Original Article

Spontaneous pneumomediastinum and subcutaneous emphysema in patients with COVID-19

ABSTRACT

Background: Coronavirus disease 2019 is an infectious disease caused by severe acute respiratory syndrome virus coronavirus 2 (SARS-COV-2). Many aspects of its pathology and pathogenesis are not well understood.

Material and Methods: We describe a series of spontaneous air leak cases we found in our coronavirus disease 2019 (COVID-19) positive 1086-patient cohort.

Results: Two out of six patients eventually required mechanical ventilation and succumbed to COVID-19. We presume that acute lung injury leading to SARS-CoV-2 with associated acute respiratory distress syndrome predisposes patients to this complication.

Conclusion: This series is presented to highlight the emerging association of COVID-19 with spontaneous air leaks leading to pneumomediastinum, pneumothorax, and subsequent subcutaneous emphysema even in patients who have never received invasive mechanical ventilation and this may be more likely with the institution of high flow nasal cannula.

Key words: ARDS; COVID -19; SARS-COV-2

Introduction

Coronavirus disease 2019 is an infectious disease caused by severe acute respiratory syndrome virus coronavirus 2 (SARS-COV-2). The disease has caused significant morbidity and mortality across the world. This disease mainly affects the lungs and common findings include fever, cough, shortnesss of breath. While it is known that forceful coughing may lead to spontaneous pneumothorax in COPD patients, in our series, only one patient was a known case of COPD and five out of six patients had no prior pulmonary disease. Oxygen therapy is the mainstay of treatment and may be given via oxygen mask, noninvasive ventilation including use of high flow nasal cannula (HFNC), bilevel positive airway pressure (BIPAP), and in severe cases via invasive ventilation. According to WHO guidelines statement,[1] the use of HFNC is placed prior to intubation and invasive ventilation in the overall plan of Covid-19 management. Similarly, the

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surviving sepsis guidelines of Society of Critical Care Medicine recommends the use of HFNC when conventional oxygen therapy fails and preferentially over noninvasive ventilation.[2] Computed tomography (CT) has an important role in the evaluation and follows up of Covid-19 patients. We present a series of cases that developed subcutaneous emphysema and pneumothorax accompanying Covid-19 pneumonia after institution of HFNC.

Materials and Methods

In our hospital cared for 1086 coronavirus disease 2019 or COVID-19 (SARS-CoV-2), patients between April 1 and August 15, 2020. Out of these, six cases developed spontaneous air leak. One patient developed pneumomediastinum, three patients developed surgical emphysema along with pneumomediastinum and two developed an isolated pneumothorax. All the case files of patients with spontaneous air leak were retrospectively reviewed. All the data was analyzed.

Results

The demographic, clinical, laboratory, and imaging data of the six patients who developed a spontaneous air leak are provided in Table 1. The first patient was a 35-year-old nonsmoker obese (BMI 31) male with no other comorbidities, presented with fever. He was hemodynamically stable but with mild hypoxemia, COVID-19 positive by RTPCR and had elevated inflammatory markers. Gradually his hypoxemia worsened requiring HFNC at 40 L/min with FiO2 80% on the 9th day of symptom onset. On the 10th day of symptom onset, he developed subcutaneous emphysema over his neck. CT scan showed changes consistent with acute respiratory distress syndrome (ARDS) plus pneumomediastinum with subcutaneous emphysema extending into the neck [Figure 1]. HFNC was continued and weaned over 5 days with clinical improvement. Successive CT scans showed a resolution of pneumomediastinum without any surgical intervention [Figure 1].

The second patient was an 80-year-old male patient with the known history of hypertension. He was a nonsmoker admitted with complaint of shortness of breath and had an oxygen saturation of 83% on room air and 95% on oxygen with nonrebreathing mask. After a day of admission, his work of breathing increased and he was put on HFNC with FiO_2 70% and flow of 30 L/min. The next day, he developed surgical emphysema extending to the neck and pneumomediastinum with mild pneumothorax. He was gradually weaned off HFNC over 2 days. No surgical intervention was required.

Another 65-year-old male patient with history of chronic smoking with emphysematous lung changes on chest X-ray was admitted with severe cough and high-grade fever. His oxygen requirement increased and was put on HFNC with Fio2 90% and flow rate 50 L/min. After 4 days of HFNC ventilation, chest X-ray revealed a right-sided pneumothorax and an intercostal drain (ICD) was inserted. However the patient's condition continued to deteriorate and he required endotracheal intubation and invasive ventilation. He eventually succumbed to the disease.

A 26-year-old female patient with fever and severe cough without any history of smoking developed left spontaneous pneumothorax. A left ICD was inserted. The patient recovered well without any ventilator support.

A 45-year-old female put on HFNC in view of respiratory distress developed pneumomediastinum and surgical emphysema. She subsequently required endotracheal intubation and invasive ventilation and eventually succumbed.

Table 1: Demographic, laboratory, and radiological data for six COVID-19 patients with spontaneous air leak

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Age	35	80	65	26	45	29
Sex	m	m	m	F	f	m
Serum creatinine at admission	0.8	0.7	1.0	0.8	1.2	1.1
Diabetes	no	no	no	No	yes	no
Timing of air leak in relation to invasive ventilation	Never intubated	Never intubated	Never intubated	Never intubated	Before	Before
Pneumomediastinum (PM)/Subcutaneous emphysema (SE)/Pneumothorax (PTX)	PM, SE extending into the neck	PM, SE	PM	Left PTX	PM, SE	Right PTX
Days from symptom onset to event	10	09	12	10	8	13
Cough	No known cough	Mild cough	mild	Forceful	mild	Forceful
Maximum respiratory rate	24	18	30	20	17	28
Smoking status	Active	Never	Never	Never	Never	Active
History of pulmonary disease	None	None	None	None	None	COPD
Chest tube placement	No	No	No	Yes	No	Yes
Length of stay (days)	14	15	25	22	40	36

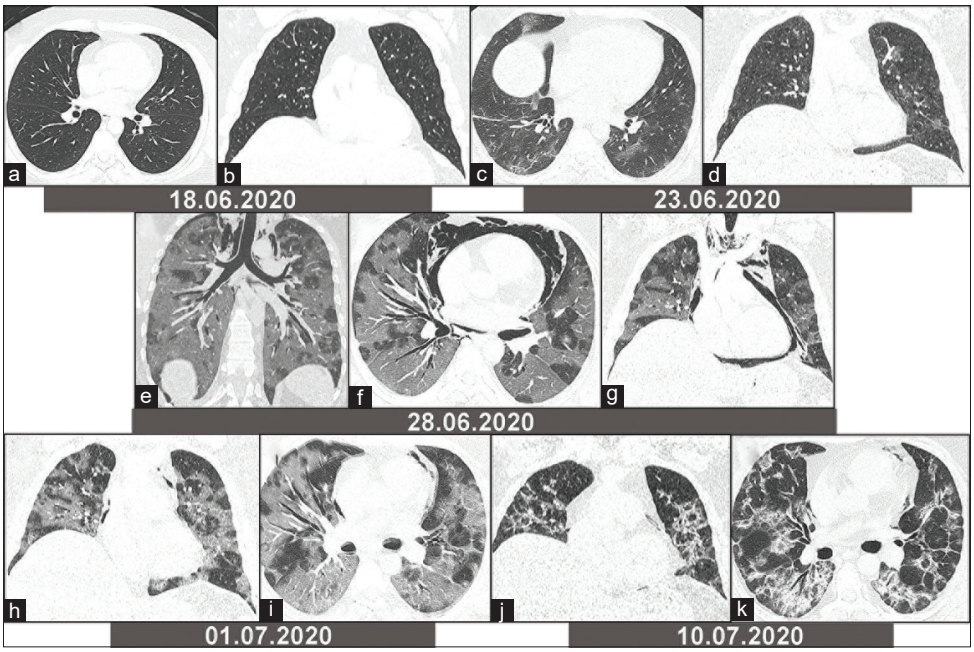

Figure 1: (a) Normal, axial image; (b) normal, coronal image; (c) mild covid, axial image, no pneumomediastinum; (d) mild covid, axial image, no pneumomediastinum; (e) coronalimage, pneumomediastinum; (f) axialimage, pneumomediastinum, minimal right pneumothorax; (g) coronal image, pneumomediastinum; (h) coronal image, minimal residual pneumomediastinum; (i) axial image, minimal residual pneumomediastinum; (j) coronal image, very minimal residual pneumomediastinum; and (k) axial image, very minimal residual pneumomediastinum

A 29-year-old male patient admitted with cough and fever. He required HFNC on the 10th day of his symptoms onset. The patient improved well on HFNC and weaned off gradually on the second day; his chest X-ray suggested of pneumomediastinum. He remained asymptomatic n recovered well.

Discussion

Air leak is a well-known complication of positive pressure ventilation. HFNC provides increased positive pressure within the airways, which may potentially cause air leak. Radiological evidence of spontaneous air leak was found in six patients with event onset 10.33 ± 1.86 days (mean ± SD) from COVID-19 symptom onset. Two out of six patients required intubation, but all pneumomediastinum/pneumothorax events occurred before intubation. No difference in age, gender, body mass index, or medical histories as compared to other COVID-19 patients was noted except for one out of six patients having an obstructive lung disease. Two out of the six patients expired.

COVID-19 infection leading to acute lung injury with associated ARDS might be associated with a spontaneous air leak. Spontaneous air leak occurs due to leakage of air from ruptured alveoli via peribronchovascular sheaths into the mediastinum, the pleural space, or the subcutaneous tissue.[3] It can occur in the setting of obstructive or restrictive lung disease exacerbation, although it has been observed in hyperventilation states such as infections, vomiting, diabetic ketoacidosis, athletic activities, or inhalational drug abuse.[4] Air leak in hospitalized SARS-CoV-2 patients has been sparsely published as case reports. As a result of the diffuse alveolar injury in severe COVID-19 pneumonia, the alveoli may be fragile and prone to rupture. If a patient should have a severe cough, this may also further induce alveolar rupture.[5]

In a similar way, if a patient is receiving positive pressure oxygen therapy in the form of HFNC or BIPAP, which are used to improve oxygenation and alleviate the respiratory distress in these patients, the chances of air leaks should be proportionally increased. Other authors too have suggested that the alveoli of COVID-19 patients may be prone to rupture due to diffuse alveolar injury caused by SARS-CoV-2.[6]

This tendency to develop spontaneous pneumothorax may be higher in patients with COPD due to the long-term increase of alveolar pressure, decrease of alveolar capillary blood supply, and poor lung tissue nutrition in COPD, leading to reduced elasticity and tolerance of the alveolar walls.[7] Pneumomediastinum unrelated to mechanical ventilation has been reported in COVID-19 and severe acute respiratory syndrome (SARS).[3,8] Chu *et al.* reported that in SARS, mean presentation of pneumomediastinum was 19.6 days post symptom onset.[3] These complications may result in sudden clinical deterioration and oxygen desaturation late

in the course of covid pneumonia. Clinicians managing these patients should be alert to the possibility of these complications, and these must be kept in mind in case of any sudden clinical deterioration.

Conclusions

This case series highlights the emerging association of COVID-19 with pneumomediastinum and pneumothorax and the need to be alert to this complication even in patients who never received mechanical ventilation or positive airway pressure support. *Any acute deterioration with rapid oxygen desaturation in a COVID-19 patient could indicate pneumothorax or pneumomediastinum.* Many of these cases have developed after the use of positive pressure ventilation in the form of NIV or HFNC or intubation.[9,10] Thus, all clinicians should be aware of these complications in patients with covid pneumonia. Further research is needed into the exact pathogenesis and prevalence of this complication.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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