

RE-EXPANSION PULMONARY EDEMA FOLLOWING TUBE THORACOSTOMY IN PNEUMOTHORAX: A RARE COMPLICATION

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ABSTRACT

Background: Re-expansion pulmonary edema (REPE) is a rare complication of tube thoracostomy. REPE can be fatal in 20% of cases. Risk factors that can cause REPE in pneumothorax are prolonged lung collapse, large-sized pneumothorax, and young age.

Case description: A 21-year-old young man came to the emergency room with a complaint of dyspnea. The chest x-ray showed a large-sized right pneumothorax. A chest tube was inserted to treat pneumothorax, and the dyspnea was improved. However, the patient started coughing continuously, and his peripheral saturation was decreased 30 minutes later. The chest computed tomography showed unilateral right ground-glass opacities that indicated re-expansion pulmonary edema. The patient got supportive therapies, including oxygen and symptomatic therapy. He was discharged after seven days of hospitalization in a good clinical condition.

Conclusion: REPE is characterized by rapid deterioration after a pleural procedure. REPE usually self-limited, and the therapy is supportive according to its severity. Early recognition of its signs and symptoms is essential to prevent the worsening of the patient's condition.

Keywords: Desaturation, Edema, Pneumothorax, Oxygen Therapy, Tube Thoracostomy

INTRODUCTION

Reexpansion pulmonary edema (REPE) is a complication that can occur after the lung has expanded in various pleural procedures.³ The incidence of REPE in pleural procedures ranges from 1-14%. Most REPE occurs after the drainage of pleural effusion. The incidence of REPE in pneumothorax after chest tube insertion is less than 1%.⁴ REPE can be potentially fatal in 20% of cases. Signs and symptoms that should be suspected are shortness of breath, tachypnea, desaturation, and cough in the

first 1 hour after chest tube insertion.⁵ Early recognition of signs and symptoms of REPE is essential to prevent delays in handling, which can cause worsening of the disease condition.³

CASE PRESENTATION

A 21-year-old man came to the emergency room with complaints that his chest was tight since 11 days ago. Initially, complaints are felt after waking up. There was no cough, no shortness of breath, no fever, no decrease of appetite, no weight loss,

and no night sweating. The patient had previously been treated at another hospital nine days ago and diagnosed with right pneumothorax. However, the patient did not want to be referred to another hospital for a chest tube insertion. Patients have never experienced complaints like this before. Previous medical history was denied. The patient was a smoker since eight years ago (seven cigarettes per day). There was no history of chronic cough in all family members who live in the same house, but there is a history of lung cancer in the mothers of patients who have died.

The general condition result was good, with the Glasgow Coma Scale (GCS) E4V5M6, blood pressure 110/70 mmHg, pulse 98 times per minute, breathing frequency 20 times per minute, peripheral saturation 97% with room oxygen, and axillary temperature 36, 3° C. The patient has a tall and thin body. The patient's height is 175 cm. The patient weighs 46 kg. The patient's body mass index is 15.0 kg / m² (underweight). Pulmonary physical examination found asymmetrical chest shape, and the right chest movement was

diminished. Fremitus palpation decreased in the right lung. Hyperresonance in the right lung field, vesicular breathing sound decreased in the right lung field. Ronchi and wheezing were not found in all lung fields.

The laboratory examination results were an increase of transaminase enzyme (SGOT 66 U/L and SGPT 101 U/L) and leukocytosis (11,120 mg/dl). The patient brought in a chest X-ray from the previous hospital nine days ago. A chest X-ray was taken in the emergency room to find the latest pulmonary picture. The most recent chest X-ray showed a partially expanded right pneumothorax when compared with the chest X-ray 9 days ago (Figure 1).

After the presence of a right pneumothorax is known, then the chest tube installation was performed in the emergency room. After the installation of the chest tube, the patient complains of tightness and coughing continuously. Vital signs GCS E4V5E6, pain scale 2, blood pressure 116/78 mmHg, pulse frequency 108x per minute, breathing frequency 24x per minute, axillary temperature 36.7 °C, peripheral oxygen saturation 93% with room air. Physical

examination was not obtained rhonchi or wheezing on auscultation. A chest X-ray evaluation is performed to determine the chest tube's position and the changes in the patient's lungs. It showed that the lungs have expanded, and the chest tube is inserted with the tip in the upper right lung, but there is a picture of infiltrates in all right hemithorax (Figure 2). The patient is given oxygen supplementation with a simple mask of 6 liters per minute. Repeated blood gas analysis was performed in the emergency room, but the results of the analysis of blood gas impression from the vein. The patient did not have suction on WSD because the chest radiograph evaluation results had expanded, and there was a suspicion of reexpansion pulmonary edema (REPE). On the second day, chest X-ray evaluation and chest HRCT examination were performed to determine the latest pulmonary features and pneumothorax causes. The results of the chest X-ray showed an infiltrate in the lower 2/3 of the right lung field. When compared with the previous chest X-ray, the infiltrate appeared to have been reduced (Figure 3). In the thoracic HRCT examination, a right

pneumothorax was obtained with a chest tube with a bleb of ± 1 cm in size attached to the right lung apex. There are ground-glass opacity and consolidation in the posterior segment of the superior lobe of the right lung, and the inferior lobe of the right lung can be the differential diagnosis of 1. Reexpansion pulmonary edema². Pneumonia (Figure 4).

A microbiological sputum examination was performed. The result was only the presence of normal flora of the airway (*Streptococcus viridans*), and no tuberculosis germ was found. Results of infection markers with procalcitonin are within normal limits, indicating no bacterial infection in the patient. Nasopharyngeal RT-PCR swab test for diagnosing Covid-19 was also performed with negative results. With all of the results, there was no pneumonia in the patient. Spirometry examination was performed to determine the patient's lung function, with results showed mild restriction without obstruction in the patient. On the fifth day, the patient had no complaints. The results of the laboratory evaluation were improved. A chest radiograph was performed after a 48-hour

clamp on the chest tube with a result, the lungs were still expanding, and the infiltrates had disappeared (Figure 5). On the seventh day, the chest tube was removed from the patient. The patient was discharged from the hospital. During treatment in the hospital, the patient is given symptomatic medication to relieve pain without antibiotics. Patients are given education to stop smoking and not do activities that can cause increased intrathoracic pressure. The patient was discharged and treated for outpatient treatment.

DISCUSSION

History and Epidemiology

Carlson et al. first reported Reexpansion pulmonary edema (REPE) in pneumothorax in 1958.⁶ REPE incidence ranges from 1-14%. Most REPE occurs after the drainage of pleural effusion. The incidence of REPE in pneumothorax after chest tube insertion is less than 1%.⁴ REPE is reported to be a fatal risk in 20% of cases. In 64% of REPE cases occur 1 hour after chest tube insertion. All cases of REPE in pneumothorax occur within the first 24

hours.³ The risk factors for REPE are the long duration of collapse (> 72 hours), size of lung collapse > 30%, rapid air and water removal in the pleural cavity, application of high-pressure negative intrapleural (suction), and young age.^{3,7} REPE is more common at the age of 20-39 years than age > 40 years. There were no significant differences in the incidence of the male or female sex, collapsed lung side, and comorbidity in patients.³ In the results of a study by Taira et al. reported that the presence of pleural effusion on the side of the pneumothorax was a significant risk factor for REPE after chest tube insertion.⁸

Pathophysiology

In 1980 REPE was thought to stem from an increase in vascular permeability due to pulmonary tissue expansion. It is challenging to predict REPE because of many influential factors.³ Known risk factors for REPE are the long duration of pulmonary collapse, large pneumothorax, and young age. REPE is more common in patients who have symptomatic PSP for more than seven days. Sewel et al. reported changes in the alveolar-

capillary basal membrane that occurred three days after lung collapse. This change makes the alveoli membrane more permeable.⁹

Pulmonary blood vessels are susceptible to this traction due to histological changes during lung collapse. According to Gumus et al., after an ischemic-reperfusion process in the lung, free radicals and anoxic stress will increase, which causes endothelial damage.³ Some studies in experimental animals have shown that the collapse of the lung will lead to endothelium thickening due to the release of cytokines such as interleukin 8 (IL-8), monocyte chemoattractant protein 1 (MCP-1), leukotriene B-4.¹⁰ The damage is compounded by an increase in free radicals such as nitric oxide and xanthine oxidase.⁴ Other mechanisms are mechanical stress and reduced surfactants.¹¹ Sue et al. described collapsed lung tissue consisting of hypoxic vasoconstriction areas. These factors will cause increased permeability of blood vessels. Pulmonary edema results from hydrostatic pressure in the area combined with negative pressure which causes a

decrease in lymphatic flow and venoconstriction.³

Clinical Examination and Diagnosis

REPE is a rare and unpredictable iatrogenic condition with a mortality rate of 20%.⁶ Symptoms vary from asymptomatic radiological features to respiratory and circulatory failure. Common symptoms are continuous coughing and shortness of breath after chest tube placement or thoracocentesis. Cough can be productive in the form of frothy pink sputum. Other symptoms are tachypnea, tachycardia, hypotension, nausea, vomiting, and cyanosis.¹² REPE is usually unilateral and occurs when the lungs expand rapidly during the ongoing evacuation of large amounts of water or air in the pleural cavity.¹³ REPE usually occurs 1-2 hours after thoracocentesis, but the onset varies and can occur up to 24 hours after the procedure. REPE can worsen within one or two days, but in mild cases, REPE will improve within a few days.⁷

There are no specific diagnostic criteria for REPE. REPE is usually described as a radiological diagnosis with or without

clinical symptoms in patients. The plain chest photo findings are not specific. REPE is usually progressive on days 1-2, and resolutions occur on days 3-7.¹³ HRCT is the best radiological examination for REPE. Ground glass opacity (GGO) is the most common form of REPE found in all patients (100%). GGO often occurs unilaterally on the lung side by a pleural drainage procedure. REPE can be found accidentally on HRCT, for example, for the purpose of finding a bleb or bullae causing a spontaneous pneumothorax. Pneumonia, bleeding, and cryptogenic organization are the differential diagnoses of REPE. The possibility of a diagnosis of pneumonia and bleeding can be ruled out from the absence of clinical symptoms such as fever and leukocytosis in patients.⁷

Prevention and Therapy

Supportive therapy is the first choice for REPE. Treatment is depended on the severity of the disease.¹¹ The risk factors must be considered before inserting a chest tube to avoid REPE. Risk factors include young age, long duration of pneumothorax

(>72 hours), large pneumothorax (>30%). In patients with risk factors should not be done suction and drainage of large volumes (more than 1 liter). A study shows that giving 40% oxygen fraction can prevent REPE when the lungs expand.¹² Some studies show that giving oxygen or antioxidants when placing a chest tube shows benefits, but these studies are studies of small populations and need further research.³

REPE usually heal itself, and most do not require further intervention. REPE therapy includes the administration of oxygen or CPAP. In some severe cases, intubation and mechanical ventilation with PEEP provide benefits. Diuretics are contraindicated in REPE because they will worsen hypovolemia. The provision of antioxidants in REPE is still under research. Some researchers use ibuprofen and misoprostol analogs on REPE for anti-inflammatory and cytoprotective effects. The contralateral side pressure sores can prevent edema progression and increase pulmonary shunt. Most REPE improves in 24 to 72 hours.¹¹

CONCLUSION

Reexpansion pulmonary edema (REPE) is rare in pneumothorax but can be fatal in 20% of cases. Risk factors that can cause REPE in pneumothorax are prolonged lung collapse (>72 hours), large pneumothorax (>30%), and young age. It is recommended not to use suction and drainage of water or air with a small volume (maximum of 1 liter) to prevent REPE. REPE is self-limited, and the management is supportive.

DISCLOSURE

The author reports no conflicts of interest in this work.

AUTHOR CONTRIBUTION

All of the authors contribute to the study from the case framework, data gathering, and data analysis until reporting the result of the study.

ETHICAL ASPECT

The patient has received signed informed consent for publication of their photograph in the journal article.

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FIGURE

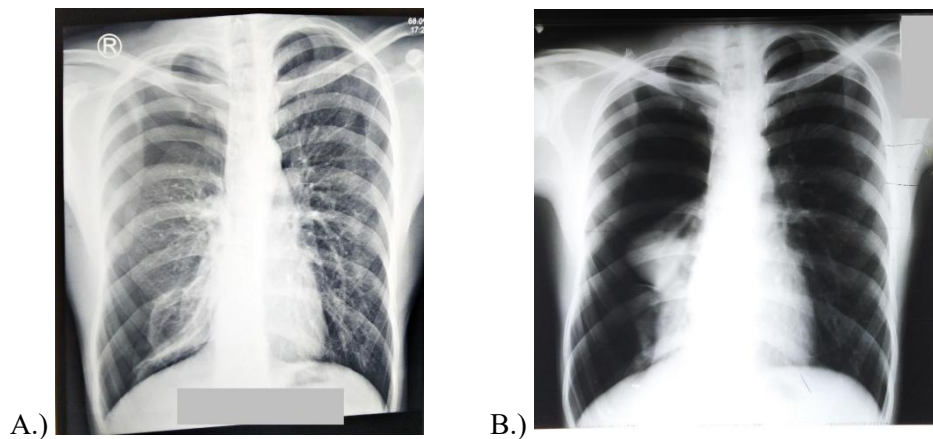


Figure 1. A.) Chest X-ray 9 days ago shows a total right pneumothorax B.) Chest X-ray in the emergency room shows the right lung has partially expanded

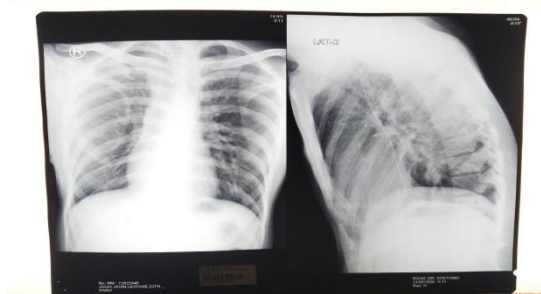


Figure 2. Chest X-ray after chest tube installation, the lungs appear to have expanded, and the right lung infiltrates are obtained

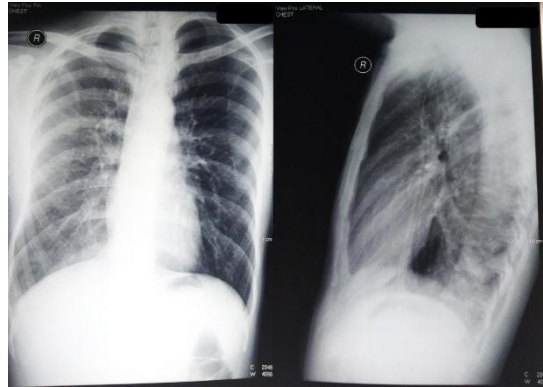


Figure 3. The chest X-ray of patients on the second day showed that the infiltrate in the right lung when compared with the previous photo was reduced.

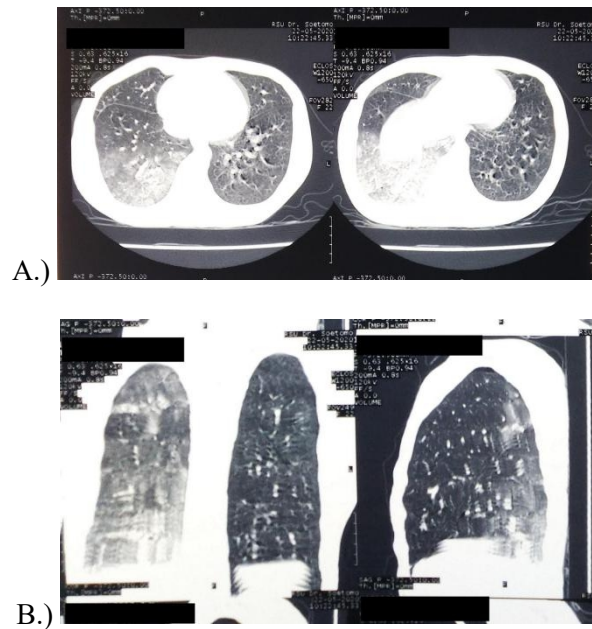


Figure 4. Patient thoracic HRCT obtained a picture of pneumothorax that has been mounted chest tube with ground-glass opacity (GGO) in the right lung can be a differential diagnosis of reexpansion pulmonary or pneumonia. A.) Axial pieces appear GGO posteriorly, B.) Image of a sagittal section showing GGO in the superior and inferior lobes of the right lung

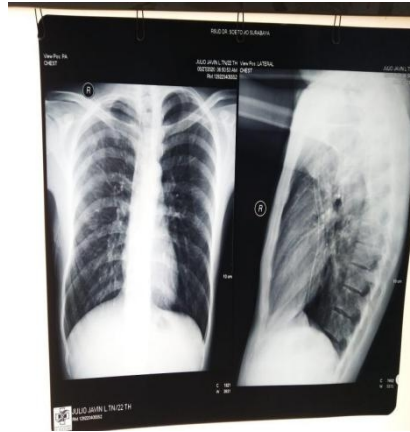


Figure 5. Chest X-ray on seventh-day lungs still appear to have expanded after a 48-hour thoracic clamp, and the infiltrates in the right lung have disappeared.