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Original Research Article

Correlation of Plasma D-Dimer Levels with the Extent of Lung Involvement in Patients with Pulmonary Tuberculosis: A Cross-Sectional Study

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Abstract

Background: Pulmonary tuberculosis (PTB) is associated with systemic inflammation and coagulation activation, leading to elevated D-dimer levels. This study evaluated the correlation between plasma D-dimer levels and the extent of lung involvement in PTB patients.

Methods: A cross-sectional study was conducted among 100 newly diagnosed, microbiologically confirmed PTB patients. Lung involvement was assessed using chest radiographs, and plasma D-dimer levels were measured by immunoturbidimetric assay. Data were analyzed using Pearson's correlation and one-way ANOVA.

Results: The mean D-dimer level was 1638.8 ± 804.1 ng/mL. Moderate lung involvement was observed in 60% of patients. Plasma D-dimer levels increased significantly with greater radiological severity ($p<0.001$) and showed a significant positive correlation with the extent of lung involvement ($r=0.62$, $p<0.001$).

Conclusion: Plasma D-dimer levels were significantly associated with the extent of pulmonary involvement in PTB, suggesting that D-dimer may serve as a simple biomarker for assessing disease severity.

Keywords: Pulmonary Tuberculosis; D-Dimer; Lung Involvement; Disease Severity.

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Introduction

Tuberculosis (TB), caused by Mycobacterium tuberculosis (MTB), remains a major global public health problem despite the availability of effective treatment. In 2023, an estimated 10.8 million people developed TB worldwide. [1,2] India contributes nearly one-fourth of the global TB burden, with a high prevalence of both active and latent tuberculosis infection. [3]

Pulmonary tuberculosis causes varying degrees of pulmonary inflammation and tissue destruction, ranging from minimal lesions to extensive consolidation, cavitation, and fibrosis. Greater lung involvement is associated with increased morbidity, making early assessment of disease severity clinically important. [4-6] Chest radiography remains the most widely used imaging modality for evaluating the extent of pulmonary involvement because of its accessibility and utility, particularly in resource-limited settings. [7-13] D-dimer, a fibrin degradation product, is an established marker of coagulation activation and is frequently elevated in inflammatory and infectious conditions, including pulmonary tuberculosis. The inflammatory response to MTB induces a hypercoagulable state through endothelial activation, increased thrombin generation, and enhanced fibrin turnover, increasing the risk of thromboembolic complications. [14,15]

Recent studies have reported higher serum D-dimer levels in patients with extensive radiological disease, suggesting that D-dimer may reflect both inflammatory activity and the severity of pulmonary involvement. However, evidence from the Indian population remains limited. [15]

Therefore, the present study aimed to evaluate the correlation between serum D-dimer levels and the extent of lung involvement in patients with pulmonary tuberculosis.

Materials and Methods

Study Design and Setting: A hospital-based cross-sectional observational study was conducted in the Department of Pulmonary Medicine, People's Hospital, People's College of Medical Sciences and Research Centre, Bhopal, India, from April 2024 to December 2025.

Ethical Approval: The study was approved by the Institutional Ethics Committee (IEC) and Research Advisory Committee (RAC). Written informed consent was obtained from all participants, and the study adhered to the Declaration of Helsinki.

Study Population: A total of 100 consecutive adults (≥18 years) with newly diagnosed, microbiologically confirmed pulmonary tuberculosis were enrolled after obtaining informed consent.

Eligibility Criteria: Patients with newly diagnosed pulmonary tuberculosis were included. Those receiving anti-tubercular therapy for more than one week, having relapse, MDR/XDR-TB, previous COVID-19 infection, major systemic illnesses, pregnancy, thromboembolic disorders, immunocompromised states, or receiving corticosteroids, anticoagulants, or thrombolytic therapy were excluded.

Study Procedure: Demographic and clinical details were recorded, followed by physical examination. Pulmonary tuberculosis was confirmed by sputum AFB microscopy and CBNAAT. Before initiation of anti-tubercular therapy, 5 mL of venous blood was collected, and serum D-dimer levels were measured using an immunoturbidimetric assay. Chest radiographs were obtained for all patients, and lung involvement was categorized as mild, moderate, or far advanced using standard radiographic criteria.

Study Variables and Outcomes: The primary variable was serum D-dimer level. Secondary variables included demographic characteristics, clinical features, sputum AFB status, CBNAAT findings, and radiological extent of lung involvement. The primary outcome was estimation of serum D-dimer levels, while secondary outcomes included their association with radiological severity and clinical characteristics.

Statistical Analysis: Data was analyzed using IBM SPSS Statistics version 30.0. Continuous variables were expressed as mean ± SD and categorical variables as frequencies and percentages. Independent t-test, one-way ANOVA, Chi-square/Fisher's exact test, and Pearson's correlation were applied as appropriate. A p-value <0.05 was considered statistically significant.

Result

The study included 100 patients with newly diagnosed pulmonary tuberculosis. More than half of the participants (52.0%) were aged 18–30 years, followed by 46–60 years (26.0%), 31–45 years (15.0%), and >60 years (7.0%). Males constituted 54.0% of the study population, while females accounted for 46.0%. Cavitary lesions were the most common radiological finding, observed in 60.0% of patients, followed by consolidation (35.0%), nodular lesions (28.0%), and hilar lymphadenopathy (22.0%). Upper lung zone involvement was the most frequent site (32.0%), followed by lower lung zone involvement (30.0%) (Table 1).

Based on chest radiographic assessment, moderate pulmonary involvement was observed in 60.0% of patients, followed by mild disease in 30.0% and far-advanced disease in 10.0%.

The mean serum D-dimer level was 1638.8 ± 804.1 ng/mL, with values ranging from 702 to 3665 ng/mL (Table 2). Mean serum D-dimer levels increased progressively with increasing radiological severity. Patients with mild disease had the lowest mean D-dimer level (1120 ± 250 ng/mL), whereas those with moderate and far-advanced disease demonstrated significantly higher levels (1980 ± 420 ng/mL and 3200 ± 380 ng/mL, respectively). One-way ANOVA showed a statistically significant difference in serum D-dimer levels among the three groups ($F = 24.6$, $p < 0.001$) (Table 3). Spearman's correlation analysis demonstrated a significant positive correlation between serum D-dimer levels and the extent of lung involvement ($r = 0.62$, $p < 0.001$), indicating that higher D-dimer levels were associated with greater radiological severity.

Discussion

The present study demonstrated a significant positive association between serum D-dimer levels and the extent of lung involvement in patients with newly diagnosed pulmonary tuberculosis. Serum D-dimer levels increased progressively with radiological severity and showed a significant positive correlation with the extent of pulmonary involvement, indicating its potential role as a biomarker of disease severity.

Most participants were young adults (18–30 years), consistent with the epidemiological pattern of tuberculosis reported by the World Health Organization and Bai W et al., who observed a higher disease burden among economically productive age groups. [16,17] A slight male

predominance was also observed, which agrees with previous reports demonstrating higher tuberculosis incidence among males. [17,18]

All patients had microbiologically confirmed pulmonary tuberculosis using sputum smear microscopy and CBNAAT, supporting the diagnostic utility of molecular testing reported by Joshi et al. [19] Radiologically, cavitary lesions and upper lobe involvement were the most common findings, similar to observations by Nunes et al. and Cozzi et al., who identified these as characteristic features of active pulmonary tuberculosis. [20,21]

The mean serum D-dimer level was markedly elevated, reflecting activation of coagulation and fibrinolytic pathways during active tuberculosis. Similar findings have been reported by Alhassan et al. [22] Patients with far-advanced disease exhibited significantly higher D-dimer levels than those with mild disease ($p<0.001$), suggesting that increasing pulmonary inflammation and tissue destruction are associated with enhanced fibrin turnover.

A significant positive correlation between D-dimer levels and radiological severity ($r = 0.62$, $p<0.001$) supports the findings of Ravimohan et al., who described inflammation-mediated lung injury and coagulation activation in active tuberculosis. [23] These findings indicate that serum D-dimer may serve as a useful adjunctive marker for assessing disease severity.

Table 1: Radiological Findings in Study Participants (N = 100)

Variable	Category	Frequency (n)	Percentage (%)
Cavity on Chest X-ray	**Present**	**60**	**60.0**
Consolidation on CXR	**Present**	**35**	**35.0**
Nodular Lesion on CXR	**Present**	**28**	**28.0**
Hilar Lymph Node (Lymphadenitis)	**Present**	**22**	**22.0**
Lung Zones Involved	**Upper**	**32**	**32.0**
	Lower	**30**	**30.0**
	Middle	**7**	**7.0**
	Middle + Lower	**14**	**14.0**
	Upper + Middle	**13**	**13.0**
	Upper + Lower	**4**	**4.0**

Table 2: Distribution of D-dimer Levels among Pulmonary TB Patients

Variable	Mean ± SD	Minimum	Maximum
D-dimer level	**1638.8 ± 804.1**	702	3665

Table 3: Comparison of Mean D-dimer Levels According to Extent of Lung Involvement

Extent of Lung Involvement	N	Mean D-dimer (ng/mL) ± SD	F value	p-value
Mild	30	1120 ± 250	24.6	0.001*
Moderate	40	1980 ± 420		
Far Advanced	10	3200 ± 380		

***Statistically significant**

The strengths of this study include microbiologically confirmed cases, D-dimer estimation before initiation of anti-tubercular therapy, and standardized radiographic assessment.

However, the single-centre cross-sectional design, relatively small sample size, and use of chest radiography instead of CT limit the generalizability of the findings. Larger prospective multicentre studies are needed to confirm these results.

Conclusion

Serum D-dimer levels were significantly associated with the radiological extent of lung involvement in pulmonary tuberculosis. Higher D-dimer levels were observed in patients with more extensive disease, suggesting that D-dimer may be a simple, readily available biomarker for assessing disease severity and supporting early risk stratification.

Further prospective multicentre studies are required to establish its prognostic value and role in monitoring treatment response.

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