PHYSICAL MEDICINE AND REHABILITATION MANAGEMENT OF PATIENT WITH BILATERAL LUNG BULLAR

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ABSTRACT

Lung bullae are defined as air spaces in the lungs, measuring more than 1 cm in diameter when distended, while giant bullae occupy at least 30% of the hemithorax. Bullae are thought to be in contact with the bronchial tree; they are preferentially filled during inspiration, causing collapse of the adjacent normal lung parenchyma. Clinical manifestations of giant bullae include cough, dyspnea, and chest pain, but in some cases, the condition may be asymptomatic. Although the diagnosis of infected bullae has been reported, tuberculosis as a causative pathogen is rare. This case Present a 27 year old male patient came to the medical rehabilitation department of feeling easily tired when walked more than 8 meters. The patient was initially diagnosed with pulmonary tuberculosis 14 months ago, and completed 12 months of antituberculosis treatment. He underwent a thoracotomy decortication wedge resection of the right superior lobe of lung and another thoracotomy to evacuate the haematoma and control the bleeding two weeks before admision. From the physical examination, he had forward head posture, rounded shoulders, and slight hyperkyphotic posture. Respiromotor status showed decreased chest expansion and asymmetrical movement during respiration. Two weeks after rehabilitation program consist of breathing control, chest expansion exercise, airway clearance technique, and aerobic exercises, the patient shows improvement. Key words: Lung Bullae, Rehabilitation, Thoracotomy, Tuberculosis.

ABSTRAK

Bula paru didefinisikan sebagai ruang udara di paru-paru, berukuran diameter lebih dari 1 cm saat menggembung, sedangkan bula besar menempati setidaknya 30% hemithorax. Bula diperkirakan bersentuhan dengan cabang bronkial; yang terisi selama selama inspirasi, menyebabkan kolapsnya parenkim paru normal. Manifestasi klinis dari bula besar meliputi batuk, dispnea, dan nyeri dada, namun pada beberapa kasus, kondisi ini mungkin tidak menunjukkan gejala. Meskipun diagnosis bula yang terinfeksi telah dilaporkan, tuberkulosis sebagai patogen penyebab jarang terjadi. Laporan kasus ini melaporkan seorang laki-laki berusia 27 tahun datang ke bagian rehabilitasi medis dengan perasaan mudah lelah jika berjalan lebih dari 8 meter. Pasien awalnya terdiagnosis tuberkulosis paru 14 bulan yang lalu, dan menyelesaikan pengobatan antituberkulosis selama 12 bulan. Dia menjalani reseksi dekortikasi torakotomi pada lobus paru superior kanan dan torakotomi lainnya untuk mengevakuasi hematoma dan mengontrol pendarahan dua minggu sebelum datang ke rumah sakit. Dari pemeriksaan fisik didapatkan postur kepala ke depan, bahu membulat, dan postur sedikit hiperkimfosis. Status respiromotor menunjukkan penurunan ekspansi dada dan gerakan asimetris saat respirasi. Dua minggu setelah program rehabilitasi yang terdiri dari kontrol pernapasan, latihan ekspansi dada, teknik pembersihan jalan napas, dan latihan aerobik, pasien menunjukkan perbaikan.

Kata kunci: Bula paru, Rehabilitasi, Torakotomi, Tuberkulosis

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Introduction

Lung bullae are defined as air spaces in the lungs, measuring more than 1 cm in diameter when distended, while giant bullae occupy at least 30% of the hemithorax.[6,7] In advanced stages, bullae may form in the subpleural space, commonly at the apices of the lung. Giant bullae are uncommon but when present can lead to compression of adjacent normal lung tissue.[8] Clinical manifestations of giant bullae include cough, dyspnea, and chest pain, but in some cases, the condition may be asymptomatic.[9] Although the diagnosis of infected bullae has been reported, tuberculosis as a causative pathogen is rare.[7] In case of giant bullae, the patient may develop sudden severe breathlessness due to the development of a spontaneous pneumothorax or sudden increase in size of the bulla due to air trapping.

This case report shows a 27-year-old male patient came to the medical rehabilitation department to continue rehabilitation program after 2 weeks being discharged from hospital. He complained of feeling tired easily when he walked more than 8 meters. He received rehabilitation program consist of breathing control, chest expansion exercise, airway clearance technique, and aerobic exercises, and the patient shows improvement

Case report

A 27 year old male patient came to the medical rehabilitation department to continue rehabilitation program after 2 weeks being discharged from hospital. He complained of feeling tired easily when he walked more than 8 meters. He had to stop and rest after walking about 20 meters. He had no shortness of breath, no cough, and no phlegm. He no longer felt pain on the surgical scar on the right side of his chest or where the chest tube was inserted. Most of his daily activities were carried out in bed. The patient was initially diagnosed with pulmonary tuberculosis about 14 months ago, and had completed 12 months of antituberculosis treatment. One year ago, he had 2 chest tubes followed by water seal drainage attached to both sides of his chest and he was diagnosed with bullae in both of his lungs. He underwent a thoracotomy decortication wedge resection of the right superior lobe of lung at May 18th, 2022, and another thoracotomy to evacuate the haematoma and control the bleeding at May 21st , 2022. He had a history of smoking for about 10 years and just stopped smoking on January 2021. From the physical examination, the nutritional status was normoweight. He had forward head posture, rounded shoulders, and slight hyperkyphotic posture. Respiromotor status showed decreased chest expansion (axillaris – proc. xyphoideus – inferior thoracal : 3 – 2.5 – 3 cm) and asymmetrical movement (right chest lags) during respiration. The result of sit to stand test was 11 times in 30 seconds, single breath count test was 21, 6-minute walking distance was 180 meters (equivalent to 3.12 METs), Barthel index 18/20 (mild dependent), fatigue severity scale was 49 (fatigue). Radiological findings form the last chest X-ray showed reduced consolidation and infiltrate in both lungs with no pneumothorax, pneumomediastinum, or subcutaneous emphysema were seen.

Figure 1. Chest radiograph

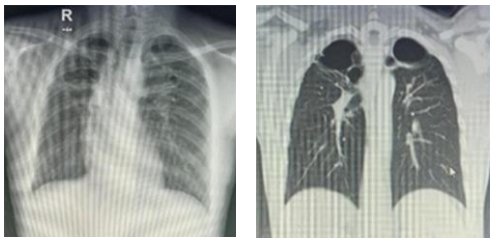

Figure 2. Lung CT-Scan.

Table 1. Rehabilitation program.

Problems	Target	Programs
Post thoracotomy decortication wedge resection of superior right lobe	- Improve lung expansion - Prevent infection - Prevent atelectasis	Home program: - Breathing control with pursed lip breathing - Chest expansion exercise 3 x 5 repetitions with upper extremitymovement - Segmental breathing exercise - Diaphragmatic breathing exercise - Airway clearance technique
Multiple bullae in segments 1,2,3 of the left lung with fibrosis, multiple nodules (granuloma)and traction bronchiectasis	- Improve gas excange - Improve breathingpattern - Improve workof breathing - Prevent - infection	- Breathing control with pursed lip breathing - Airway clearance technique - Segmental breathing exercise - Diaphragmatic breathing exercise
Limited chest expansion	- Increase chest expansion - Increase lung expansion	Home program: - Chest expansion exercise 3 x 5 repetitions with upper extremitymovement - Segmental breathing exercise - Diaphragmatic breathing exercise - Postural correction using visualfeedback (mirror)

Two weeks afret rehabilitation program, the patient reported improvement where he felt tired easily when walked more than 20 meters. Single breath counting test 24 per minutes, and chest expansion 3,5 – 3 – 4 cm.

Discussion

Mycobacterium tuberculosis enters pulmonary macrophages after the inhalation of aerosolized droplets and encounters a beneficial long-term survival environment. Mycobacteria are intriguing due to their remarkable ability to adapt to the human host after avoiding both the innate and adaptive immune responses. Dendritic cells and inflammatory mediators further recruit lymphocytes, monocytes, polymorphonuclear leukocytes, and phagocytes which proliferate and transform into a complex multicellular structure, the so-called histopathological hallmark of TB–granuloma, involved in both pathogenesis and immune protection (as depicted in Figure 5).[1]

The course of the disease depends on the interaction between the host response and the virulence of the organism. The major host defense against the tubercle bacillus is cell-mediated immunity, which is affected primarily by means of macrophages and T lymphocytes. When host factors prevail, there is gradual healing with formation of parenchymal scars. When the organism overpowers host defenses, the disease progresses, either locally or in other parts of the lung or body after spread of bacteria via the airways, lymphatic vessels, or bloodstream. There is a tendency toward more fulminant, disseminated, and even extrapulmonary disease in immunocompromised hosts.[2]

Patient had history of being diagnosed with pulmonary tuberculosis. He had a history of smoking 12 cigarettes per day for 10 years and he had just stopped smoking on January 2021. Smoking plays a key role in the development of tuberculosis infection. Cigarette smoking increases the risk of developing tuberculosis by 3 – 5 folds. It is also a predictor of poor tuberculosis treatment prognosis and outcomes. Some studies reported that smoking increases the severity and mortality rate of tuberculosis. Tuberculosis and smoking take a more severe disseminated course, more extensive lung involvement, and less cavity closure. A person who smokes one packet of cigarettes daily inhales 1.12µg of iron; iron-loading in the alveolar macrophages makes them more susceptible to the growth of *Mycobacterium tuberculosis*. Cigarette smoke increases the threat of *Mycobacterium tuberculosis* infection by suppressing the innate and adaptive immune response with decreased levels of pro-inflammatory cytokines and circulating immunoglobulins and reduces the

activity of alveolar macrophages, dendritic cells, and natural killer cells. The effect of oxidative stress is also important, as it induces apoptosis in both activated and non-activated macrophages, favoring the multiplication of the bacilli and making the process chronic. This might be the reason for less effective tuberculosis treatment outcomes among specific populations. Therefore, smoking cessations are an effective way to decrease treatment failure and drug resistance.[4,5]

Lung bullae are defined as air spaces in the lungs, measuring more than 1 cm in diameter when distended, while giant bullae occupy at least 30% of the hemithorax.[6,7] Bullae are thought to be in contact with the bronchial tree; they are preferentially filled during inspiration, causing collapse of the adjacent (more) normal lung parenchyma. Because their space occupancy interferes with normal respiratory mechanics and thus, normal gas exchange, bullae lead to increased work of breathing with associated exercise limitation and dyspnea.[6] In advanced stages, bullae may form in the subpleural space, commonly at the apices of the lung. Giant bullae are uncommon but when present can lead to compression of adjacent normal lung tissue.[8] Clinical manifestations of giant bullae include cough, dyspnea, and chest pain, but in some cases, the condition may be asymptomatic.[9] Although the diagnosis of infected bullae has been reported, tuberculosis as a causative pathogen is rare.[7]

In case of giant bullae, the patient may develop sudden severe breathlessness due to the development of a spontaneous pneumothorax or sudden increase in size of the bulla due to air trapping.[8] Secondary spontaneous pneumothorax is a pneumothorax that occurs in association with underlying lung disease, such as pulmonary tuberculosis. Secondary spontaneous pneumothorax that does not receive prompt intervention may progress to tension pneumothorax, which is a life-threatening condition. Significant risk factors for the development of tension pneumothorax in pulmonary tuberculosis are co-infection, advanced tuberculosis (i.e., fibrotic adhesion and the size of bullae), and smoking. The pathogenesis of spontaneous tension pneumothorax in pulmonary tuberculosis includes necrosis of pleura and pleural-pulmonary fibrotic adhesion, which possibly allows air leakage to the pleural cavity and is termed pleural porosity. The management of tension pneumothorax obviously requires immediate needle decompression followed by chest tube drainage insertion.[10] And that was what happened to the patient on April 2021, when he suddenly felt shortness of breath getting worse in a few hours until he felt difficult to breathe and finally began to loss of consciousness. There was a lot of air trapped in his lungs and 2 chest tubes were placed on his chest, one on the right chest and the other on the left, followed by WSD, to drain the trapped air out. Bullectomy can greatly improve symptoms and respiratory function in patients with giant bullae.[9] Bullectomy causes significant improvements in dyspnea, gas exchange, pulmonary function, and exercise capacity. On average, improvements persist for approximately 3 to 4 years but begin to decline thereafter. This may be secondary due to decompression of the functioning lung and the ipsilateral bronchi following bullectomy. Although reported early mortality rates after bullectomy are low (from 0% to 2.5%), surgery is not without risk in these patients. Complications include prolonged air leak for more than 7 days (53%), atrial fibrillation (12%), need for postoperative mechanical ventilatory support (9%), and pneumonia (5%).[6]

An individualized exercise program positively affected various outcomes of the patient after thoracotomy. Diaphragmatic breathing, ventilatory movement strategy, and thoracic expansion exercise are used to improve the efficiency of ventilation and gas exchange; subsequently, they increase the excursion of the diaphragm. Thoracic expansion exercises also improve the mobility of the chest wall, trunk, and shoulder girdles. Airway clearance techniques facilitate the clearance of retained secretions; thus, they prevent atelectasis and infection.[13]

Pulmonary tuberculosis induced muscle

wasting and fatigue due to the combination of decreased appetite and changed metabolism related to the inflammatory processes as well as immune responses, in addition to losing both fat and lean tissue.[16] In this patient, fatigue could be due to the chronic inflammatory process, because there were no muscle hypertrophy and muscle hypotonus form the physical examination, and patient's nutritional status is normal. There are also other factors that contribute to fatigue in this patient, such as physical deconditioning, low physical activity, low cardiorespiratory and muscle endurance.[17] We prescribed aerobic exercise program for this patient to improve cardiorespiratory fitness, increase physical activity levels, and diminish the severity of fatigue.[18]

The distance covered on the 6MWT represents the degree of functional limitation inpatients with chronic pulmonary diseases of different etiologies; many of these changes can be considered a better predictor of mortality than FEV1 and nutritional status. Pinto-Plata and colleagues divided patients with chronic obstructive pulmonary disease into classes of 100m according to the distance walked during the test and showed that each category had significant differences in mortality outcomes. Moreover, in patients with severe chronic obstructive pulmonary dis-ease, a performance of less than 300 m distance walked during the test represents a mortality rate twice as high.[19] The increase in the distance covered during the six-minute walk test indicated an increase in exercise tolerance.[13] The reason for this improvement can be attributed to the physiological effect, i.e. a decrease in the demand for ventilation and the decrease in the level of lactic acid in the blood, resulting in improved aerobic metabolism in muscles, thus relieving muscle fatigue.[16]

Conclusion

Although the diagnosis of infected bullae has been reported, tuberculosis as a causative pathogen is rare. This case report present a 27 years old male with lung bullae who suffers from tuberculosis 14 months before admission. Multidisiplinary approach is required for this patient including physical exercise and rehabilitation. This case report shows that rehabilitatoin program can help improve symtomps and prevent any decline in a personal functioning.

REFERENCES

1. Meca AD, Mititelu-Tarţău L, Bogdan M, Dijmarescu LA, Pelin AM, Foia LG. Mycobacterium tuberculosis and Pulmonary Rehabilitation: From Novel Pharmacotherapeutic Approaches to Management of Post-Tuberculosis Sequelae. J Pers Med. 2022;12(4):1–21.
2. Kim HY, Song KS, Goo JM, Lee JS, Lee KS, Lim TH. Thoracic Sequelae and Complications of Tuberculosis. Radiographics. 2001;21(4):839–58.
3. Ravimohan S, Kornfeld H, Weissman D, Bisson GP. Tuberculosis and lung damage: From epidemiology to pathophysiology. Eur Respir Rev. 2018;27(147).
4. Khan AH, Sulaiman SAS, Hassali MA, Khan KU, Ming LC, Mateen O, et al. Effect of smoking on treatment outcome among tuberculosis patients in Malaysia; A multicenter study. BMC Public Health. 2020;20(1):1–8.
5. Jain NK. Chronic obstructive pulmonary disease and tuberculosis. Lung India.2017;34(5):468-469.
6. Sharma N, Justaniah AM, Kanne JP, Gurney JW, Mohammed TLH. Vanishing lung syndrome (giant bullous emphysema): CT findings in 7 patients and a literature review. J Thorac Imaging. 2009;24(3):227–30.
7. Heo J, Bak SH, Ryu SM, Hong Y. Tuberculosis-Infected Giant Bulla Treated by Percutaneous Drainage Followed by Obliteration of the Pulmonary Cavity Using Talc. Korean J Thorac Cardiovasc Surg. 2020;1–4.
8. Shah N, Bhargava R, Ahmed Z, Pandey D, Shameem M, Bachh A, et al. Unilateral bullous emphysema of lung. Lung India. 2007;24(1):30.
9. Chen MT, Tang SE. Tuberculosis-related giant bullae mimicking tension

pneumothorax. Intern Emerg Med. 2017;12(7):1069–70.
10. Pradana AD. Spontaneous Tuberculosis-Associated Tension Pneumothorax: A Case Report and Literature Review. Case Reports Acute Med. 2020;3(2):35–9.
11. Zafar H, Albarrati A, Alghadir AH, Iqbal ZA. Effect of Different Head-Neck Postures on the Respiratory Function in Healthy Males. 2018.
12. Meca AD, Mititelu-Tarţău L, Bogdan M, Dijmarescu LA, Pelin AM, Foia LG. Mycobacterium tuberculosis and Pulmonary Rehabilitation: From Novel Pharmacotherapeutic Approaches to Management of Post-Tuberculosis Sequelae. J Pers Med. 2022;12(4):1–21.
13. Kim HY, Song KS, Goo JM, Lee JS, Lee KS, Lim TH. Thoracic Sequelae and Complications of Tuberculosis. Radiographics. 2001;21(4):839–58.
14. Ravimohan S, Kornfeld H, Weissman D, Bisson GP. Tuberculosis and lung damage: From epidemiology to pathophysiology. Eur Respir Rev. 2018;27(147).
15. Khan AH, Sulaiman SAS, Hassali MA, Khan KU, Ming LC, Mateen O, et al. Effect of smoking on treatment outcome among tuberculosis patients in Malaysia; A multicenter study. BMC Public Health. 2020;20(1):1–8.
16. Jain NK. Chronic obstructive pulmonary disease and tuberculosis. Lung India.2017;34(5):468-469.
17. Sharma N, Justaniah AM, Kanne JP, Gurney JW, Mohammed TLH. Vanishing lung syndrome (giant bullous emphysema): CT findings in 7 patients and a literature review. J Thorac Imaging. 2009;24(3):227–30.
18. Heo J, Bak SH, Ryu SM, Hong Y. Tuberculosis-Infected Giant Bulla Treated by Percutaneous Drainage Followed by Obliteration of the Pulmonary Cavity Using Talc. Korean J Thorac Cardiovasc Surg. 2020;1–4.
19. Shah N, Bhargava R, Ahmed Z, Pandey D, Shameem M, Bachh A, et al. Unilateral bullous emphysema of lung. Lung India. 2007;24(1):30.
20. Chen MT, Tang SE. Tuberculosis-related giant bullae mimicking tension pneumothorax. Intern Emerg Med. 2017;12(7):1069–70.
21. Pradana AD. Spontaneous Tuberculosis-Associated Tension Pneumothorax: A Case Report and Literature Review. Case Reports Acute Med. 2020;3(2):35–9.
22. Zafar H, Albarrati A, Alghadir AH, Iqbal ZA. Effect of Different Head-Neck Postures on the Respiratory Function in Healthy Males. 2018.