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ORIGINAL ARTICLE

The correlation between thoracic radiographic findings in pulmonary tuberculosis and type 2 diabetes mellitus

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ABSTRACT

Tuberculosis (TB), specifically pulmonary tuberculosis, is a contagious chronic infectious disease caused by *Mycobacterium tuberculosis*. Type 2 diabetes mellitus (T2DM) is a significant comorbidity that influences the clinical presentation of TB. Patients with pulmonary TB and T2DM exhibit a more severe clinical profile and a broader range of symptoms compared to those with PTB alone. Radiologically, TB-T2DM patients often present with more extensive, multilobular lesions and a higher incidence of cavitation. This study aimed to determine the association between the characteristics of chest X-ray findings in patients with pulmonary TB complicated by T2DM and those without T2DM at Royal Prima General Hospital, Medan. This research employed a quantitative methodology with a cross-sectional design. The sample comprised 50 medical records of pulmonary TB patients with T2DM and 50 medical records of pulmonary TB patients without T2DM. Data analysis involved univariate and bivariate statistical methods. The results indicated that the extent of lesions observed on chest X-rays in patients with pulmonary TB patients with T2DM, as well as those without T2DM, varied from minimal to moderate to extensive. The types of lesions identified included infiltrates, infiltrates with fibrosis, and fibrosis. No significant association was found between the extent of lesions or the type of lesions in pulmonary TB patients with T2DM and those without T2DM. The most prevalent lesion extent was moderate, and the most common lesion type was infiltrates with fibrosis.

Keywords: pulmonary tuberculosis, type 2 DM, chest photo, lesion area, lesion type

Introduction

Tuberculosis (TB) is a lower respiratory tract infection caused by the *Mycobacterium tuberculosis* bacillus, which invades lung tissue or parenchyma. TB spreads through the air when an individual with an active TB infection coughs, sneezes, or disperses saliva. Pulmonary tuberculosis is highly contagious. Transmission occurs primarily through the expulsion of droplet nuclei during coughing or sneezing, particularly among close contacts such as family members residing in the same household.[1]

Pulmonary tuberculosis (pulmonary TB) is a chronic, contagious infectious disease caused by *Mycobacterium tuberculosis*. This disease is prevalent in developing countries, particularly in densely populated urban environments, and is associated with poverty.[2] Currently, pulmonary TB remains a significant public health issue and is among the top 10 causes of mortality worldwide.[3] The WHO's 2020 Global Tuberculosis Report indicates that approximately 10 million individuals suffer from pulmonary TB. The highest incidence rates are observed in Southeast Asia, with Indonesia ranking second globally in case

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numbers, following India.[4] In Indonesia, the highest burden of pulmonary TB cases is concentrated in the regencies and cities of Java and parts of Sumatra, attributable to high population densities. The prevalence of TB in Indonesia increased in 2019 compared to 2018. According to 2019 data from the World Health Organization (WHO), there were an estimated 845,000 cases of pulmonary TB in Indonesia, equivalent to 312 cases per 100,000 population. The number of new and relapsed TB cases registered in Indonesia in 2019 was 562,049, an increase from the 565,980 cases registered in 2018. Pulmonary TB cases are estimated to comprise 89% of all TB cases. Regarding gender distribution, TB incidence is higher in males than in females, with percentages of 51% and 37%, respectively. TB incidence in children aged 0-14 years is estimated to be 12% of all TB cases in Indonesia.[5]

Pulmonary TB has substantial consequences for affected individuals, their families, and the nation. Individuals with TB are more susceptible to other diseases, particularly infectious diseases, and experience a reduction in productive life expectancy. Furthermore, pulmonary TB patients often become a burden on their families and face social stigma.[6] Type 2 diabetes mellitus (T2DM) is a significant comorbidity that influences the clinical presentation of TB.[5] Diabetes mellitus is a chronic condition characterized by elevated blood glucose levels due to the body's inability to produce or effectively utilize insulin. Insulin, a crucial hormone produced by the pancreas, facilitates glucose transport from the bloodstream into body cells, where it is converted into energy. Insulin deficiency or cellular resistance to insulin results in hyperglycaemia, a hallmark of T2DM.[7] T2DM poses a global health challenge. According to the International Diabetes Federation, the global prevalence of T2DM in adults aged 20-79 years was 537 million in 2021, and this figure is projected to rise to 643 million by 2030 and 783 million by 2045. More than four out of five (81%) adults with T2DM reside in low- and middle-income countries. T2DM is a leading cause of mortality in developing nations, accounting for 6.7 million deaths in 2021, approximately one death every five seconds. Asian data indicate that 1 in 11 adults, totalling 90 million individuals, have diabetes. This number is projected to reach 113 million by 2030 and 151 million by 2045. More than 1 in 2 adults with diabetes remain undiagnosed. In 2021, diabetes caused 747,000 deaths in Asia.[8] The 2018 Basic Health Research (Riskesdas) in Indonesia revealed a 2% prevalence of T2DM based on doctor diagnoses in individuals aged >15 years, an increase from 1.5% in the 2013 survey. However, the prevalence of T2DM based on HbA1c testing increased from 6.9% to 8.5% in 2018. These data suggest that only 25% of individuals with T2DM are aware of their condition. In 2013-2018, the four provinces with the highest T2DM prevalence were Yogyakarta, Jakarta, North Sulawesi, and East Kalimantan, with Aceh ranking seventh nationally. However, Riau, Jakarta, Banten, Gorontalo, and West Papua exhibited the highest increases in prevalence, at 0.9%.[9] In 2019, the Medan City Health Office reported 27,075 T2DM patients, with 85% aged >55 years and 70% being female, distributed across 39 primary health centres in Medan. These data indicate a high prevalence of T2DM in North Sumatra.[10]

Patients with pulmonary TB and T2DM exhibit more severe clinical manifestations and a wider range of symptoms than those with TB alone. Radiological examinations of TB-T2DM patients reveal more extensive, multilobar lesions and a higher frequency of cavitation. Sputum smear microscopy for acid-fast bacilli (AFB) requires a longer duration to transition from positive to negative cultures in TB-T2DM patients. 5 Chest X-ray findings in T2DM patients with pulmonary TB tend to be more severe than in those without DM. Cavitation is observed in 75% of pulmonary TB patients with concurrent T2DM.[3]

Chest X-ray is a rapid imaging technique and a primary diagnostic tool with high sensitivity for pulmonary TB.[11] Pulmonary tuberculosis and T2DM are diseases with high morbidity and mortality rates. The persistent high incidence of pulmonary TB in Indonesia, coupled with the increasing prevalence of T2DM as a metabolic disorder, and the interaction between these two diseases necessitate special attention. T2DM can exacerbate pulmonary TB symptoms and increase the risk of relapse following treatment completion. Further research is warranted to elucidate the relationship between chest X-ray findings in pulmonary TB and T2DM.[3] This study aimed to determine the association between the characteristics of chest X-ray findings in patients with pulmonary TB complicated by T2DM and those without T2DM at Royal Prima General Hospital, Medan.

Method

The type of research used in this study is quantitative research with a cross-sectional approach, conducted at Royal Prima General Hospital, Medan City, from March 2024 until completion. The population in this study consisted of medical records of pulmonary TB patients with and without T2DM who received

treatment at Royal Prima General Hospital Medan in 2023, totaling 100 medical records. This comprised 50 medical records of pulmonary TB patients with T2DM and 50 medical records of pulmonary TB patients without T2DM. The determination of the sample size used in this study was conducted using total sampling. Total sampling is a sampling technique that includes the entire population, thus the sample in this study consisted of 50 medical records of pulmonary TB patients with T2DM and 50 medical records of pulmonary TB patients without T2DM. The independent variable in this study was the characteristics of the thoracic radiograph findings. The dependent variables in this study were pulmonary TB with Type 2 Diabetes Mellitus and pulmonary TB without diabetes. The research instrument used in this study was patient medical records. The data analysis used in this study was univariate analysis and bivariate analysis.

Results

In this study, among patients with pulmonary TB without T2DM, there were 30 male patients (60%) and 20 female patients (40%). Among patients with pulmonary TB and concurrent T2DM, there were 28 male patients (56%) and 22 female patients (44%). Analysis of the data revealed the following lesion distribution in patients with pulmonary tuberculosis (TB) without type 2 diabetes mellitus (T2DM): minimal lesion extent was observed in 8 patients (16%), moderate lesion extent in 35 patients (70%), and extensive lesion extent in 7 patients (14%). These findings indicate that the majority of pulmonary TB patients without T2DM in this study presented with moderate lesion extent. In patients with pulmonary TB and T2DM, minimal lesion extent was observed in 6 patients (12%), moderate lesion extent in 29 patients (58%), and extensive lesion extent in 15 patients (30%). Similar to the non-diabetic group, the majority of pulmonary TB patients with T2DM in this study exhibited moderate lesion extent.

Table 1. Characteristics of pulmonary TBs lesions based on T2DM status

Variable	Pulmonary TB without T2DM (n=50)		Pulmonary TB with T2DM (n=50)	
	n	%	n	%
Lesion extent				
Minimal	8	16,0	6	12,0
Moderate	35	70,0	29	58,0
Extensive	7	14,0	15	30,0
Lesion type				
Infiltrates	11	22,0	15	30,0
Infiltrates an fibrotic	31	62,0	25	50,0
Fibrotic	8	16,0	10	20,0

The research findings indicate that among non-diabetic pulmonary TB patients, 11 patients (22%) exhibited infiltrative lesions, 31 patients (62%) showed combined infiltrative and fibrotic lesions, and 8 patients (16%) presented with fibrotic lesions. These results demonstrate that the majority of non-diabetic pulmonary TB patients in this study displayed combined infiltrative and fibrotic lesions. In T2DM patients and pulmonary TB, 15 patients (30%) had infiltrative lesions, 25 patients (50%) had combined infiltrative and fibrotic lesions, and 10 patients (20%) had fibrotic lesions. These findings reveal that the majority of pulmonary TB patients with T2DM in this study also exhibited combined infiltrative and fibrotic lesions.

Table 2. Relationship between severity and lesion type of pulmonary TB with T2DM status

Variable	Pulmonary TB without T2DM		Pulmonary TB with T2DM		Total		p
	n	%	n	%	n	%	
Lesion extent							
Minimal	8	8,0	6	6,0	14	14,0	0,153
Moderate	35	35,0	29	29,0	64	64,0	
Extensive	7	7,0	15	15,0	22	22,0	
Lesion type							
Infiltrates	11	11,0	15	15,0	26	26,0	0,477
Infiltrates an fibrotic	31	31,0	25	25,0	56	56,0	
Fibrotic	8	8,0	10	10,0	18	18,0	

Cross-tabulation revealed the following distribution of lesion extent in pulmonary TB patients: among non T2DM patients, 8 (8%) exhibited minimal lesions, 35 (35%) moderate lesions, and 7 (7%) extensive lesions. In contrast, among TB patients with T2DM, 6 (6%) presented with minimal lesions, 29 (29%) with

moderate lesions, and 15 (15%) with extensive lesions. Chi-square analysis yielded a significance value (Sig) of 0.153, which exceeds 0.05. This finding indicates no statistically significant association between the extent of pulmonary TB lesions and the presence of T2DM in patients at Royal Prima General Hospital, Medan.

Furthermore, cross-tabulation of lesion type demonstrated that among non-T2DM TB patients, 11 (11%) had infiltrative lesions, 31 (31%) infiltrative and fibrotic lesions, and 8 (8%) fibrotic lesions. Among TB patients with T2DM, 15 (15%) exhibited infiltrative lesions, 25 (25%) infiltrative and fibrotic lesions, and 10 (10%) fibrotic lesions. The chi-square test resulted in a Sig value of 0.477, which is greater than 0.05. Consequently, this suggests no statistically significant relationship between the type of pulmonary TB lesion and the presence of T2DM in patients at Royal Prima General Hospital, Medan.

Discussion

This study investigated the correlation between the extent of lung lesions in patients with pulmonary tuberculosis (TB) who also had type 2 diabetes mellitus (T2DM) and those without diabetes. The results indicated a disparity in lesion extent between the two groups. Among the non-diabetic TB patients, 16% exhibited minimal lesions, 70% moderate lesions, and 14% extensive lesions, suggesting a predominance of moderate lesion extent within this group. In contrast, among TB patients with T2DM, 12% presented with minimal lesions, 58% with moderate lesions, and 30% with extensive lesions, again indicating a majority with moderate lesion extent, but with a higher proportion of extensive lesions compared to non-diabetic patients. Cross-tabulation suggests that there is no statistically significant correlation between the extent of lung lesions and the presence of T2DM in pulmonary TB patients at Royal Prima General Hospital, Medan.

These findings are consistent with a study by Olivia[12], which also found no significant correlation between patient characteristics and lesion extent in chest radiographs of TB patients with a history of T2DM. Conversely, a study by Nabilah[13] reported a significant association between T2DM and extensive lesions in TB patients, highlighting the potential influence of diabetes on TB severity. The interplay between TB and diabetes is thought to stem from alterations in chemotaxis, phagocytosis, and antigen presentation by phagocytes. Diabetic individuals are more susceptible to TB infection due to impaired immune cell function and host defense mechanisms against Mycobacterium tuberculosis.

Furthermore, studies such as that by Fachri[14] have indicated that TB is more prevalent in non-diabetic patients. In diabetic TB patients, lesions are often located in the lower lung fields, attributed to immune system dysfunction. Mycobacterium tuberculosis tends to thrive in areas of high pressure, and diabetic TB patients experience increased alveolar oxygen pressure in the lower lung lobes. With age, diabetic patients may experience increased alveolar ventilation (VA) and decreased perfusion (Q), leading to VA/Q mismatch and elevated alveolar oxygen pressure in the lower lungs, potentially explaining the frequent occurrence of lesions in these areas.[15]

This study also examined the correlation between the type of lung lesions and the presence of T2DM in pulmonary TB patients. The results showed that among non-diabetic TB patients, 22% presented with infiltrative lesions, 62% with infiltrative and fibrotic lesions, and 16% with fibrotic lesions, indicating a predominance of combined infiltrative and fibrotic lesions. Among TB patients with T2DM, 30% had infiltrative lesions, 50% had infiltrative and fibrotic lesions, and 20% had fibrotic lesions, again showing a majority with combined lesions. Cross-tabulation analysis showed no statistically significant correlation between the type of lung lesions and the presence of T2DM in pulmonary TB patients at Royal Prima General Hospital, Medan.

These findings align with a study by Inges[16], which also found no significant association between chest radiograph lesion types and the presence of T2DM in TB patients. The increased risk of TB in T2DM patients is thought to be related to defects in alveolar macrophages or T6 lymphocytes. While Wang et al. observed an increase in mature alveolar macrophages in active TB patients, no significant difference in T lymphocyte counts was found between TB patients with and without diabetes. However, diabetic TB patients exhibited a lower proportion of mature alveolar macrophages. Radiographic findings revealed that infiltrative lesions were commonly observed in both diabetic and non-diabetic TB patients. In diabetic patients, cavitary and fibrotic lesions tended to develop after infiltrative lesions, whereas non-diabetic patients were more likely to develop nodular lesions following infiltrates.[17]

Conclusion

The findings revealed that the extent of lesions observed in chest radiographs of pulmonary TB patients, whether or not they had T2DM, varied across the three categories. However, there was no statistically significant association between the extent of lesions and the presence of T2DM. Similarly, the type of lesions observed in chest radiographs varied across the three categories, but no significant association was found between the type of lesions and the presence of T2DM. The most frequently observed extent of lesions was moderate, while the most common type of lesion was infiltrate with fibrosis. These findings suggest that the extent and type of lesions in pulmonary TB patients are not significantly influenced by the presence of T2DM in this particular study population.

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