



Contents lists available at ScienceDirect

Respiratory Medicine Case Reports

journal homepage: www.elsevier.com/locate/rmcr

Case Report

Evolution of SARS-CoV-2 related pneumatoceles: A case report

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ARTICLE INFO

Handling Editor: DR AC Amit Chopra

ABSTRACT

Pneumatoceles are thin-walled, air or fluid-filled cysts within the lung parenchyma typically formed due to inflammation or bronchial injury from infectious and non-infectious etiologies. To our knowledge, there are only a handful of cases in the literature reporting complicated pneumatoceles as a result of acute respiratory distress without the use of positive-pressure ventilation. We present a unique case of a 34-year-old male who rapidly developed complicated pneumatoceles associated with SARS-CoV-2 pneumonia, without positive pressure ventilation, with complete resolution after conservative management.

1. Background

A male patient in his 30s was admitted to the medical intensive care unit with acute hypoxic respiratory failure in the setting of COVID-19 infection. The patient received COVID-19 treatment per protocol as well as high-flow nasal cannula to maintain oxygen saturation above 92 % with improvement of symptoms. A week into his hospitalization, his clinical course was complicated by a spontaneous right-sided pneumothorax. The patient underwent a CT-guided chest tube placement with subsequent imaging revealing rapidly progressing pneumatoceles with air-fluid levels, attributed to his known COVID-19 pneumonia after an extensive infectious work-up. The patient's chest tube was ultimately removed and enhanced airway clearance measures were implemented. The patient clinically improved and was safely discharged home on room air. At 3- and 9-month follow-up visits, he was asymptomatic with serial CXRs confirming resolution of pneumatoceles without further complications.

2. Case presentation

A male patient in his early 30s with no medical history was initially admitted to the intensive care unit with acute hypoxic respiratory failure in the setting of COVID-19 infection. He received COVID-19 treatment per protocol as well as high-flow nasal cannula 60 % fraction of oxygen at 40 L per minute to keep oxygen saturation above 92 %. After 5 days, improvement in oxygenation was noted. However, fatigability was persistent, and a mild rising leukocytosis was observed. A chest x-ray (CXR) showed extensive bilateral opacities; some concerning for possible cavitation. However, a follow-up computed tomography (CT) of the chest showed bilateral infiltrates but negative for cavitory lesions (Fig. 1). Four days later, his course was complicated by a spontaneous right-sided pneumothorax (PNX) thought to be caused by persistent cough. A CT-guided chest tube was placed to treat the PNX. A routine follow-up CXR was concerning for a loculated pneumothorax and evolving multifocal infection (Fig. 2a). A new CT chest was notable for the

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<https://doi.org/10.1016/j.rmcr.2024.102027>

Received 7 March 2024; Accepted 26 April 2024

Available online 27 April 2024

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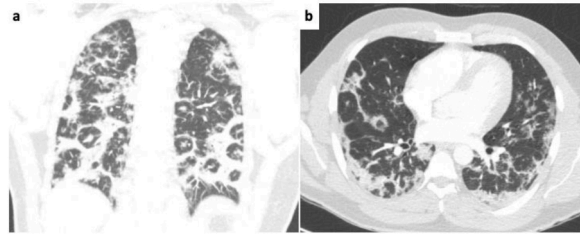


Fig. 1. Coronal (a) and Transverse (b) views of a CT of the chest showing significant bilateral infiltrates yet without any cavitary lesions.

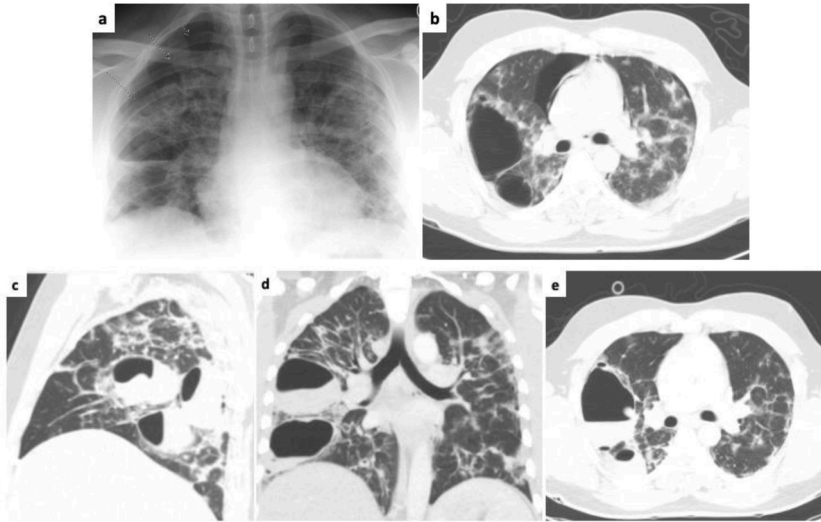


Fig. 2. (a) CXR with spontaneous pneumothorax. (b) CT chest notable for pneumothorax/pneumomediastinum with new pneumatoceles. Largest being 8.5 cm × 6.8 cm. (c–e) Sagittal, Coronal, and Transverse views pneumatoceles with fluid-filled levels.

known pneumothorax and pneumomediastinum now with development of several thin-walled cysts, the largest being 8.5 cm by 6.8 cm, without significant ground glass surrounding, and primarily consistent with pneumatocele formation (Fig. 2b). A surveillance CT chest was notable for increased size of the pneumatoceles with new air fluid levels. Even though the clinical status was unchanged, the presence of enlarging pneumatoceles with air-fluid levels (Fig. 2c–e) was concerning for a superimposed infection. After extensive negative infectious evaluation, including MRSA nasal swab, urine *Streptococcus pneumoniae* and *Legionella* Antigens, serum *Aspergillus*, serum *Cryptococcus*, urine *Histoplasma*, induced Sputum for Gram Stain, Aerobic, Fungal, and AFB Cultures, initial empiric antimicrobial regimen with piperacillin-tazobactam was discontinued. Subsequently, the patient's chest tube was removed and enhanced airway clearance measures were implemented. The patient clinically improved and was safely discharged home on room air.

At the 3-month follow-up, the patient reported an ability to perform all his normal activities without restriction. He denied any cough, chest pain or shortness of breath at rest or exertion. He had not yet tried any routine exercise as most of the facilities were closed due to the COVID-19 pandemic. It was decided that we would continue to monitor him clinically and radiographically with a CXR and clinic follow-up in 6-months Fig. 3a shows a CXR taken at the 3-month follow-up with improved, yet persistent pneumatoceles. At the 9-month follow-up, the patient remained asymptomatic. A month prior to this visit, he started running daily for approximately 30 minutes, without any cough, shortness of breath, or chest pain. He was looking forward to resuming strength training, now that his preferred gym was back in full operation. Fig. 3b shows a follow-up CXR at 9 months with resolution of pneumatoceles. Given

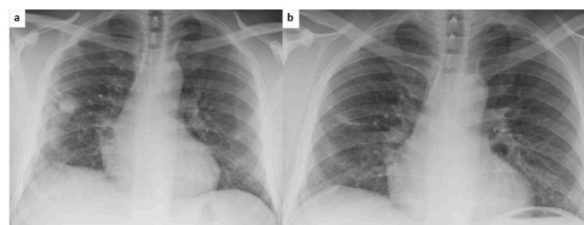


Fig. 3. (a) CXR at 3-month follow-up. (b) CXR at 9-month follow-up showing complete resolution of the pneumatoceles.

resolved pneumatoceles without further complications, he was recommended to follow up as needed due to his excellent clinical status.

3. Discussion

Pneumatoceles are transient, thin-walled, air or fluid-filled lesions that develop within the lung parenchyma. These lesions can be accompanied by adjacent consolidation and/or ground-glass opacities. Pneumatoceles can be formed as a result of underlying inflammation or bronchial injury, from both infectious and non-infectious etiologies [1,2]. We describe a unique case of multiple, rapidly enlarging pneumatoceles with the presence of air-fluid levels after COVID-19 pneumonia, with rapid and complete resolution after conservative management.

Infectious etiologies such as *Staphylococcus aureus*, *Streptococcus pneumoniae*, and recently SARS-CoV-2 [3–5] have been associated with pneumatoceles. Recently, a large retrospective cross-sectional study of patients who tested positive for SARS-CoV-2 and underwent CT chest, the majority of which were admitted to intensive care unit and treated with positive pressure ventilation, showed that pneumatoceles and pneumothoraces accounted for 10 % and 3 % of these complications, respectively [6]. However, multiple giant pneumatoceles secondary to COVID-19 pneumonia without positive-pressure ventilation are extremely rare and scarcely reported to our knowledge.

Pneumatoceles are usually noncomplicated and have an overall good prognosis; however, complications of pneumatoceles include parenchymal-pleural and bronchopleural fistulation with the formation of pneumothoraces and pneumomediastinum [1]. In addition, intrathoracic complications are associated with a higher need for intubation, less successful extubation, and longer hospitalization courses [6–12]. While these complications are rare, they tend to occur more frequently in patients requiring positive pressure ventilatory support [6–8], unlike our patient, who only required non-invasive ventilation during his hospitalization. Our patient developed a spontaneous pneumothorax which fortunately resolved rapidly after treatment with a CT-guided chest tube. Also, as superimposed infections have been previously reported [5], our patient had a thorough negative work-up which was essential to avoid unnecessary prolonged antimicrobial treatment and rather focus on a more conservative approach. Our case also demonstrates the importance of rapid and accurate recognition of pneumatoceles, as delay in the diagnosis may lead to unnecessary, harmful, and potentially dangerous diagnostic and therapeutic procedures.

The originality of our case resides in the natural evolution and complete resolution of multiple large pneumatoceles with conservative treatment. There are no well-established guidelines or treatment algorithms for the management of pneumatoceles. This case highlights the importance of reassurance and close monitoring for possible complications from these pulmonary lesions in order to avoid unnecessary and potentially dangerous therapeutic procedures. Treating the underlying cause is the initial step, and then resolution typically occurs in weeks to months [1]. However, surgical intervention may be necessary in cases with secondary complications with imminent cardiac or respiratory compromise [12]. Our patient was followed up closely in the outpatient setting, and subsequent CXRs demonstrated complete resolution of the pneumatoceles without additional interventions.

CRedit authorship contribution statement

Fernando A. Camacho: Investigation, Writing – original draft, Writing – review & editing. **Carlo Arevalo:** Conceptualization, Project administration, Writing – original draft, Writing – review & editing. **Margaret Connolly:** Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Joseph Modrak:** Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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