

Comparative Evaluation of Clinico-Radiological Features in Pulmonary Tuberculosis Patients with and without Diabetes MellitusAfrah Sharif¹, Sachin Khanduri², Salma Khan³, Avani Kanojia⁴, Akshat Kumar Yadav⁵, Aastha Agrawal⁶¹Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India²Head of Department, Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India³Junior Resident, Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India⁴Junior Resident, Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India⁵Junior Resident, Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India⁶Junior Resident, Department of Radiodiagnosis, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India

Received: 25-07-2024 / Revised: 23-08-2024 / Accepted: 26-09-2024

Corresponding Author: Dr. Avani Kanojia

Conflict of interest: Nil

Abstract:

Background: Tuberculosis (TB) is a major health burden in the world. About 10.6 million people fell ill with TB and approximately 1.6 million deaths have occurred in the year 2021. Tuberculosis (TB) and diabetes mellitus (DM) are two diverse conditions of immense public health importance existing for centuries. TB is today one of the commonest and widespread communicable infectious diseases largely but not necessarily confined to low-economic groups. DM on the other hand spearheads the group of chronic non-communicable diseases affecting people across all socio-economic strata. This study aimed to compare the clinico-radiological features of Pulmonary Tuberculosis patients with and without Diabetes Mellitus.

Method: We performed a prospective analysis of all patients who were microbiologically confirmed positive patients of pulmonary TB, aged 18 years or older or had extra-pulmonary involvement with pulmonary TB, between July 2022 to June 2024, at Era's Lucknow Medical College and Hospital, Lucknow. We also evaluated the proportion of patients, who were diabetics or non-diabetics, and were affected by pulmonary tuberculosis, by their follow up.

Results: We performed study on a total of 148 patients, divided into two groups: 74 patients with both pulmonary tuberculosis and diabetes mellitus, and 74 patients with pulmonary tuberculosis but without diabetes mellitus. The study aimed to compare the clinico-radiological features of Pulmonary Tuberculosis patients with and without Diabetes Mellitus.

Conclusion: Fever and expectoration are more prevalent in pulmonary tuberculosis (PTB) patients with diabetes, although these differences are not statistically significant.

Keywords: Pulmonary Tuberculosis (PTB), Diabetes Mellitus (DM), clinico-radiological features.

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Introduction

Tuberculosis (TB) is a major health burden in the world. About 10.6 million people fell ill with TB and approximately 1.6 million deaths have occurred in the year 2021[1]. Diabetes is a complex metabolic disorder characterized by elevated blood glucose levels due to insulin resistance, insufficient insulin production or both [2]. Majority of the diabetic patients can be classified into two broad categories, type 1 and type 2. The type 1 diabetes is

mostly related to autoimmune destruction of pancreatic β -cells resulting in absolute or near absolute failure of insulin production and secretion. It constitutes about 5% - 10% of total diabetic population. Whereas type 2 diabetes is related to insulin resistance [3]. Tuberculosis and diabetes mellitus co-occurrence has been observed in about 0.4 million people in 2021[1]. Tuberculosis (TB) and diabetes mellitus (DM) are two diverse conditions

of immense public health importance existing for centuries. TB was traditionally identified with poverty while DM was considered as an entity associated with prosperity. TB is today one of the commonest and widespread communicable infectious diseases largely but not necessarily confined to low-economic groups. DM on the other hand spearheads the group of chronic non-communicable diseases affecting people across all socio-economic strata. Both DM and TB have been associated with significant morbidity and mortality from time immemorial. The high prevalence of DM and TB being in epidemic proportions has rightly earned them the names 'the converging epidemics' and 'double burden' [4]. Due to rapid changes in lifestyle, urbanization, and epidemiological changes, DM is increasingly seen in low- and medium-income groups, and in younger individuals more frequently than before. The prevalence of DM is increasing faster where TB is endemic already. [5]

Materials and Method

This prospective study was carried out as a cross-sectional study. It was done at Department of Respiratory Medicine in collaboration with Departments of Radiodiagnosis, Microbiology and Medicine, Era's Lucknow Medical College, Lucknow from July 2022 to June 2024. The inclusion Criteria included Patients aged 18 years or older, microbiologically confirmed positive patients of pulmonary TB, pulmonary TB patients with extrapulmonary involvement as well. The exclusion criteria included patients with any other co morbidities like HIV, cirrhosis, CKD, HTN, patients with only extra Pulmonary TB and Pregnant females. The total sample size was 148. Patients were equally divided as cases of pulmonary tuberculosis with diabetes mellitus and

pulmonary tuberculosis without diabetes mellitus. The Clearance for carrying out this study was obtained from the Institutional Ethical Committee, Era's Lucknow Medical College, and Lucknow. An informed consent was obtained from all the patients.

Figures 1 and 2 illustrate non-contrast HRCT thorax of a 52 yr old, diabetic with TB showing consolidation with central cavitation in superior segment of left lower lobe (blue arrow) with multiple discrete confluent nodules showing tree-in-bud pattern in postero-basal segments of bilateral lower lobes (not visualised in the picture).

Figure 3 illustrates HRCT thorax of a 27 yr old non-diabetic with TB showing consolidation with central cavitation in posterior segment of right upper lobe (yellow arrow) with surrounding multiple discrete confluent nodules showing tree-in-bud pattern (red arrow) and also left upper lobe.

Methodology

All patients attending OPD and indoor patients in the Department of Respiratory Medicine and Medicine were screened for pulmonary Tuberculosis. According to their signs and symptoms.

Detailed recording of history and complete physical examination was done. Investigations were done which included digital chest x-ray PA view, HRCT thorax, sputum smear/CBNAAT or BAL AFB/CBNAAT. Microbiologically confirmed patients were then divided into 2 groups on the basis of blood sugar fasting, post prandial and HbA1C as pulmonary tuberculosis with diabetes mellitus and pulmonary tuberculosis without diabetes mellitus. Clinico-radiological features were compared among both the groups.

Results

Table 1: Clinical Comparison in Pulmonary Tuberculosis Patients with Diabetes and Without Diabetes

Clinical History	Without Diabetes		Diabetes		P-value
	N (74)	%	N (74)	%	
Fever	65	87.83%	71	95.94%	P=0.8084
Cough	66	89.18%	65	87.84%	>0.9999
Expectoration	51	68.90%	57	77.02%	P=0.7855
Weight Loss	59	79.7%	64	86.48%	P=0.7987
Loss Of Appetite	68	91.89%	70	94.59%	>0.9999
Breathlessness	38	51.35%	53	71.62%	P=0.2979
Haemoptysis	15	20.27%	20	27.70%	P=0.6324

Among PTB patients without diabetes, the most common symptoms are loss of appetite (91.89%), cough (89.18%), fever (87.83%), and weight loss (79.70%).

In PTB patients with diabetes, the most common symptoms are fever (95.94%), loss of appetite

(94.59%), weight loss (86.48%), and expectoration (77.02%).

The p-values for all symptoms (fever, cough, expectoration, weight loss, loss of appetite, breathlessness, and haemoptysis) indicate no statistically significant differences between the two groups.

Table 2: Chest X-Ray Findings in Pulmonary Tuberculosis Patients with Diabetes and Without Diabetes Mellitus

Chest X-Ray	Cavity			Consolidation			Infiltrates		
	Without Diabetes	Diabetes	P-Value	Without Diabetes	Diabetes	P-Value	Without Diabetes	Diabetes	P-Value
Upper Zone	5	3	P<0.0001*	24	3	P<0.0001*	15	5	P=0.00025*
Upper+Middle	14	0		0	2		1	1	
Middle Zone	1	1		8	0		0	0	
Middle+Lower	1	0		3	1		0	1	
Lower Zone	0	15		8	34		1	11	

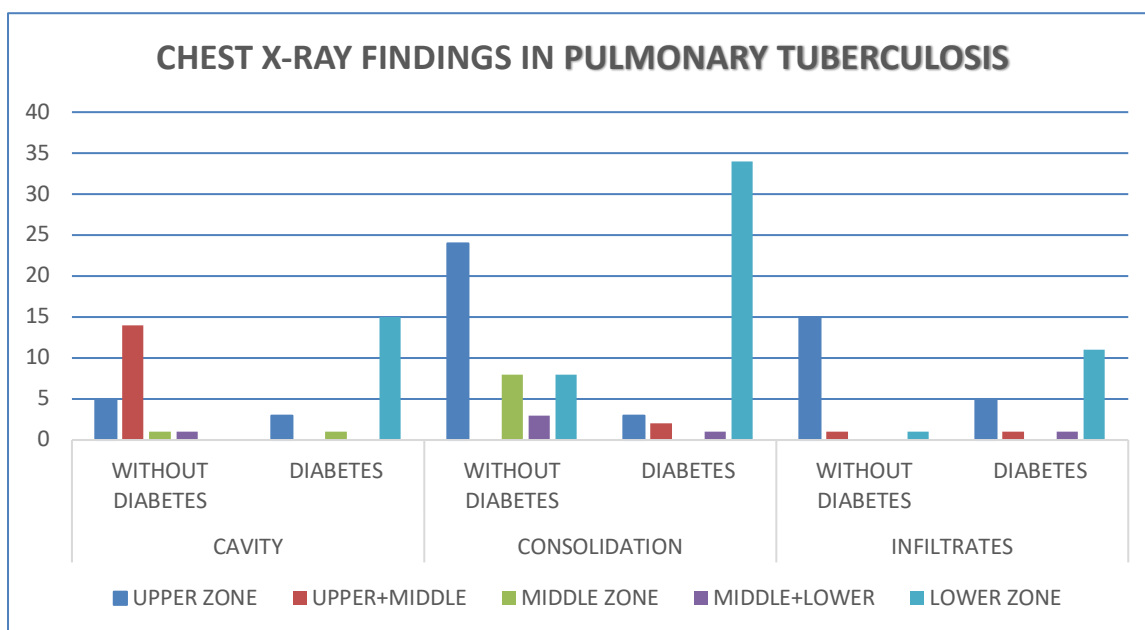


Figure 1: Chest X-Ray Findings In Pulmonary Tuberculosis

In this table in the upper zone, patients with diabetes exhibit a lower incidence of cavity, consolidation, and infiltrates compared to their non-diabetic counterparts, with p-values indicating strong statistical significance ($p < 0.0001$). Conversely, in the lower zone, the prevalence of these abnormalities is markedly higher in diabetic individuals, denoted by significantly elevated p-values ($p < 0.0001$ for cavity and consolidation, $p = 0.00025$ for infil-

trates). Within the middle zone, there appears to be a less pronounced discrepancy, with minimal occurrences of these abnormalities in both groups. However, the data suggests a trend towards increased prevalence in diabetic patients for consolidation and infiltrates. These findings imply a potential association between diabetes and pulmonary pathology, particularly affecting the upper and lower lung regions.

Table 3: HRCT Thorax Findings in Pulmonary Tuberculosis Patients with Diabetes and Without Diabetes

HRCT Thorax	Tree In Bud			Cavity			Consolidation		
	Without Diabetes	Diabetes	P-Value	Without Diabetes	Diabetes	P-Value	Without Diabetes	Diabetes	P-Value
Upper Lobe	37	5	P<0.0001*	3	5	P<0.0001*	23	3	P=0.00059
Upper+Middle	13	3		14	0		1	2	
Middle Lobe	0	0		1	1		8	0	
Middle+Lower	3	4		0	6		3	1	
Lower Lobe	13	27		0	16		8	33	

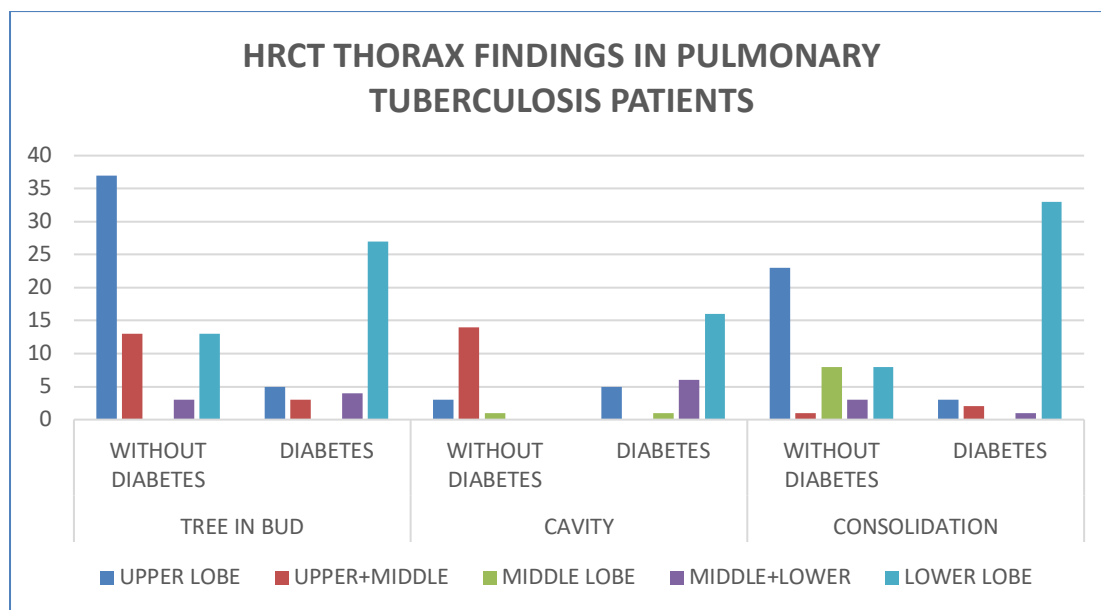


Figure 2: HRCT Thorax Findings In Pulmonary Tuberculosis Patients

In this table in the upper lobe, diabetics patients exhibit significantly fewer instances of tree-in-bud appearances, cavities and consolidations compared to their non-diabetic counterparts, all with robust statistical significance ($p < 0.0001$). The middle lobe presents minimal abnormalities in both diabetic and non-diabetic patients, although a single case each of cavities and consolidations is noted among diabetic individuals. In the middle + lower lobes,

while diabetic patients show slightly more tree-in-bud appearances and consolidations compared to non-diabetic patients, these differences do not reach statistical significance. However, in the lower lobe, diabetic patients display a markedly higher prevalence of tree-in-bud appearances, cavities, and consolidations compared to non-diabetic patients, all with significant statistical differences ($p < 0.0001$).

Table 4: Sensitivity and Specificity of chest x-ray and HRCT thorax

		Sensitivity	Specificity	PPV	NPV
Infiltrates	X-Ray	0.796	0.806	0.848	0.744
	HRCT	0.848	0.744	0.796	0.806
Cavity	X-Ray	0.263	0.914	0.769	0.533
	HRCT	0.545	0.954	0.800	0.861
Consolidation	X-Ray	0.400	0.914	0.824	0.604
	HRCT	0.786	0.954	0.786	0.954

HRCT consistently demonstrates superior performance across all variables. It exhibits higher sensitivity in detecting infiltrates (0.848 vs. 0.796), cavity (0.545 vs. 0.263), and consolidation (0.786 vs. 0.400), indicating its ability to accurately identify abnormalities. Additionally, HRCT shows higher specificity for cavity (0.954 vs. 0.914) and consolidation (0.954 vs. 0.914), suggesting fewer false positives. With higher PPV and NPV for cavity (0.800, 0.861) and consolidation (0.786, 0.954), respectively, HRCT provides more reliable diagnostic information compared to X-Ray.

Discussion

The coexistence of tuberculosis (TB) and diabetes mellitus (DM) is emerging as a significant public health concern. With the global rise in diabetes, particularly in countries with high TB rates, the number of individuals suffering from both condi-

tions is expected to surge. Research indicates that individuals with diabetes are at a significantly higher risk of developing active TB. The study included a total of 148 patients, divided into two groups: 74 patients with both pulmonary tuberculosis and diabetes mellitus, and 74 patients with pulmonary tuberculosis but without diabetes mellitus. The study aimed to compare the clinico-radiological features of Pulmonary Tuberculosis patients with and without Diabetes Mellitus. The clinical history of pulmonary tuberculosis (PTB) patients with and without diabetes mellitus (DM) was also compared. The results show that there are no statistically significant differences in the prevalence of various symptoms between the two groups, as indicated by the p-values. This suggests that the presence of diabetes does not significantly alter the clinical presentation of PTB. Alavi et al., 2014 study found that PTB patients with diabetes often

exhibit more severe and prolonged symptoms compared to those without diabetes.[6] This aligns with the slightly higher prevalence of symptoms such as fever, weight loss, and expectoration among diabetic PTB patients in our study. However, Alavi's study also noted that these differences were more pronounced in terms of clinical outcomes rather than the prevalence of symptoms, which might explain the lack of statistically significant differences in the current data.

Diabetic patients are more prone to unusual radiographic presentations. Lesions with predominant bilateral involvement, lower lung zone involvement, and multilobe involvement, along with higher incidences of pleural effusion, have been identified in diabetics. The study also compares the presence of cavities in different zones of the chest as detected by chest X-ray and high-resolution computed tomography (HRCT) thorax in PTB patients with and without diabetes. The analysis reveals significant differences in cavity detection between the two imaging methods and between the two patient groups. Vishwakarma et al., 2021 conducted a prospective study on the clinical and radiological presentations of pulmonary infections in diabetic patients. They found that diabetic patients had more extensive radiological abnormalities, including cavities and lower lung zone involvement.[7] This aligns closely with the current data showing significant differences in cavity detection in PTB patients with diabetes, particularly in the lower zones detected by HRCT.

Higher prevalence of consolidations in diabetic PTB patients, particularly in the lower lung zones, and the superior detection capability of HRCT over chest X-ray, are consistent with findings from studies by Chiang et al. 2017 and Alkabab et al., 2021. The current study aligns with Chiang et al.'s findings, showing that diabetic patients exhibit more consolidations, particularly in the lower zones, as detected by both chest X-ray and HRCT. This highlights the influence of glycemic control on TB radiographic presentations. Alkabab et al., 2021 study compared the effectiveness of CT versus chest X-ray in detecting pulmonary TB in patients with and without diabetes. The study concluded that CT is superior to chest X-ray in identifying consolidations and other abnormalities in both diabetic and non-diabetic patients, with diabetic patients showing more extensive disease. [7] The current study supports Alkabab et al., 2021 findings by demonstrating that HRCT thorax detects more consolidations than chest X-ray in both diabetic and non-diabetic PTB patients. [8]

The CT findings of tuberculosis (TB) in diabetic patients differ from those in non-diabetic patients, with a higher occurrence of non-segmental distribution, cavitory lesions, and a predilection for the lower lobes. The current study's findings are con-

sistent with those of Chiang et al., 2017 demonstrating a significant presence of infiltrates in the upper and lower zones of diabetic patients. The greater sensitivity of HRCT in detecting these abnormalities is in line with Chiang et al.'s conclusions. [9] Specifically, the current study shows that HRCT detected significantly more infiltrates than chest X-ray in both diabetic and non-diabetic patient groups. Additionally, the higher number of infiltrates in the lower zones of diabetic patients underscores the importance of advanced imaging techniques for accurate diagnosis and assessment of disease severity.

The comparison of diagnostic performance between X-ray and high-resolution computed tomography (HRCT) reveals that HRCT consistently outperforms X-ray across various pulmonary abnormalities in PTB patients. For infiltrates, HRCT exhibits higher sensitivity (0.848 vs. 0.796), indicating a greater ability to detect true positives. In terms of cavity detection, HRCT shows markedly superior sensitivity (0.545 vs. 0.263) and higher specificity (0.954 vs. 0.914), suggesting it is more accurate and produces fewer false positives. Similarly, for consolidation, HRCT demonstrates better sensitivity (0.786 vs. 0.400) and specificity (0.954 vs. 0.914). Additionally, the positive predictive value (PPV) and negative predictive value (NPV) for cavity (0.800, 0.861) and consolidation (0.786, 0.954) are higher for HRCT, reflecting its enhanced reliability in confirming and excluding these conditions. Overall, these findings underscore HRCT's superior diagnostic capability compared to X-ray, highlighting its importance in accurately identifying and managing pulmonary tuberculosis, especially in complex cases or in patients with coexisting conditions like diabetes. [5]

Conclusion

The study revealed that in clinical history, fever and expectoration are more prevalent in pulmonary tuberculosis (PTB) patients with diabetes, although these differences are not statistically significant. Chest X-ray and HRCT thorax imaging identify significant discrepancies in the presence of cavities, consolidation, and 'tree in bud' patterns, especially in the lower zones and lobes in PTB patients with diabetes.

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