

Pneumomediastinum in COVID-19: A series of three cases and review of literature

SAGE Open Medical Case Reports
Volume 9: 1–6
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DOI: 10.1177/2050313X211011807
journals.sagepub.com/home/sco



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Abstract

Coronavirus disease-19 caused by severe acute respiratory syndrome Corona virus-2 is characterised by wide heterogeneity in clinical presentation. The typical radiographic findings in COVID-19 include bilateral ground-glass opacities and/or consolidations predominantly affecting the lower lobes and posterior segments of lungs. Other rare abnormal radiographic findings include pneumothorax, pneumomediastinum and pneumopericardium. There has been an increased incidence of pneumomediastinum, a rare but potentially life-threatening complication during this pandemic. It may be spontaneous or secondary. Pneumomediastinum may be due to barotrauma, cytokine storm induced diffuse alveolar injury or direct viral infection of type I and type II pneumocytes. The presence of pneumomediastinum in COVID-19 patients may indicate extensive alveolar membrane destruction and those patients need close monitoring. There are no consensus guidelines in managing COVID-19 patients with pneumomediastinum. Higher mortality rates (70.58%) are reported in intubated COVID-19 patients with pneumomediastinum. The development of pneumomediastinum in COVID-19 should be considered as a poor prognostic factor.

Keywords

Pneumomediastinum, COVID-19, SARS CoV-2, pneumopericardium

Date received: 13 January 2021; accepted: 30 March 2021

Introduction

Coronavirus disease-19 (COVID-19) caused by severe acute respiratory syndrome Corona virus-2 (SARS CoV-2) is characterised by wide heterogeneity in clinical presentation ranging from asymptomatic infection to critical and fatal illness. The lung is the primary target organ, and hypoxemic respiratory failure is the major complication in COVID-19 patients; other complications include that of cardiac, renal, neurologic, and haematological system. The characteristic haematological abnormalities of COVID-19 patients have prognostic implications, and it is very challenging in managing these haematological complications in COVID-19.¹

There has been a significant increase in the number of intubations and need for mechanical ventilation during this pandemic and studies have shown that approximately 12%–24% of hospitalised patients required endotracheal intubation.^{2,3} Pneumomediastinum (PM) also known as mediastinal emphysema is defined by the presence of air in the mediastinum. Spontaneous pneumomediastinum (SPM) was first described

by Louis Hamman in the year 1939;⁴ hence, it is called as ‘Hamman Syndrome’. The incidence of SPM is reported to be 1 in 32,896.⁵ Chest pain, dyspnea, and subcutaneous emphysema are the most common clinical manifestations.⁶

It may be spontaneous or secondary to traumatic, non-traumatic and iatrogenic causes. PM has been reported previously in staphylococcal pneumonia, fungal pneumonia, human immunodeficiency virus infection in association with pneumocystis and tuberculosis, cytomegalovirus pneumonitis and in patients with haematological malignancies.⁷ There has been an increased incidence of this rare but potentially life-threatening complication during this pandemic. We report

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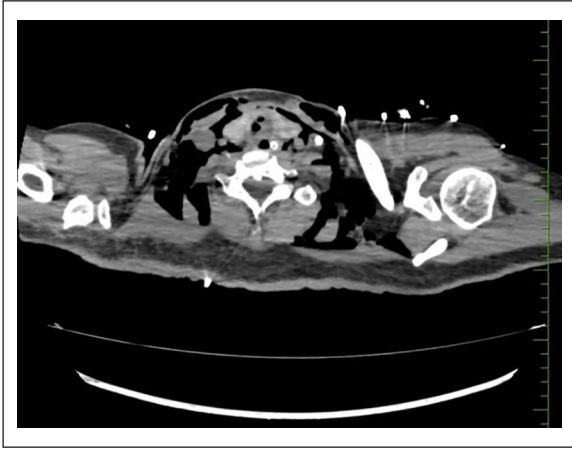


Figure 1. CT-scan chest of patient 1 showing pneumomediastinum.

the clinical course, management, complications and outcome in three cases of COVID-19 complicated by PM.

Case details

Patient: 1

A 51-year-old man with a past medical history of type 2 diabetes mellitus and hypertension, presented with complaints of fever, myalgia and dry cough for 8 days. No history of chronic obstructive pulmonary disease (COPD) and asthma. He denied smoking history. He tested positive for COVID-19 by reverse transcription polymerase chain reaction (RT-PCR), and he was initially treated elsewhere with remdesivir, dexamethasone and antibiotics (co-amoxiclav and doxycycline). On arrival, the patient was conscious, oriented, and febrile (temperature: 101°F) with a pulse rate (PR) of 106/min and blood pressure (BP) of 140/90 mmHg. Arterial blood gas (ABG) analysis showed metabolic acidosis and type-I respiratory failure. He was hypoxic (SpO₂: 86% on room air) and started on high-flow oxygen at 15 L/min.

His initial investigations revealed severe hyperglycemia (random blood sugar: 493 mg/dL (70–140 mg/dL)), hyperkalemia (6.4 meq/L (3.5–5.5 meq/L)), azotemia (urea: 101 mg/dL (7–20 mg/dL), creatinine: 1.3 mg/dL (0.9–1.3 mg/dL)), and leucocytosis (27,700 cells/mm³ (4000–11,000 cells/mm³)). Urine ketones were positive and serum ketones level was elevated, he was started on insulin infusion. Chest X-ray revealed bilateral patchy consolidations. Inflammatory markers were elevated (lactate dehydrogenase (LDH): 529 U/L (105–333 U/L), ferritin: 2783.4 ng/mL (20–250 ng/mL), interleukin-6 (IL-6): 329.4 pg/mL (5–15 pg/mL), and C-reactive protein (CRP): >199 mg/L (<10 mg/L)).

Due to worsening hypoxemia, he was intubated on the same day of admission and was started on volume control ventilator support. Because of persistent hypoxia, computed tomography scan (CT-scan) chest (Figure 1) done on sixth



Figure 2. Chest X-ray of patient 1 showing features of ARDS, subcutaneous emphysema and resolving pneumomediastinum.

day of admission revealed PM, pneumopericardium with an extension of air into the fascial planes of the neck and subcutaneous and intermuscular planes of the chest, dense consolidation in the left lower lobe and intraparenchymal septated cavity. He was started on Meropenem, Targocid and voriconazole, and PM was managed conservatively. He had methicillin-resistant *Staphylococcus aureus* bacteremia, and bronchial wash cultures grew *Klebsiella pneumoniae*, antibiotics and antifungals were continued. Repeat X-ray done on eighth day of admission showed features of adult respiratory distress syndrome (ARDS), consolidation, subcutaneous emphysema and resolving PM (Figure 2).

His condition further deteriorated, and he went into septic shock for which he was started on inotropes. Because of the need for prolonged ventilator support, he underwent tracheostomy. The patient's inflammatory markers continued to remain high, and he remained haemodynamically unstable, requiring inotropes and mechanical ventilation. Despite aggressive management, his condition deteriorated, and he died due to his disease on tenth day of hospitalisation.

Patient: 2

A 77-year-old man with a history of hypertension presented with complaints of shortness of breath (SOB) for 1 week. No history of fever, cough or chest pain, and no history of COPD and asthma. He denied smoking history. COVID-19 RT-PCR done elsewhere initially was negative. CT-scan chest done on the day of admission showed multiple confluent areas of ground-glass opacities and crazy paving pattern with a severity score of 26. On arrival in emergency room (ER), he was afebrile and hypoxic (PR: 96/min, BP: 120/80 mmHg, temperature: 98.4°F, SpO₂: 89% on room air). Physical examination was notable for bilateral crepts. ABG revealed type-I respiratory failure, and he was started on high-flow oxygen

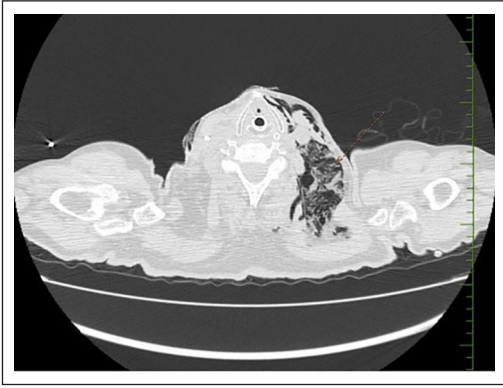


Figure 3. CT chest of second patient showing pneumomediastinum with pneumopericardium.

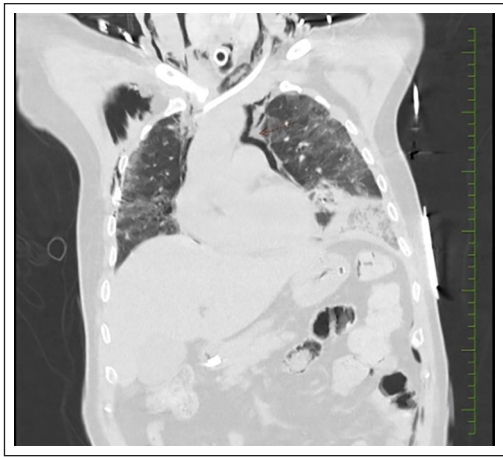


Figure 4. CT chest of second patient showing pneumomediastinum with pneumopericardium.

at 10L/min. Baseline labs were notable for leucocytosis ($16,300 \text{ cells/mm}^3$) and hyponatremia (124 meq/L).

Inflammatory markers were elevated (LDH: 311 U/l, ferritin: 1403.8 ng/mL, IL-6: 177.8 pg/mL, CRP: >199 mg/L). Blood and urine cultures were sent, and he was started on dexamethasone, enoxaparin, remdesivir and antibiotics (co-amoxiclav and doxycycline). CT chest with pulmonary thromboembolism (PTE) protocol (Figures 3 and 4) was done on day 5 to rule out pulmonary embolism. It did not show evidence of pulmonary embolism, compared to the previous CT, lower lobe consolidation and PM was a new finding. In view of worsening hypoxia and increased work of breathing, he was intubated on the same day and was started on volume control ventilator support. Hyponatremia was managed with dietary and fluid modifications. PM was managed conservatively, and serial X-rays showed resolving PM and pneumopericardium (Figure 5).

During the course of hospital stay, he had fluctuating haemodynamics requiring inotropes, and antibiotics were escalated to Meropenem and Targocid for new-onset fever.

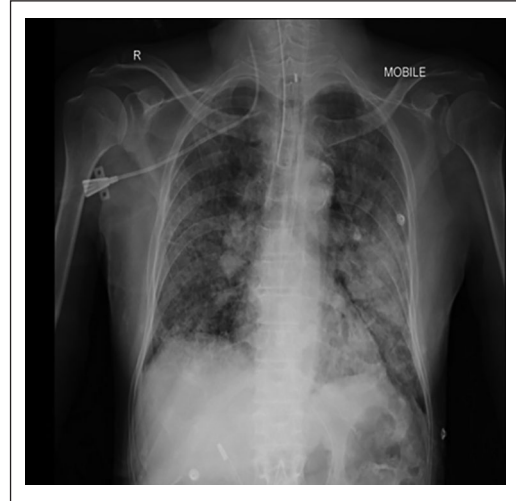


Figure 5. Chest X-ray of second patient showing features of ARDS, and resolving pneumopericardium and pneumomediastinum.

He developed acute kidney injury secondary to sepsis, severe metabolic acidosis and was dialysed. On the 16th day of admission, he had supraventricular tachycardia and was reverted to sinus rhythm with synchronised shock, and he was continued on anti-coagulants, inotropes and ventilator support. Despite aggressive management, his condition deteriorated, and he died due to multi-organ dysfunction syndrome and refractory hypoxemia on 17th day of hospitalisation.

Patient: 3

This 53-year-old lady with a history of type 2 diabetes mellitus and dyslipidemia, presented with complaints of fever and headache for 5 days. She denied a history of cough, chest pain, giddiness, urinary or gastrointestinal symptoms. No history of COPD, asthma and smoking. She had come in contact with a COVID-19 positive patient. COVID-19 RT-PCR was positive.

She was conscious, oriented, febrile (PR: 88/min, BP: 110/80 mm Hg, temperature: 101.4°F) at the time of presentation. She was maintaining SpO_2 of 98% on room air. Physical examination was unremarkable. Baseline labs were notable for hypokalemia (3.2 meq/L), and inflammatory markers were mildly elevated (ferritin: 301.5 ng/mL and CRP: 13.6 mg/L). She was started on dexamethasone, remdesivir and enoxaparin.

During the hospital stay, she had worsening hypoxia for which she was started on oxygen support via nasal prongs. CT chest (Figure 6) done on ninth day of admission revealed no evidence of pulmonary embolism, multiple patchy areas of ground-glass opacities with intralobular septal thickening and subpleural fibrotic bands, moderate PM extending into the subcutaneous planes of the neck with a severity score of 16. She was managed conservatively and continued on



Figure 6. CT chest of third patient showing pneumomediastinum.



Figure 7. Chest X-ray of third patient showing resolution of pneumomediastinum.

anti-coagulants. A repeat chest X-ray (Figure 7) showed resolution of PM. She improved clinically, maintaining oxygen saturation (SpO_2) $>96\%$ on room air, and was discharged home on 15th day of admission.

Discussion

The typical abnormal radiographic findings reported in COVID-19 patients are bilateral ground-glass opacities and/or consolidations with peripheral/subpleural distribution, predominantly affecting the lower lobes and posterior segments of lungs. Other rare abnormal radiographic findings include pneumothorax (PTX), PM and pneumopericardium. PM is reported in 4% of the patients with ARDS, and it is found to be a predictive factor for PTX in these patients.^{8,9}

Kangas-Dick et al.¹⁰ reported PM in 10% of the intubated patients with COVID-19. Similar reports of increased incidence of PM as well as PTX was reported during SARS pandemic in 2003.⁷ Pneumopericardium is further rare, and very few cases are reported in association with COVID-19.^{11–13} In our series, first patient had pneumopericardium along with PM, and necrotising pneumonia with cavity formation and second patient had a pre-peritoneal extension of air along with pneumopericardium. All three patients had subcutaneous emphysema.

The pathophysiology of increased incidence of PM in COVID-19 patients is not clear. Increase in the number of intubations and resultant barotrauma secondary to mechanical ventilation may be a significant factor contributing to this and is usually evident within 24h of intubation. There are reported cases of PM in COVID-19 patients unrelated to intubation. In our series, first patient developed PM 5 days after intubation, in second patient PM was detected prior to intubation, and third patient was never intubated. Our first patient required high positive end-expiratory pressure (PEEP), as well as high plateau pressure for maintaining oxygenation which might have increased the risk of barotrauma and PM. In a retrospective study by G McGuinness et al.,¹⁴ higher rates of barotrauma were seen in patients with COVID-19 infection and invasive mechanical ventilation than patients with ARDS and patients without COVID-19 infection.¹⁴

The structural changes in lungs caused by COVID-19 and lung damage associated with mechanical ventilation may be responsible for PM in these patients. But, a recent study by DHL Lemmers et al.¹⁵ have shown that there is significant increase in PM/subcutaneous emphysema in COVID-19 ARDS (13.6%) patients than non-COVID-19 ARDS (1.9%) despite use of low tidal volume and low airway plateau pressure lung protective ventilator strategies in COVID-19 patients. Thus, if barotrauma is eliminated, the underlying lung pathology due to infection should be considered as cause for development of PM. CoV ARDS is associated with increased risk of pulmonary vascular thrombosis, and subsequent necrosis and damage to alveolar membrane that can contribute to barotrauma.

Spontaneous PM in COVID-19 patients may occur as a result of the cytokine storm induced diffuse alveolar injury or direct viral infection of type I and type II pneumocytes makes alveoli more liable to rupture resulting in alveolar membrane rupture, the resultant gush of air circulates through the peri-bronchial and perivascular sheaths to the mediastinum, popularly known as ‘Macklin phenomenon’. Viral infection associated tracheal oedema increasing risk of tracheal injury during intubation, increased alveolar pressure due to violent coughing secondary to viral infections may all attribute to the development of PM in COVID-19 patients.^{10,16,17}

Males seem to be more affected than the females. In our series, two (66%) out of three were male patients and mean

age was 60.3 years which is in concordance with results of the study by Kangas-Dick et al.¹⁰ Two patients had diabetes, and two patients had hypertension in our series. Mean time from admission to PM was 1 week in all three of our cases. While PM was detected at around third week of illness in SARS pandemic, in most of the reported cases of COVID-19 including ours, it is being detected between 7 and 14 days frequently.^{7,10}

A recent report summarising the outcome of 5279 COVID-19 patients reported a mortality rate of 60.4% in the patient requiring mechanical ventilation.² Chu et al.⁷ reported that the presence of PM could complicate SARS and indicate worsening of the disease, requiring more aggressive management. Similarly, Kangas-Dick et al.¹⁰ reported higher mortality rate (70.58%) in intubated COVID-19 patients with PM. Two (66%) out of three patients in our series have died, in concordance with the data. COVID-19 patients may have a higher susceptibility to compressive effects of PM, due to significant loss of physiological reserve of the lung, especially in severe cases.¹⁷

PM is usually self-limiting and is managed conservatively. Treatment of the underlying causes and least damaging ventilator settings possible to achieve adequate oxygenation are the mainstays in managing PM. But, PM can lead to worsening respiratory acidosis and failure. COVID-19 patients with PM seem to have a more complicated clinical course and poor outcome. There are no consensus guidelines in managing COVID-19 patients with PM. Wali et al.¹⁷ managed patients aggressively by placing chest drains, whereas Volpi et al.¹⁸ successfully managed two patients of PM by conservative approach. Hamad et al.¹⁹ suggested inserting a unilateral intrapleural chest drain to protect at least one side against potential pneumothorax. All three patients in our series were managed conservatively – one patient recovered, and the other two patients died due to multi-organ failure. Barotrauma appears to be marker for worsening clinical condition and is an independent risk factor for increased mortality and length of hospital stay.

In the retrospective analysis by Kangas-Dick et al.,¹⁰ more than half of the patients with PM were managed conservatively, and there was no significant difference in the mortality rates between those managed with tube thoracotomy and those managed by conservative approach. In the absence of mediastinal compressive symptoms, conservative approach to these patients is suggested, and approach should be decided case-to-case basis.

Conclusion

PM is a rare but potentially life-threatening complication which is being increasingly reported in association with COVID-19. PM may be spontaneous or secondary. The presence of PM in COVID-19 patients may indicate extensive alveolar membrane destruction and those patients need close monitoring. The development of PM in COVID-19 should be considered as a poor prognostic factor. Furthermore, more

extensive studies are required to establish the association between the presence of PM and outcomes in COVID-19.

Author contributions

All the authors contributed equally to this study.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Written informed consent was obtained from the patient(s)/a legally authorised representative(s) for their anonymised information to be published in this article. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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References

1. Sahu KK and Cerny J. A review on how to do hematology consults during COVID-19 pandemic. *Blood Rev.* Epub ahead of print 8 November 2020. DOI: 10.1016/j.blre.2020.100777.
2. Christopher MP, Jones SA, Yang J, et al. Factors associated with hospital admission and critical illness among 5279 people with coronavirus disease 2019 in New York City: prospective cohort study. *BMJ* 2020; 369: m1966.
3. Richardson S, Hirsch JS, Narasimhan M, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalised with COVID-19 in the New York City area. *JAMA* 2020; 323: 2052–2059.
4. Hamman L. Spontaneous mediastinal emphysema. *Bull Johns Hopkins Hospital* 1939; 64: 1–21.
5. Bodey GP. Medical mediastinal emphysema. *Ann Intern Med* 1961; 54: 46–56.
6. Macia I, Moya J, Ramos R, et al. Spontaneous pneumomediastinum: 41 cases. *Eur J Cardiothorac Surg* 2007; 31(6): 1110–1114.
7. Chu CM, Leung YY, Hui JY, et al. Spontaneous pneumomediastinum in patients with severe acute respiratory syndrome. *Eur Respir J* 2004; 23(6): 802–804.
8. Weg JG, Anzueto A, Balk RA, et al. The relation of pneumothorax and other air leaks to mortality in the acute respiratory distress syndrome. *N Engl J Med* 1998; 338: 341–346.
9. Gammon RB, Shin MS and Buchalter SE. Pulmonary barotrauma in mechanical ventilation. *Chest* 1992; 102: 568–572.
10. Kangas-Dick A, Gazivoda V, Ibrahim M, et al. Clinical characteristics and outcome of pneumomediastinum in patients

- with COVID-19 pneumonia. *J Laparoendosc Adv Surg Tech A* 2021; 31: 273–278.
11. Li S, Chau E, Ghasem W, et al. Air should not be there: a case of pneumomediastinum and pneumopericardium in COVID-19. *Cureus* 2020; 12(11): e11696.
 12. Sahu KK, Mishra AK and Goldman Y. A rare case of pneumopericardium secondary to COVID-19. *Heart Lung* 2020; 49(6): 679–680.
 13. Ghods K, Aghaamoo S, Amini Fooladi N, et al. Spontaneous massive pneumopericardium in a patient with COVID-19. *Eur J Cardiothorac Surg*. Epub ahead of print 26 December 2020. DOI: 10.1093/ejcts/ezaa465.
 14. McGuinness G, Zhan C, Rosenberg N, et al. Increased incidence of barotrauma in patients with COVID-19 on invasive mechanical ventilation. *Radiology* 2020; 297(2): E252–E262.
 15. Lemmers DHL, Abu Hilal M, Bnà C, et al. Pneumomediastinum and subcutaneous emphysema in COVID-19: barotrauma or lung frailty? *ERJ Open Res* 2020; 6(4): 00385-2020.
 16. Joshi S, Bhatia A, Singh P, et al. Pneumomediastinum as a Presenting Feature of COVID-19-an Observation. *J Assoc Physicians India* 2020; 68(10): 81–82.
 17. Wali A, Rizzo V, Bille A, et al. Pneumomediastinum following intubation in COVID-19 patients: a case series. *Anaesthesia* 2020; 75(8): 1076–1081.
 18. Volpi S, Ali JM, Suleman A, et al. Pneumomediastinum in COVID-19 patients: a case series of a rare complication. *Eur J Cardiothorac Surg* 2020; 58: 646–647.
 19. Hamad AM, Elmahrouk AF and Abdulatty OA. Alveolar air leakage in COVID-19 patients: Pneumomediastinum and/or pneumopericardium. *Heart Lung* 2020; 49(6): 881–882.