A Case of Spontaneous Pneumomediastinum in Covid-19 Pneumonia

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ABSTRACT

Spontaneous pneumomediastinum (SPM) is defined as free air in the mediastinum thought to be due to non-traumatic rupture of marginal alveoli without evidence of underlying lung disease. Secondary causes must be excluded, including perforations of the esophagus, trachea, and bronchi, due to their propensity for unfavorable outcomes. Infectious etiologies have been documented to cause pneumomediastinum, but this is most frequently observed in the setting of mechanical and noninvasive positive-pressure ventilation (NIPPV). Here we present a case of asymptomatic spontaneous pneumomediastinum in a patient with COVID-19 in absence of mechanical ventilation.

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Introduction

Spontaneous pneumomediastinum (SPM) is a rare condition in which free air develops within mediastinal structures in the absence of apparent provocative trauma.[1,2] Diagnostic evaluation includes workup for concomitant pneumothoraces, as well as for secondary etiologies such as esophageal perforation or rupture. In rare instances, pneumomediastinum can be seen in the setting of pulmonary infections, particularly due to barotrauma in patients requiring ventilatory support. Cases have been documented in relation to the SARS-CoV outbreak. We present a case of a non-intubated, adult patient who developed SPM secondary to infection with COVID-19.

Case

A 48-year-old male with no significant past medical history presented to the emergency department complaining of progressively worsening dyspnea after testing positive for COVID five days prior.

On presentation, the patient was afebrile and hemodynamically stable with an oxygen saturation of 81% on room air. Physical exam noted coarse breath sounds throughout all lung fields bilaterally on auscultation. Initial admission chest x ray imaging (Figure 1a) demonstrated patchy opacities within both lungs, but was otherwise unremarkable. The patient was admitted for severe COVID pneumonia and placed on high flow nasal cannula (HFNC). Inflammatory markers were elevated with a C-reactive protein (CRP) at 24.7. Initial pharmacotherapy included intravenous dexamethasone and tocilizumab. He responded well to treatment and was successfully from HFNC to 4L of nasal cannula the following day.

On the second day of admission, he was noted to have interval development of subcutaneous emphysema on exam. A stat chest x-ray was obtained (image 1b), revealing pneumomediastinum and subcutaneous emphysema of the chest and neck in absence of tamponade physiology or hemodynamic compromise. Concomitant pneumothorax was excluded. The patient remained normotensive, without increased oxygen requirement or acute change in symptoms. Given hemodynamic stability, intervention was not required for pneumomediastinum and was monitored with serial chest x-rays. Further imaging was obtained with contrasted CT chest and gastrograffin esophagram to further evaluate for etiology of pneumomediastinum. CT chest redemonstrated pneumomediastinum and prior ground glass opacities (Figure 1c) and gastrograffin esophagram was negative for esophageal tear or perforation.

Treatment for COVID pneumonia was continued with clinical improvement and he was successfully weaned off supplemental oxygen. Serial chest x-rays demonstrated stable pneumomediastinum without significant change. He was safely discharged home after six days of inpatient treatment and monitoring. Follow up chest x-ray was obtained as an outpatient one week after discharge, (Image 1d) noting overall improvement in pneumomediastinum and ground glass opacities. Serial outpatient clinical visits have demonstrated continued improvement with no return of prior symptoms.

Discussion

Pneumomediastinum is a well-known complication associated with mechanical ventilation, a common therapy employed for many patients afflicted with COVID-19;[3] however, SPM has

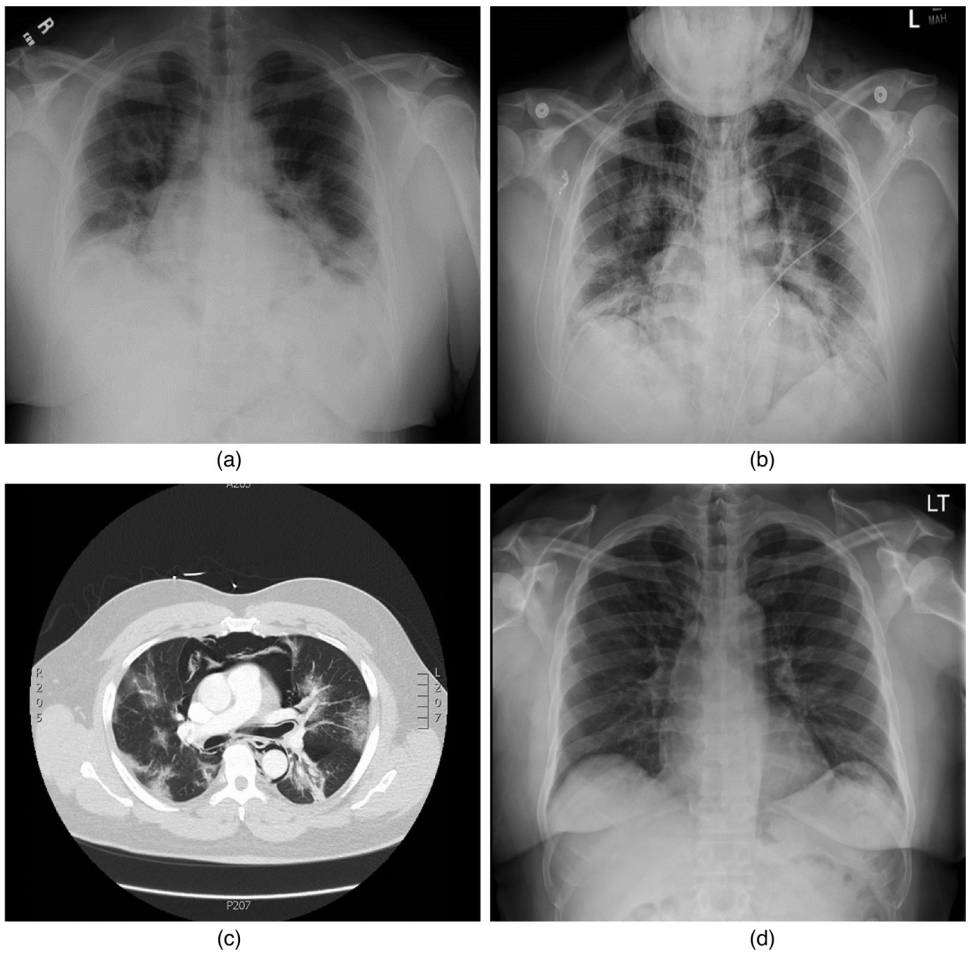

Figure 1. (a) Chest x-ray on admission. (b) Chest x-ray finding pneumomediastinum. (c) CT chest demonstrating pneumomediastinum. (d) Chest x-ray after discharge

emerged as a complication in non-ventilated COVID-19 patients as well. Additional triggering events associated with SPM include bronchial asthma attack, vomiting, valsalva maneuver, coughing, pulmonary function tests, and diabetic ketoacidosis (DKA).[4] While the pathogenesis has not been fully elucidated, the literature suggests that it may be due to the pressure differences across the alveolar membrane resulting from rapid increments of airway pressure leading to terminal alveolar rupture with migration of air toward the mediastinum, known as the "Macklin Phenomenon." In COVID-19, it is thought that inflammatory damage to the alveoli and the pneumocytes makes them more susceptible to rupture in the setting of barotrauma.[4,5]

SPM requires expedited evaluation as it can result in compression of cardiac structures and the great vessels, mimicking cardiac tamponade physiology. The clinical presentation can range from non-specific symptoms to insidious. The most common clinical symptoms include chest pain, palpitations, shortness of breath, dizziness, syncope, and altered mental status. The most common physical exam finding is subcutaneous emphysema throughout the upper chest and into the neck. Additionally, Hamman's sign is an auscultatory finding described as crackles with each heartbeat; while uncommon, it is highly specific for SPM.[4] In the case of a more insidious presentation concerning for malignant pneumomediastinum, patients can show signs of tension pneumothorax with compression of the trachea and great vessels causing decreased venous return; however, this presentation is very rare.[6] The physical exam is often significant for Beck's Triad, which is composed of low blood pressure, jugular venous distension, and muffled heart sounds, as seen in cardiac tamponade. In this case, the first sign of pneumomediastinum was the onset of subcutaneous emphysema, without hemodynamic compromise and with the patient remaining hemodynamically stable throughout the hospital course.

SPM most commonly occurs in younger males with tall stature and low body mass index. Individuals with a history of smoking, tobacco use, or inhaled recreational drug use are at increased risk for development of SPM.[7] However, it is important to recognize that SPM can occur due to secondary causes in patients without a history of pneumothorax, underlying pulmonary disease or parenchymal abnormality, and in the absence of

tobacco use history due to secondary causes. The development of SPM in COVID-19 has been observed in patients with no pre-existing bullae or emphysema on admission or initial CT [Secondary etiologies of SPM should also be considered for treatment and prevention of sequelae leading to hemodynamic compromise. These etiologies include esophageal rupture, COPD, interstitial lung disease, lung cancer, asthma exacerbation, and foreign body in the airway. Initial evaluation typically consists of chest x-ray, demonstrating air outlining the mediastinal structures in most cases.[7] CT of the chest with contrast can be considered for further evaluation with an equivocal chest x-ray and high suspicion of SPM.[4]

Esophageal perforation causing SPM is of particular concern as it has a high propensity for infection along with increased mortality.[8] Rupture can be due to excessive vomiting, or Boerhaave's syndrome. Symptoms in these cases are often significant for Meckler's triad, which includes vomiting, lower chest pain, and cervical subcutaneous emphysema. Other causes of spontaneous esophageal ruptures have been reported and include increased intraluminal pressure, preexisting esophageal disease, and neurogenic causes of perforation.[9] Evaluation with water soluble, or gastrografin (meglucamine diatrizoate), esophagram is often the initial test used to rule out esophageal rupture, followed by barium esophagram if the gastrografin swallow is not definitive.[10] While barium swallow is more likely to demonstrate small perforations as compared to gastrografin, its use is not first line due to the possibility of mediastinitis and subsequent fibrosis with its extravasation.[8,11] While esophageal rupture was unlikely due to absence of vomiting and retching in this patient, because of its unfavorable outcomes, exclusion of esophageal involvement was important in evaluation.[9]

SPM has been shown to have a favorable prognosis as it is more often than not a self-limiting disease.[12] However, in the setting of COVID-19, the development of SPM can be a poor prognostic indicator, possibly representing progression of disease.[13] Takada and Matsumoto *et al* suggest a treatment algorithm with two days of observation, followed by discharge without long follow-up after amelioration of symptoms.[2] While this patient was showing signs of improvement from a COVID-19 standpoint, the onset of pneumomediastinum alerted the team to pay close attention the patient's clinical status for signs of hemodynamic decline, as well as worsening of pneumomediastinum that would warrant a cardiothoracic surgery consult.

Conclusion

There are many causes of pneumomediastinum, both benign and malignant, that must be considered in the evaluation of a patient presenting with subcutaneous emphysema. This case demonstrates the potential for COVID-19 pneumonia to cause SPM in the absence of mechanical ventilation. While the patient in this case was asymptomatic at the time of presentation, expedited evaluation was crucial in ruling out life-threatening causes and sequelae that could have resulted in hemodynamic compromise.

Author Contribution

The authors confirm contribution to the paper as follows:
Study conception and design:, Graey Wolfley DO, Sarah Jayne Sutton OMS-IV, Sierra Canapp DO.
Data collection: Sarah Jayne Sutton OMS-IV, Sierra Canapp DO, Graey Wolfley DO.
Analysis and interpretation of results: Francis Essien DO, Graey Wolfley DO.
Draft manuscript preparation: Sarah Jayne Sutton OMS-IV, Sierra Canapp DO, Graey Wolfley DO.
Informed consent was obtained from the patient.

Ethical Approval

Our study did not require formal approval from an IRB board because this was a case report.

Informed Consent

Informed consent was obtained from patient for publication and use of images.

Trial Registration

Our case report is not a clinical trial and does not have a trial registration.

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