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Pneumothorax, *Giant Bullae* and Bronchiectasis in Pediatric Patients with a History of Pulmonary TB

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ABSTRACT

Pulmonary tuberculosis (*TB*) remains a major infectious disease in children, particularly in developing countries. Post-*TB* pulmonary complications, such as pneumothorax, giant bullae, and bronchiectasis, can significantly impair respiratory function over time. This case report highlights a 17-year-old girl with a history of *BTA*-positive pulmonary *TB* who developed pneumothorax, giant bullae, varicose bronchiectasis, and centrilobular emphysema. After completing *OAT* therapy in August 2024, she underwent *VATS*, bulectomy, and wedge resection due to persistent lung abnormalities. Thoracic *CT* imaging revealed extensive lung damage, including bronchiectasis and bullae. Currently, the patient is stable and asymptomatic. This case emphasizes the importance of early detection and comprehensive management of post-*TB* bronchiectasis in pediatric patients. Timely intervention can improve prognosis, especially given the high regenerative capacity of children's lungs. Early recognition of complications and appropriate treatment are crucial to prevent long-term respiratory impairment in children recovering from pulmonary *TB*.

INTRODUCTION

Tuberculosis (*TB*) is a chronic infectious disease caused by the bacterium *Mycobacterium tuberculosis* and is highly contagious. *TB* remains a significant global health problem, with Indonesia ranking second worldwide in the number of cases, estimated at around 969,000 people (Pawlowski et al., 2012; Lanzadame & Vento, 2016). According to data from the Indonesian Ministry of Health in 2022, there were approximately 110,881 cases of *TB* in children under 15 years old, accounting for about 15.3% of the national total, including 143 cases of drug-resistant *TB* (*TB RO*). Various factors contribute to the high incidence of *TB*, such as low socioeconomic status, limited access to health services, overcrowding among the homeless poor, the spread of *HIV* infection, weakened immune systems, and the virulence and quantity of *TB* bacteria (Ministry of Health, 2022; Ministry of Health, 2016; Ministry of Health, 2023).

Most *TB* transmission occurs through the air when individuals inhale droplets containing bacilli from an infected person. In children, the source of transmission is generally adults with active *TB*. The *Mycobacterium tuberculosis* bacteria primarily develop in the lungs,

especially in those with weakened immune systems, and can spread to other organs via the bloodstream (*hematogen*) and lymphatic system (*lymphogen*). Although *TB* can affect nearly all organs—including the lungs, brain, kidneys, gastrointestinal tract, bones, and lymph nodes—the lungs remain the most frequently affected (Pawlowski et al., 2012; Shah & Bhaskar, 2017).

Various sequelae and complications can arise from *TB*, both pulmonary and extrapulmonary, in patients regardless of treatment. Notably, complications such as bulla formation, pneumothorax, and post-infection bronchiectasis can occur (Simanjuntak et al., 2023). Pneumothorax is seen in about 5% of post-*TB* patients, mainly those with severe cavitary lesions and multiple bullae, but is rare in *miliary tuberculosis* (Simanjuntak et al., 2023; Marhana et al., 2022). The incidence of bilateral pneumothorax in *miliary tuberculosis* is only 1.3–1.5%, and pulmonary bullae with bilateral pneumothorax is a rare but lethal condition, with a mortality rate exceeding 50%. Pneumothorax can develop secondary to pulmonary necrosis or rupture of multiple bullae due to emphysematous changes, while structural airway damage from *TB* infection leads to bronchiectasis (Ministry of Health, 2020; Simanjuntak et al., 2023; Marhana et al., 2022; Hariyanto & Hasan, 2016; Yumma & Mayasari, 2022).

Previous studies, such as those by Simanjuntak et al. (2023), have examined the risks of pneumothorax and bronchiectasis in post-*TB* patients, highlighting the severity of pulmonary damage in advanced cases. Similarly, Marhana et al. (2022) focused on the incidence and high mortality rate of bilateral pneumothorax in *TB* patients. However, these studies primarily discuss clinical outcomes and do not thoroughly address the long-term effects or management strategies for *TB*-related complications in children or the general population (Lanzafame, 2016).

This research aims to address these gaps by focusing on the long-term consequences of *TB*-related complications, particularly the incidence of pneumothorax, bronchiectasis, and bulla formation in both children and adults. The study seeks to provide a more comprehensive understanding of post-infection complications and propose intervention strategies. The findings are expected to contribute to improved patient management and early detection protocols, ultimately enhancing care quality and reducing mortality associated with severe *TB* complications.

RESEARCH METHOD

This study employed qualitative research methods. The qualitative research method focused on in-depth observation of phenomena and the exploration of the meanings contained within them. The sharpness of the analysis in this study was highly dependent on the strength of the narrative conveyed through word selection and sentence structure. Basri stated that the essence of qualitative research lay in the process that took place and the interpretation of the results. The main focus of this research was on the elements of humans, objects, and institutions, and how the interaction between these elements helped in understanding a particular event, behavior, or phenomenon (Safarudin et al., 2023).

The data collection technique in this study was the examination of case report documents. Data were collected through a thorough review of the patient's medical records, results of radiological examinations, records of medical procedures, and the history of tuberculosis treatment that the patient had undergone. The study of these documents allowed researchers to obtain a comprehensive overview of the clinical, chronological, and developmental aspects of the patient's condition. The data that had been collected were then analyzed in three stages: data reduction, data presentation, and drawing conclusions. Through this approach, the research provided an in-depth picture of the long-term impact of pulmonary

TB on children and highlighted the importance of comprehensive treatment to prevent further lung damage.

RESULT AND DISCUSSION

The case above reported a 17-year-old girl with a previous history of tuberculosis confirmed bacteriologically positive with BTA positive before treatment. The last history of shortness of breath was in February 2024 and there were no complaints of cough, fever was denied, night sweats were denied, decreased appetite and weight loss were denied at the beginning of tuberculosis diagnosis. The MTB TCM examination history from sputum samples was obtained as a result of MTB detected high, Rifampicin sensitive. The patient was given OAT therapy (with BB 35 kg), adult KDT intensive phase (HRZE 75/150/400/275 mg), 1x3 tabs, and vitamin B6 1x1 tabs. The patient has completed treatment on August 22, 2024.

Enforcement of the diagnosis of tuberculosis (TB) in children requires a thorough evaluation, which includes an in-depth anamnesis, physical examination, as well as various supporting examinations such as tuberculin tests, chest X-rays, rapid molecular tests (TCM), and BTA smear examinations. A definitive diagnosis is established by the discovery of Mycobacterium tuberculosis bacteria through sputum examination, gastric rinsing, cerebrospinal fluid, pleural fluid, or tissue biopsy results. Given the difficulty of obtaining definitive evidence of TB infection in children, the diagnosis approach relies heavily on a history and a targeted and thorough clinical examination (Källenius G, 2012; Lanzanfame & Vento, 2016; Ministry of Health, 2020).

The clinical symptoms of TB can be systemic or generalized symptoms or according to the associated organs. The clinical symptoms of tuberculosis in children are not typical, as similar symptoms can also be caused by various diseases besides TB.[2] Systemic symptoms include weight loss or no gain in the previous 2 months or failure *to thrive* even though there has been good nutritional improvement in 1-2 months, long fever (≥ 2 weeks) and/or recurrent without obvious cause and generally not high, cough for a long time ≥ 2 weeks is *non-remitting*, lethargic or malaise, children who are less active in play (Ministry of Health, 2016; Ministry of Health, 2023).

Children and adolescents weighing more than 30 kg are generally given adult Fixed Dose Combination Anti-Tuberculosis Drugs (OAT), which are taken daily during the intensive and advanced phases. If daily KDT is available for children, it is given according to the dose listed in Table 4. The main difference between the treatment of TB in children and adults lies in the dosage of the drug administered. Children, especially those under 5 years of age, have a faster rate of drug metabolism, so they require higher doses (based on mg/kg of body weight) than older children or adults (Ministry of Health, 2016; Ministry of Health, 2020; Ministry of Health, 2023).

Table 1. Adult KDT OAT dosage for children and adolescents BB >30 kg (daily dose)

Weight (kg)	Intensive Phase HRZE 75/150/400/275 mg	Advanced Phases HR 75/150 mg
31-<35	3	3
35-<65	4	4
≥65	5	5

Treatment for drug-sensitive tuberculosis (TB SO) involves the use of a combination of drugs INH (H), Rifampicin (R), Pyrazinade (Z), and Etambutol (E), with doses adjusted based on the patient's weight. The type of regimen and duration of OAT administration are determined by age, type of TB, and severity of the disease (see Table 2). The intensive phase lasts for two months and consists of a minimum of three types of drugs, namely R, H, and Z.

Etambutol is added in this phase for cases in adolescents, severe pulmonary TB, severe extrapulmonary TB, as well as children who are also infected with HIV. Meanwhile, the advanced phase uses two types of drugs, namely R and H, for 4 to 10 months depending on the severity. In the case of extra-pulmonary TB such as TB meningitis, bone TB, or pulmonary TB, the duration of the advanced phase can be extended to 12 months (Källenius G, 2012).

The patient was reported to have pneumothorax on April 12, 2024 due to complications of pulmonary tuberculosis and was referred to Dr. Soetomo Hospital for chest tube insertion. Pneumothorax, specifically secondary spontaneous pneumothorax (PSS), is a pulmonary emergency caused by underlying diseases such as COPD, emphysema, cystic fibrosis, TB, lung cancer, and HIV-related infections such as PCP. This condition occurs due to air leakage from the lungs into the pleural cavity through tearing or rupture of the pleural in connection with the bronchi, often due to thin-walled bubbles due to emphysema. Management depends on the type and severity of pneumothorax and the patient's clinical condition, and can be both medical and surgical. Recommended actions include chest tube insertion, broncopleural fistula closure, and bulopeural resection to prevent recurrence and improve lung function (Monday et al., 2022).

On August 27, 2024, the patient came to the RSDS Respi Polyclinic with suspicion of bronchiectasis and planned to undergo a thoracic CT scan with contrast. The results of the examination brought during control to the Pediatric Respiratory Polyclinic of Dr. Soetomo Hospital on September 24, 2024 showed the presence of pulmonary TB with giant bullae in the medius and posterior lobes, as well as multiple bullae in the apical segments of the right and left superior lobes of the lungs (Bhalla et al., 2015; Alshammari et al., 2021; Mohamed et al., 2023; Tran et al., 2020; Kuo et al., 2018). Varicose bronchiectasis was also found in the posterior segment of the superior lobe of the right lung, centrilobular emphysema in various segments of the inferior lobe of the right and left lungs, as well as subcarinal lymphadenopathy, AP window, paraaorta, and subcentimeter lymph nodules in the right paratracheal. Although thoracic X-rays are often used to detect bulla, pneumothorax, and bronchiectasis, *High Resolution Computed Tomography* (HRCT) has proven to be more sensitive and is the gold standard in detecting and distinguishing the condition, especially in clarifying unclear findings on thoracic images. HRCT provides a specific description of bronchiectasis such as cylindrical, varicose, cystic, or mixed forms (Monday et al., 2022; Hariyanto & Hasan, 2016; Yumma & Mayasari, 2022).

Pathologically, the pulmonary bulla is a dilation of the distal air cavity to the terminal bronchioles, with thin walls and a size of more than 1 cm, which can suffer damage to its walls. The formation of a bulla is caused by a partial obstruction of the airway, which creates a one-way valve mechanism for air to enter upon inspiration but get trapped during expiration so that the bulla grows further (Park et al., 2020; Lee et al., 2019; Ahmed et al., 2017; Yoo et al., 2016; Tschopp et al., 2015). The higher elasticity of the pulmonary parenchyma around the bulla than the bulla itself causes the lung tissue to be pulled away during expiration, supporting further expansion of the bulla. Enlargement of the bulla can pressure the surrounding lung tissue, cause atelectasis (lung collapse), and shift the mediastinum. In many cases, bulla experiences progressive enlargement, while spontaneous regression is rare. If the bulla ruptures, complications can arise in the form of spontaneous pneumothorax (Debora et al., 2023).

Bronchiectasis is a chronic condition characterized by permanent dilation of the bronchial ducts, which is accompanied by inflammation of the bronchial walls and surrounding lung tissues. The main symptom of bronchiectasis is a recurrent, persistent, or difficult to overcome airway infection. The rest of the symptoms that often appear include coughing up blood, chronic obstruction of the respiratory tract, and respiratory disorders that tend to worsen gradually (Yumma & Masyasari, 2022). Morphologically bronchiectasis is divided into 3 types: (1) Cylindrical or tubular, characterized by airway dilation. (2) Varicose veins, characterized by focal constrictive areas accompanied by airway dilatation due to defects in the

bronchial wall. (3) cystic or sacular lesions, characterized by progressive dilation of the airways that end in cysts of large size, sacroular, or *grape-like clusters* and is the most severe description of bronchiectasis (Hariyanto & Hasan, 2016).

The most common cause of bronchiectasis is infection, although in some cases the cause is unknown (idiopathic). One of the mechanisms underlying the occurrence of post-infection bronchiectasis is the presence of respiratory tract infections in the early stages of life, which can damage the structure of the airways that are still developing. This makes the airways more susceptible to recurrent infections, and infections that persist over time can lead to bronchiectasis (Kapur et al., 2016; Masekela et al., 2017; Gaillard et al., 2019; King et al., 2020; Choi et al., 2023). The process of its pathogenesis involves a combination of recurrent inflammation of the bronchial wall and fibrosis of the lung tissue, which gradually weakens the bronchial wall and leads to permanent dilation . The dominant inflammatory cells in the lumen of the airway are neutrophils, which play a role in the appearance of purulent sputum, while macrophages, dendritic cells, and lymphocytes located in the walls of the airways contribute to airway obstruction (Hariyanto & Hasan, 2016).

The clinical picture of bronchiectasis in children is mostly found in preschool and early school age. Productive cough in the morning and aggravated until daylight is a typical sign and is found in 97% of cases, while purulence of sputum in 46% of cases, hemoptysis occurs in 14% of cases but is rare, shortness of breath and wheezing are found in 7% and 21% in each case (Polverino et al., 2017; Chalmers et al., 2018; Guan et al., 2020; Somayaji et al., 2022; Suárez-Cuartin et al., 2023). On physical examination of the lungs, crackles were found in 82% of cases, rough ronki in 44% of cases and wheezing in 21% of cases.*Clubbing of the finger* is reported in 37-51% of patients. The image of the thoracic image as an important initial stage and can be found honeycomb appearance appears as ring-like shadows or tram lines can also be an image of overinflation of the affected lung area. HRCT as the gold standard in bronchiectasis (Yumma & Masyasari, 2022).

The management of bronchiectasis includes various aspects, including recognizing and managing acute exacerbations with the administration of antibiotics, controlling the growth of microorganisms, and treating the underlying conditions that cause it. Other important efforts include reducing excessive inflammatory responses, improving airway hygiene, managing sedentary mucus production, and performing surgical procedures when necessary to remove severely damaged parts of the lung that could potentially be a source of infection or bleeding. Although the cause of bronchiectasis cannot be identified in about 50% of cases, if humoral immune disorders, mycobacterial or Pseudomonas infections, and cystic fibrosis are found, then the prognosis and treatment strategies can be more targeted (Monday et al., 2022; Hariyanto & Hasan, 2016; Yumma & Mayasari, 2022).

The prognosis of bronchiectasis in children is generally quite good if the cause of lung damage can be identified and treated early. Lung tissue growth occurs rapidly in children under 6 years of age, but this ability begins to decline with age. The damage that occurs at an early age can still be compensated by healthy lung growth, as long as the factors that cause bronchiectasis do not persist. (Shah & Bhaskar, 2016; Yumma & Mayasari, 2022).

Early detection and proper management of cases of tuberculosis-induced bronchiectasis, such as the one experienced by this patient, is crucial to prevent the progression of progressive lung tissue damage. Prompt and appropriate treatment can help control symptoms, reduce the frequency of recurrent infections, and prevent more severe complications. In addition, optimal medical interventions also play an important role in improving lung function and improving patients' quality of life in the long term, so that they can carry out their daily activities better and productively.

CONCLUSION

This case describes a 17-year-old girl with a history of *BTA*-positive pulmonary tuberculosis who, despite completing *OAT* therapy, developed significant pulmonary complications including extra-pneumothorax, giant and multiple bullae, varicose-type bronchiectasis, centrilobular emphysema, and lymphadenopathy, necessitating interventions such as chest tube insertion and *VATS* bulectomy with wedge resection. Currently, the patient is stable and asymptomatic. Bronchiectasis in children, though more common in preschool age, can persist into adolescence if not adequately managed, highlighting the importance of early and accurate diagnosis using clinical, radiological (with *HRCT* as the gold standard), and microbiological assessments. Management should be comprehensive, involving antibiotics during exacerbations, inflammation control, bronchial hygiene improvement, and surgery in severe cases, as early intervention can lead to a favorable prognosis due to the regenerative capacity of pediatric lung tissue. Therefore, prompt detection and appropriate treatment of post-tuberculosis bronchiectasis are crucial to prevent further lung damage and improve long-term outcomes. Future research should focus on long-term follow-up of pediatric patients with post-TB bronchiectasis to better understand outcomes and optimize management strategies.

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