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HRCT FINDINGS OF PULMONARY TB IN DIABETIC VERSUS NON DIABETIC PATIENTS

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Abstract

Background: *Tuberculosis (TB) and diabetes mellitus (DM) are closely linked, with DM worsening TB severity. However, studies show conflicting findings on DM frequency in TB and its impact on HRCT patterns. No local studies address these variations. Given this controversy, this study was planned to evaluate HRCT findings in diabetic versus non-diabetic TB patients.*

Objectives: *To determine the frequency of diabetes in patients with pulmonary tuberculosis. 2) To compare the high resolution computed tomography findings of pulmonary tuberculosis in diabetic versus non-diabetic patients.*

Duration: *Six months w.e.f 21-12-2023 to 20-06-2024*

Methodology: *Two hundred pulmonary TB patients were enrolled and referred for HRCT. Demographics, including age, gender, BMI, smoking, and hypertension, were recorded. Patients were categorized into diabetic and non-diabetic groups. HRCT findings were analyzed using SPSS 25.0. The chi-square test assessed differences, with $p < 0.05$ considered significant. Stratification ensured robust comparisons.*

Results: *Mean age of 53.82 ± 9.07 years; 60.5% were male, and 39.5% were female. The mean BMI was 25.26 ± 3.01 kg/m², with 46.0% having normal weight and 54.0% being overweight or obese. Diabetes was present in 39.5% of cases. HRCT findings showed significantly higher rates of non-segmental consolidation (22.8% vs. 7.4%, p=0.002), multiple cavities (24.1% vs. 5.8%, $p < 0.001$), and the bud-in-tree sign (30.0% vs. 18.2%, p=0.045) in diabetics. Other findings, including consolidation, nodules, and pleural effusion, were comparable ($p > 0.05$). Stratification results remained consistent.*

Conclusion: *The study found diabetes in 39.5% of pulmonary tuberculosis patients. Diabetics had significantly higher rates of non-segmental consolidation, multiple cavities, and the bud-in-tree sign on HRCT, while other findings showed no significant differences. Stratification yielded similar results, underscoring diabetes' impact on TB severity and its influence on pulmonary manifestations.*

INTRODUCTION

Tuberculosis (TB) remains a formidable challenge among infectious diseases, with global cases rising steadily. According to the 2014 World TB Report, approximately 9 million new TB cases were reported in 2013, resulting in 1.5 million deaths. Diabetes mellitus (DM) is a well-recognized public health

concern, significantly impacting TB incidence. Studies indicate that individuals with DM are nearly three times more susceptible to developing TB compared to the general population.[1,2] Given this increased vulnerability, diabetes is now acknowledged as a critical risk factor for TB, influencing disease presentation and treatment response.[3,4]

If diabetes-related glucose intolerance remains unaddressed, the severity of pulmonary TB can escalate further.[5] Some researchers argue that type II diabetes plays a crucial role in the onset and progression of pulmonary TB.[6,7] High-resolution computed tomography (HRCT) findings indicate that TB patients with diabetes exhibit larger and more numerous cavities, particularly in the lower lung regions, compared to non-diabetic individuals.[8,9] The prevalence of cavitary lesions and lower-lobe involvement is significantly higher among diabetic TB patients.[10] Despite these observations, the exact relationship between TB and type II diabetes remains incompletely understood.[11]

The use of HRCT for lung imaging in diabetic TB patients remains limited. Compared to conventional CT, HRCT offers superior diagnostic accuracy by detecting pulmonary lesions more effectively. It provides detailed imaging of lesion shape, internal density, and surrounding vasculature, offering critical insights for clinical diagnosis.[12,13] Understanding lung morphological changes in diabetic TB patients is vital, and HRCT imaging research can help achieve this goal.[14]

Wu et al. reported that diabetic TB patients had higher detection rates of lower lung lobe lesions (30.0% vs. 17.1%), non-segmental consolidation (26.7% vs. 2.4%, $P < 0.01$), and single or multiple cavities (50.0% vs. 30.0%, $P < 0.01$). Other findings such as bronchiectasis (33.3% vs. 41.3%), consolidation (76.6% vs. 68.3%), nodules (63.3% vs. 73.2%), and ground-glass opacity (16.7% vs. 24.2%) showed no significant differences ($P > 0.05$). Prevalence of DM in the study sample was 42.2%, whereas Alkabab et al. reported a prevalence of 28.6%.[16] Existing literature had controversy, therefore, the rationale for this study was to determine the prevalence of diabetes among pulmonary TB patients and to compare HRCT findings between diabetic and non-diabetic patients. This study will provide valuable insights into HRCT's role in in TB patients, especially those with diabetes, ultimately enhancing clinical practice and knowledge.

METHODOLOGY

This cross-sectional study was conducted after approval from the ethical review committee at the Department of Radiology, Fatima Memorial Hospital, Lahore, over six months. A sample size of 200 patients was determined using the WHO calculator, with a 95% confidence level, a 7% margin of error, and a diabetes prevalence of 42.2% among pulmonary TB patients.[16] Pulmonary tuberculosis was defined as patients with positive Mycobacterium tuberculosis detected on Gene Xpert, while diabetes was classified as HbA1c ≥6.5% for more than one year. HRCT findings included lesions at the lower lung lobe, non-segmental consolidation, singular or multiple cavities within a lesion, bud-in-tree sign, consolidation, nodules (<5mm), ground glass opacity, bronchiectasis, pleural effusion, mediastinal lymphadenopathy, and hilar lymphadenopathy. Patients were selected using non-probability consecutive sampling, with inclusion criteria covering individuals aged 40–70 years, of both genders, diagnosed with pulmonary TB, while exclusion criteria ruled out those on immunosuppressive medication or corticosteroids in the six months before TB diagnosis. Two hundred eligible patients were enrolled from OPD and referred to the radiology department after taking informed written consent. Demographics, including name, age, gender, BMI, TB duration, smoking (>5 pack-years), hypertension (BP >140/90 mmHg), family history of TB, residence, and occupation, were recorded. Patients were divided into diabetic and non-diabetic groups based on the frequency of diabetes. HRCT scans were conducted using a 16-slice Philips Brilliance CT and a Hitachi Pronto CT system with collimation and interval settings of 10 mm. The presence or absence of HRCT abnormalities was documented as per the operational definitions. Data were analyzed using SPSS version 25.0. Mean ± standard deviation was calculated for age, BMI, and TB duration, while frequency and percentage were used for gender, smoking, hypertension, family history of TB, residence, employment, diabetes, and HRCT findings. The chi-square test was applied to compare HRCT findings between diabetics and non-diabetics, with a significance threshold of $p < 0.05$.

Stratification was performed based on age, gender, BMI, TB duration, smoking, BP, family history of TB, and employment, with post-stratification HRCT findings compared using the chi-square test in each stratum, considering $p < 0.05$ as significant.

RESULTS

The study included 200 participants diagnosed with pulmonary tuberculosis, with a mean age of 53.82 ± 9.07 years. Among them, 106 (53.0%) were between 40 and 55 years old, while 94 (47.0%) were between 56 and 70 years old. Males comprised 121 (60.5%) of the participants, whereas females accounted for 79 (39.5%). The mean BMI was 25.26 ± 3.01 kg/m², with 92 (46.0%) classified as having a normal weight and 108 (54.0%) categorized as overweight or obese. Regarding tuberculosis duration, 81 (40.5%) participants had been diagnosed for up to three years, while 119 (59.5%) had TB for more than three years. Hypertension was present in 83 (41.5%) participants, while 117 (58.5%) did not have hypertension. Employment status showed that 109 (54.5%) were employed, while 91 (45.5%) were unemployed. Smoking history revealed that 57 (28.5%) participants were smokers, whereas 143 (71.5%) were non-smokers. A family history of tuberculosis was reported by 46 (23.0%) of the participants, while 154 (77.0%) had no such history. In terms of residence, 97 (48.5%) lived in rural areas, while 103 (51.5%) were from urban settings. The mean HbA1C level was 7.07 ± 1.66. The data was distributed normally. Data is given in Table 1.0. Among the participants, 79 (39.5%) were diagnosed with diabetes, while 121 (60.5%) were non-diabetic. Data is given in Table 2.0. Both the groups were statistically comparable with each other for all baseline characteristic (p-value>0.05), as given in table 3.0. The comparison of HRCT findings between diabetic and non-diabetic patients showed notable differences. Lesions in the lower lung lobe were slightly more frequent in diabetic patients (59.5%) than in non-diabetic patients (50.4%) ($p = 0.208$). Non-segmental consolidation was significantly higher in diabetic patients (22.8% vs. 7.4%, $p = 0.002$). Multiple cavities within lesions were more common in diabetics (24.1%) than non-diabetics (5.8%) ($p < 0.001$), while the bud-in-tree sign was also significantly higher in diabetics (30.0% vs. 18.2%, $p = 0.045$). Consolidation, nodules, ground-glass opacity, bronchiectasis, pleural effusion, mediastinal lymphadenopathy and hilar lymphadenopathy showed no significant differences between the groups ($p > 0.05$). Mediastinal and hilar lymphadenopathy were similar in both groups ($p > 0.05$). Data is given in Table 4.0. Stratification of HRCT findings between the groups on the basis of age, gender, BMI, TB duration, smoking, blood pressure, family history of TB and employment wherein results were similar as before stratification.

Table 1.0: Demographic Characteristics of Participants Diagnosed with Pulmonary TB Included in the Study

Characteristics	Total (n=200)
Age (years)	53.82±9.07
• 40-55 years	106 (53.0%)
• 56-70 years	94 (47.0%)
Gender	
• Male	121 (60.5%)
• Female	79 (39.5%)
BMI (Kg/m²)	25.26±3.01
• Normal Weight	92 (46.0%)
• Overweight / Obese	108 (54.0%)
Duration of TB	
• Upto 3 years	81 (40.5%)
• >3 years	119 (59.5%)
Blood Pressure	
• Hypertension	83 (41.5%)

• No-Hypertension	117 (58.5%)
Occupation	
• Employed	109 (54.5%)
• Unemployed	91 (45.5%)
Smoking	
• Yes	57 (28.5%)
• No	143 (71.0%)
Family History of TB	
• Yes	46 (23.0%)
• No	154 (77.0%)
Residence	
• Rural	97 (48.5%)
• Urban	200 (51.5%)
HbA1C	7.07±1.66

Table 2.0: Frequency of Diabetic Patients in Study Population with Pulmonary TB

Diabetes	Frequency (n)	Percent (%)
Yes	79	39.5 %
No	121	60.5 %
Total	200	100.0 %

Table 3.0: Comparison of Baseline Characteristics between Diabetic and non-Diabetic patient with Pulmonary TB

Characteristics	Diabetic (n=79)	Non-Diabetic (n=121)	p-value
Age (years)	53.39±9.44	54.09±8.84	0.596
• 40-55 years	40 (50.6%)	66 (54.5%)	0.588
• 56-70 years	39 (49.4%)	55 (45.5%)	
Gender			
• Male	49 (62.0%)	72 (59.5%)	0.721
• Female	30 (38.0%)	49 (40.5%)	
BMI (Kg/m^2)	25.40±3.02	25.17±3.01	0.598
• Normal Weight	34 (43.0%)	58 (47.9%)	0.497
• Overweight / Obese	45 (57.0%)	63 (52.1%)	
Duration of TB			
• Upto 3 years	28 (35.4%)	53 (43.8%)	0.239
• >3 years	51 (64.6%)	68 (56.2%)	
Blood Pressure			
• Hypertension	34 (43.0%)	49 (40.5%)	0.721
• No-Hypertension	45 (57.0%)	72 (59.5%)	
Occupation			
• Employed	42 (53.2%)	67 (55.4%)	0.759
• Unemployed	37 (46.8%)	54 (44.6%)	
Smoking			
• Yes	21 (26.6%)	36 (29.8%)	0.627

• No	58 (73.4%)	85 (70.2%)	
Family History of TB			
• Yes	17 (21.5%)	29 (24.0%)	0.688
• No	62 (78.5%)	92 (76.0%)	
Residence			
• Rural	39 (49.4%)	58 (47.9%)	0.843
• Urban	40 (50.6%)	63 (52.1%)	
HbA1C	8.94±1.07	5.85±0.14	0.000

Chi Square test/ Independent sample t test, taking p-lvaue≤0.05 as significant.

Table 4 .0: Comparison of HRCT Findings between the Groups

Characteristics	Diabetic (n=79)	Non-Diabetic (n=121)	p-value
Lesions at Lower Lung Lobe			
• Yes	47 (59.5%)	61 (50.4%)	0.208
• No	32 (40.5%)	60 (49.6%)	
Non-segmental Consolidation			
• Yes	18 (22.8%)	9 (7.4%)	0.002
• No	61 (77.2%)	112 (92.6%)	
Singular Cavities within Lesion			
• Yes	15 (19.0%)	19 (15.7%)	0.545
• No	64 (81.0%)	102 (84.3%)	
Multiple Cavities within Lesion			
• Yes	19 (24.1%)	7 (5.8%)	0.000
• No	60 (75.9%)	114 (94.2%)	
Bud-in-tree sign			
• Yes	24 (30.0%)	22 (18.2%)	0.045
• No	555 (69.6%)	99 (81.8%)	
Consolidation			
• Yes	55 (69.6%)	72 (59.5%)	0.146
• No	24 (30.4%)	49 (40.5%)	
Nodules			
• Yes	53 (67.1%)	87 (71.9%)	0.468
• No	26 (32.9%)	34 (28.1%)	
Ground Glass Opacity			
• Yes	14 (17.7%)	32 (26.4%)	0.152
• No	65 (82.3%)	89 (73.6%)	
Bronchiectasis			
• Yes	29 (36.7%)	38 (31.4%)	0.437
• No	50 (63.0%)	83 (68.6%)	
Pleural Effusion			
• Yes	22 (27.8%)	24 (19.8%)	0.188
• No	57 (72.0%)	97 (80.2%)	
Mediastinal Lymphadenopathy			
• Yes	13 (65.0%)	18 (14.9%)	0.763

• No	66 (83.5%)	103 (85.1%)	
Hilar Lymphadenopathy			
• Yes	14 (17.7%)	23 (19.0%)	0.819
• No	65 (82.3%)	98 (81.0%)	

Chi Square test, taking p-lvaue≤0.05 as significant.

DISCUSSION

Tuberculosis (TB) remains a major global health concern, with diabetes mellitus (DM) increasingly recognized as a significant risk factor for its development and severity.[17] DM alters immune responses, leading to more extensive lung involvement and atypical presentations in TB patients.[18,19] However, existing literature shows conflicting findings regarding the frequency of DM in TB and its impact on HRCT patterns.[15,16] Additionally, there was no local data addressing these variations. Given these controversies, this study was planned to assess HRCT findings in diabetic versus non-diabetic TB patients in a local setting.

This study included 200 pulmonary tuberculosis patients with a mean age of 53.82 ± 9.07 years. Males comprised 60.5% of participants, and the mean BMI was 25.26 ± 3.01 kg/m². Diabetes was present in 39.5% of cases. HRCT findings showed significantly higher rates of non-segmental consolidation, multiple cavities, and the bud-in-tree sign in diabetics. Other findings, including consolidation, nodules, mediastinal lymphadenopathy and hilar lymphadenopathy were comparable. Baseline characteristics were statistically similar between groups, and stratification based on demographic factors showed consistent results.

Previous literature shows that Wu et al. in China found that diabetic TB patients had higher rates of lower lung lobe lesions (30.0% vs. 17.1%), non-segmental consolidation (26.7% vs. 2.4%), and cavitary lesions (50.0% vs. 30.7%) compared to non-diabetics ($p < 0.05$). Other findings, including consolidation, nodules, and bronchiectasis, showed no significant differences. Rout et al. in India found that diabetic TB patients had higher rates of lower lung lobe lesions (53.1% vs. 26.5%, $p < 0.05$), non-segmental consolidation (28% vs. 2%, $p < 0.01$), and cavitary lesions (37.5% vs. 8.1%, $p < 0.01$) compared to non-diabetics. These findings suggest that TB in diabetics more frequently involves the lower lobes, non-segmental patterns, and cavitary lesions on CT scans.[10] Yang et al. in China found that TB-DM patients had significantly more severe TB on CT than TB-NDM patients (89.61% vs. 68.97%, $p < 0.0001$). They exhibited higher rates of consolidation, cavitary lesions, bronchiectasis, exudative, and fibrous lesions, while lung lobe distribution showed no significant difference.[15] Alkabab et al. in Saudi Arabia found that TB-DM patients (28.6%) had more cavitary lesions when HbA1c exceeded 6.5%. CT detected cavities in 58.8% of patients with negative chest X-rays, highlighting its diagnostic advantage over X-rays.[16] Jung et al. in Korea studied 335 PTB patients, including 82 (24.5%) with DM, of whom 63.4% had uncontrolled DM. Cavitation and bronchial erosion were significantly higher in uncontrolled DM patients compared to non-DM and controlled DM groups ($p < 0.001$), while controlled DM showed no significant difference from non-DM.[20] Dubey et al. in India found that non-segmental consolidation was significantly associated with pulmonary tuberculosis in diabetics compared to non-diabetics ($p=0.007$). Miliary TB was also more common in diabetic TB patients ($p=0.0324$), indicating a distinct disease pattern.[21]

CONCLUSION

The study revealed that 39.5% of pulmonary tuberculosis patients had diabetes. Diabetic patients exhibited significantly higher rates of non-segmental consolidation, multiple cavities, and the bud-in-tree sign on HRCT. Other findings, such as consolidation, nodules, and lymphadenopathy, showed no significant differences. Stratification by demographic and clinical factors yielded similar results. These findings emphasize the influence of diabetes on pulmonary TB manifestations, highlighting its impact on disease severity.

LIMITATIONS & RECOMMENDATIONS

Strengths of this study include its local relevance, robust sample size, and comprehensive HRCT

analysis, providing valuable insights into TB-DM interactions. However, limitations include its single-center design, potential selection bias, and lack of long-term follow-up. Future research should explore longitudinal changes in HRCT patterns post-treatment and assess treatment outcomes in diabetic TB patients. Larger multicenter studies are needed to validate these findings and establish standardized imaging criteria for TB-DM diagnosis and management.

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Authors Contribution

Author 1

Substantial contributions to study design, acquisition of data
Analysis & Interpretation of Data, Manuscript writing
Has given final approval of the version to be published
Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Author 2

Substantial contributions to concept, study design
Data Analysis, Manuscript writing, Critical Review
Has given final approval of the version to be published
Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

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