Late-onset pneumothorax and bullous disease on post-COVID-19 pneumonia with severe ARDS

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INTRODUCTION

During the diagnosis and treatment of COVID-19 pneumonia, patients may have a number of complications. Complications arise as a result of cell damage, a strong innate immune response with the release of inflammatory cytokines, and the pro-coagulant condition induced by SARS-CoV-2 infection.[1,2]

Fibrosis and pulmonary bullae are two COVID-19 problems that might occur. In the instance of COVID-19 pneumonia, ground glass opacity (GGO) and consolidation findings occurred early on CT scan, increased in quantity and density, and were eventually absorbed, leaving fibrous alterations in their original site. Pulmonary bullae are air-filled pockets in the lung that develop as a result of emphysematous deterioration of the lung parenchyma. Bullae development is caused by inflammatory injury to the bronchioles, which results in air entrapment. Bullae may form as a result of mechanical forces interacting with weakened tissue. [3] Pulmonary bulla can rupture into spontaneous pneumothorax (SP), which can indicate a poor prognosis.[4]

There has been no specific report on the prevalence of SP in COVID-19 to date. Several prior studies reported SP during diagnosis and therapy of COVID-19.[3,5–7] Although SP due to pulmonary bullae rupture is relatively common in COVID-19 patients. However, late-onset bullous disease and SP after recovering from COVID-19 is unusual. In order to improve clinicians' understanding and treatment of the disease, we summarized the clinical characteristics of our patient with late-onset bullous disease and SP after recovering from COVID-19.

CASE

Our patient was a 48-year-old male presented with sudden shortness of breath accompanied by chest pain that occurs when coughing or changing positions. Three weeks earlier, the patient had finished treatment in the COVID-19 isolation room for 20 days with a diagnosis of COVID-19 pneumonia with severe ARDS, and he still complained of non-productive cough when leaving the isolation room. On physical examination, his blood pressure was 130/80 mmHg, heart rate 105 bpm, respiratory rate was 26 times/minute, temperature 36.7°C, and oxygen saturation was 87% on room air, and he appeared comfortable on an oxygen 15 L/min via non-rebreathing mask (oxygen saturation increased to 98%). On the right hemithorax there was decreased tactile fremitus, decreased vesicular breath sounds, and hyperresonance to percussion. No rhonchi or wheezing were found. Chest X Ray showed right lung pneumothorax and CT scan showed a right pneumothorax with infected subpleural giant bullae in right perihilar, right lung collapse, minimal right-to-left lung herniation and post-covid pulmonary fibrosis (Fig 1 and Fig 2).

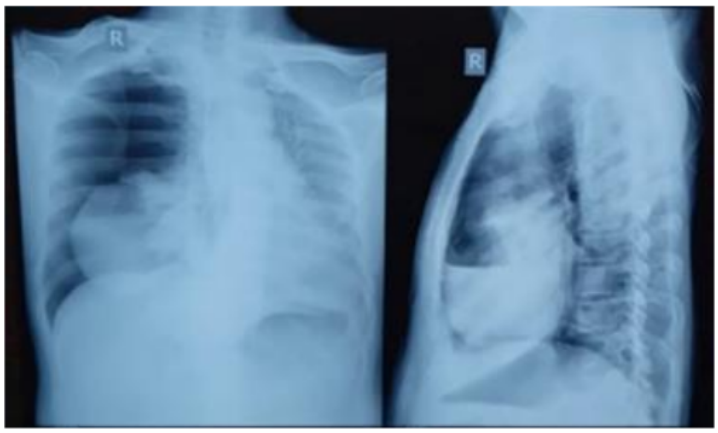

Figure 1. CXR on admission reveals a right pneumothorax, pneumonia, and bullae in the right hemithorax.

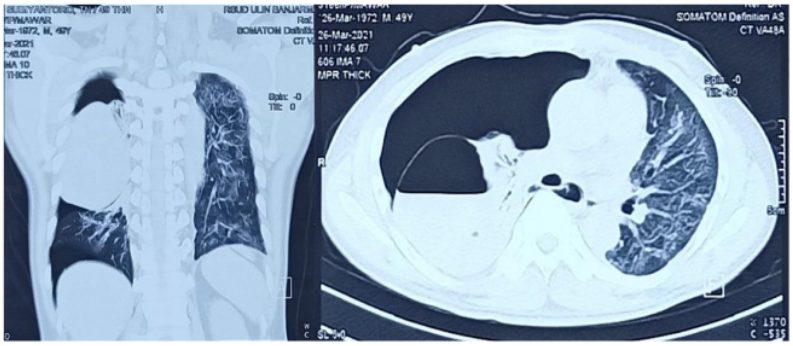

Figure 2. Chest CT scan showed right pneumothorax, Post covid pulmonary fibrosis, infected giant bullae subpleura right perihilar, accompanied by right lung collapse and minimal right to left lung herniation. No left intrapulmonary bullae seen

On admission, a complete blood count showed increased white blood cells of 14.900/ul (normal reference: 4.000-10.500/ul) with a decreased lymphocyte count of 7.4% (normal reference: 20-40%), and NLR and ALC were 11.2 and 1.4 x 109/L, respectively. The metabolic blood panel was normal. Arterial blood gas was taken with oxygen supplement 15 L/m showed pH 7.37, PaCO2 53.9, PaO2 115 mmHg, HCO3 31.4, BE 6, SaO2 98%, and ratio PaO2/FiO2 141,9 with interpretation of respiratory acidosis compensated with metabolic alkalosis.

Culture and sensitivity examination of the pleural fluid showed the growth of *Providencia stuartile* bacteria. The patient then received high flow oxygenation therapy and a chest tube was placed for the management of pneumothorax. Subsequently, the patient was treated with antibiotics according to the results of culture and antibiotic sensitivity with piperacilin/tazobactam and amikacin. The patient did not undergo a bullectomy with consideration of the post-COVID-19 condition. On the 15th day of treatment, the CT scan evaluation still showed infected giant bullae in the superior lobe of the right lung, but slightly smaller in size compared to the previous chest CT scan (Fig 3A). On the 36th day of treatment, the CT scan finally showed no bullae and right lung expansion compared to the previous CT scan (Fig 3B). The patient showed clinical and radiological improvement following 41 days of treatment and could be managed as an outpatient.

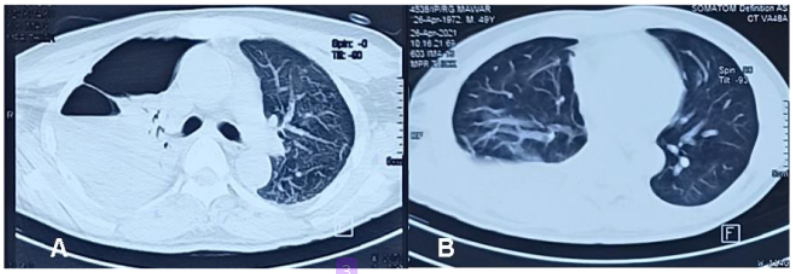

Figure 3. A. Extensive pulmonary fibrosis in the posterior segment of the right inferior lobe, middle lobe, and superior lobe of the right lung. Infected giant bullae in the superior lobe of the right lung which is smaller in size than the previous chest CT scan. Right pneumonia which is reduced in size compared to before; B. Post COVID Fibrosis of both lungs with traction bronchiectasis. No bullae and pneumonia were seen. Right lung expansion looks better than previous CT scan results.

DISCUSSION

In severe COVID-19 cases, SARS-CoV-2 infection triggers a cytokine storm, which is an overactive immune response. A cytokine storm is a possibly lethal immunological condition characterized by high-level immune cell activation and excessive synthesis of inflammatory cytokines and chemical mediators. This condition causes an increase of immune cell infiltration from the

circulation, such as neutrophils, macrophages, and T cells, into the site of infection, causing destructive effects on human tissue due to destabilization of endothelial cell to cell interactions, vascular barrier injury, extensive alveolar damage, capillary damage, multiorgan failure, and death. Cytokine storms will eventually cause lung injury, which can proceed to acute lung injury or its more severe version, acute respiratory distress syndrome (ARDS).[8–10]

A pulmonary bullae is a well-defined air-space in the lung parenchyme that measures more than 1 cm in diameter in the swollen condition and has less than 1 mm of wall thickness. A bullae is classified as a giant pulmonary bullae (GPB) if it takes up at least 30% of one hemithorax.[11] Risk factors known to be associated with the development of bullae are smoking history, alpha-1 antitrypsin deficiency, alpha-1 anti-chymotrypsin deficiency, pulmonary sarcoidosis, Marfan's syndrome, Ehlers–Danlos syndrome, marijuana smoking, and inhaled fiberglass exposure.[12]

COVID-19 ARDS is hypothesized to be linked to the development of bullous pulmonary disease. The underlying pathophysiology for bullae production is inflammatory injury to the bronchiole, which causes structural changes that contribute to air entrapment and the formation of GPB. The interaction of mechanical forces such as high-flow O2 support on the weaker tissue may also lead to bullae formation.[2,13,14]

Edema, vascular congestion, and microthrombi each have the potential to cause the rupture of preexisting bullae.[12] Spontaneous pneumothorax (SP) can result from the rupture of these bullae. Despite being a male, our patient never smoked. He also had no chronic lung disease as risk factors for bullae development or pneumothorax. As a conclusion, it may be hypothesized that the formation of GPB and SP in this patient is associated to his history of COVID-19 condition with severe ARDS.

The surgical intervention of a bullectomy is the standard method of treatment for GPB. The indications for bullectomy are progression of symptoms with disability, obstructive spirometry, and a single or dominant bullae with radiological evidence of compression of surrounding preserved lung parenchyma.[11,15] However, adhesions between lung tissues and mediastinal structures may occur in post-COVID-19 patients, causing complications during surgical intervention. In addition, risk factors such as length of hospitalization, morbidity, and mortality may increase.[16] Therefore, due to the difficulties of the process and the increased risk of the patient following surgery, we only perform chest tube insertion on our patients.

As shown in the CT scan results, this patient has infected bullae, specifically a right pneumothorax with infected giant bullae subpleura right perihiler. Furthermore, the presence of leukocytosis and an examination of pleural fluid culture and sensitivity showing growth of Providencia stuartile bacteria with sensitivity to several antibiotics such as piperacilin tazobactam, amikacin, gentamicin, and trimethoprim/sulfamethoxazole support it. The patient was then treated with piperacilin/tazobactam and amikacin based on culture and antibiotic sensitivity.

Despite only being treated conservatively with a chest tube and antibiotics, the patient showed clinical improvement. WSD installation had been found to improve the condition of pneumothorax and expanded the initially compressed lung. The lung expansion increased with time, and the bulla reduced until it was no longer visible on the 36th day of therapy. GPB resolution without surgery has already been reported, and is known as an "autobullectomy." The exact mechanism of the natural resolution of the giant bullae is is yet unknown. Reduced pneumothorax, which leads to lung expansion, and healing of inflammatory lung conditions with antibiotics and anti-inflammatory therapy may contribute in the resolution of giant bullae.[11,17]

CONCLUSION

Our patient was diagnosed with infected giant bullae and pneumothorax post COVID-19 pneumonia with severe ARDS. The patient did not undergo a bullectomy with consideration of the post-COVID-19 condition and was managed conservatively with an adequate chest tube and antibiotics. Patient responded well to therapy, showed clinical improvement and could be managed as an outpatient.

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