema	Conservative	Recovered and discharged
30.	Correa Neto et al. [33], May 2020, Sao Paulo, Brazil	1	80	Female	Hypertension, CAD	Pneumothorax, pneumoperitoneum	Intubation, chest tube, exploratory laparotomy	Expired
31.	Kolani et al. [34], May 2020, Fez, Morocco	1	23	Female	Nil	Pneumomediastinum	Conservative	Recovered and discharged
32.	Lacroix M et al. [35], May 2020, Paris, France	1	57	Male	Not reported	Pneumomediastinum, subcutaneous emphysema	Intubation	Not reported

[a] Data for each case varies. To be conscientious of space, these were not individually reported.

Finally, the severity of associated symptoms in COVID-19 infection may lead to increased respiratory effort and cough due to the resulting ventilation/perfusion mismatch and contribute to alveolar cystic rupture [8].

While the risk of spontaneous pneumothorax in COVID-19 infection is uncertain, it is reasonable to predict that patients receiving invasive ventilation, or other predispositions to spontaneous pneumothorax may have an increased risk. However, the associated severity and prognosis of spontaneous pneumothorax concomitantly in COVID-19 infection has yet to be established [9]. Interestingly, in our case study and others, pneumothorax occurred days to weeks after onset of symptoms [1–6, 9–35]. Even though our patient did not present with evidence of cysts or bullae on initial CXR or CT, the delayed time frame to onset of pneumothorax could have given rise to pulmonary changes which predisposed him to pneumothorax. Thus, initial inflammatory insult and resulting increased respiratory effort due to COVID-19 may inflict micro-lesions within the tissue which predispose patients to spontaneous pneumothorax, but require weeks for adequate cystic lesions to develop, thus enabling pneumothorax to occur [3].

Review of the current literature reveals 32 case reports of spontaneous pneumothorax or pneumomediastinum in 58 COVID-19 pneumonia infections, of which 14 patients expired and 43 underwent chest tube placement (Table 1). Thus, spontaneous pneumothorax is a known complication of COVID-19 infection, although with an undetermined prevalence and long-term risk.

4. Conclusion

Spontaneous pneumothorax in COVID-19 infection is a rare, emergent, but treatable complication and may present days to weeks after apparent resolution of initial COVID-19 symptoms. Clinicians should consider spontaneous pneumothorax in patients with acute dyspnea and chest pain, particularly if they have a recent history of COVID-19 pneumonia. Additionally, the hypothesized underlying mechanism may increase a patient's risk for pneumothorax even weeks after recovery from COVID-19 infection, due to lung insult and subsequent increased respiratory effort. However further research is needed in this area.

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Declaration of competing interest

All named authors declare that they have no conflict of interests, financial or otherwise.

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