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Original Article

Correlation of Chest Imaging Patterns with Microbiological Findings in Pulmonary Tuberculosis

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ABSTRACT

***Background*:** Pulmonary tuberculosis presents with diverse chest imaging patterns that may reflect the underlying bacillary burden. Correlating radiological findings with microbiological results can aid in early diagnosis and assessment of disease severity. ***Objectives*:** To evaluate the correlation between chest imaging patterns and microbiological findings in patients with pulmonary tuberculosis. ***Materials and Methods*:** This hospital-based observational cross-sectional study included 150 adult patients with suspected pulmonary tuberculosis. All patients underwent chest X-ray evaluation and microbiological testing, including sputum smear microscopy for acid-fast bacilli (AFB), cartridge-based nucleic acid amplification test (CBNAAT), and mycobacterial culture. Chest imaging patterns were categorized and correlated with microbiological positivity. ***Results*:** Cavitary lesions were the most frequently observed imaging pattern (38.0%) and demonstrated the highest AFB smear positivity (82.5%), indicating a higher bacillary load. Non-cavitary infiltrates and consolidation showed comparatively lower smear positivity but high CBNAAT detection rates, highlighting the added diagnostic value of molecular testing. Radiological extent of disease showed a significant positive association with both smear and CBNAAT positivity, with extensive disease demonstrating the highest microbiological yield ($p < 0.001$). ***Conclusion*:** Chest imaging patterns correlate significantly with microbiological findings in pulmonary tuberculosis. Cavitary disease is associated with high bacillary load, while molecular tests enhance detection in non-cavitary disease. A combined radiological and microbiological approach improves diagnostic accuracy and disease assessment.

***Keywords*:** Pulmonary tuberculosis; Chest imaging patterns; AFB smear microscopy.

INTRODUCTION:

Pulmonary tuberculosis (PTB) continues to be a major global health challenge despite the availability of effective diagnostic tools and treatment regimens. According to the World Health Organization, tuberculosis remains one of the leading causes of death from a single infectious agent worldwide, with India accounting for a substantial proportion of the global disease burden[1]. Early and accurate diagnosis of PTB is essential not only for initiating timely therapy but also for reducing disease transmission and preventing complications.

Chest imaging plays a pivotal role in the initial evaluation and management of patients with suspected pulmonary tuberculosis. Chest radiography is widely used as a first-line imaging modality due to its accessibility, low cost, and ability to identify characteristic pulmonary abnormalities[2]. Common radiological patterns associated with PTB include parenchymal infiltrates, cavitary lesions, consolidation, fibrotic changes, nodules, and miliary shadows. These imaging patterns often reflect the extent of pulmonary involvement, disease chronicity, and underlying pathophysiological processes[3].

Microbiological confirmation remains the cornerstone of tuberculosis diagnosis. Sputum smear microscopy for acid-fast bacilli (AFB) is a rapid and inexpensive diagnostic method, but its sensitivity is limited, particularly in patients with low bacillary load or non-cavitary disease[4]. Mycobacterial culture, although considered the gold standard, requires prolonged incubation periods and is not readily available in all settings[5]. Molecular diagnostic techniques, such as cartridge-based nucleic acid amplification tests (CBNAAT), have significantly improved diagnostic

sensitivity and allow rapid detection of *Mycobacterium tuberculosis* along with rifampicin resistance[6].

Several studies have demonstrated that radiological severity and specific imaging patterns, particularly cavitary lesions, are associated with higher bacillary load and increased sputum smear positivity[7]. Cavities provide an oxygen-rich environment favorable for mycobacterial multiplication, thereby increasing infectivity and transmission risk[8]. Conversely, non-cavitary patterns such as infiltrates or miliary shadows are often associated with smear-negative disease, making microbiological diagnosis more challenging[9]. In such cases, molecular tests and culture play a crucial role in establishing the diagnosis.

In the Indian context, reliance on chest radiography is particularly high due to resource constraints and limited access to advanced imaging modalities such as computed tomography[10]. Understanding the correlation between chest imaging patterns and microbiological findings can help clinicians anticipate diagnostic yield, select appropriate investigations, and avoid delays in treatment initiation. Moreover, such correlation may aid in identifying patients with high infectivity and guiding public health interventions.

The present study was undertaken to evaluate the correlation between chest imaging patterns and microbiological findings in patients with pulmonary tuberculosis, with the aim of improving diagnostic strategies and clinical decision-making.

MATERIALS & METHODS:

Study Design

This was a **hospital-based observational cross-sectional study** conducted to evaluate the correlation between chest imaging patterns and microbiological findings in patients with pulmonary tuberculosis.

Study Setting

The study was carried out in the Department of Pulmonary Medicine in collaboration with the Department of Radiology and Department of Microbiology at Mahavir Institute of Medical Sciences, Vikarabad.

Study Duration

The study was conducted over a period of **12 months**

Study Population

A total of **150** adult patients presenting with clinical and radiological suspicion of pulmonary tuberculosis during the study period were screened for eligibility.

Inclusion Criteria

- Age ≥ 18 years
- Clinical symptoms suggestive of pulmonary tuberculosis (cough >2 weeks, fever, weight loss, hemoptysis, night sweats)
- Radiological findings suggestive of pulmonary tuberculosis on chest X-ray
- Ability to provide adequate sputum samples
- Patients not previously treated for tuberculosis

Exclusion Criteria

- Extra-pulmonary tuberculosis without pulmonary involvement
- Patients already receiving anti-tubercular therapy
- Known HIV-positive patients (if excluded as per study design)
- Patients with chronic lung diseases such as bronchiectasis or lung malignancy
- Inadequate or contaminated sputum samples

Clinical Evaluation

A detailed clinical history was obtained using a structured proforma, including:

- Demographic details (age, sex)
- Presenting symptoms and duration
- Smoking history
- Past history of tuberculosis
- Comorbid conditions

All patients underwent thorough physical examination.

Chest Imaging Assessment

All enrolled patients underwent **chest radiography (posteroanterior view)** at presentation.

Chest X-ray findings were independently reviewed by a radiologist and classified into the following patterns:

- **Cavitary lesions**
- **Non-cavitary infiltrates**
- **Consolidation**
- **Fibrotic changes**
- **Miliary pattern**

The **extent of disease** was categorized as:

- **Minimal**
- **Moderate**
- **Extensive**

based on the area of lung involvement.

Microbiological Evaluation

All patients provided **two sputum samples** (spot and early morning).

The following microbiological tests were performed:

1. Sputum Smear Microscopy

- Ziehl–Neelsen staining for detection of acid-fast bacilli (AFB)
- Smear results graded according to standard guidelines

2. Cartridge-Based Nucleic Acid Amplification Test (CBNAAT)

- Performed for detection of *Mycobacterium tuberculosis*
- Semi-quantitative bacterial load reported as very low, low, medium, or high
- Rifampicin resistance status assessed

3. Mycobacterial Culture

- Culture performed using solid or liquid culture systems where available
- Culture positivity used as reference microbiological confirmation

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using **SPSS version 22.** Categorical variables were

expressed as **frequency and percentage.** Continuous variables were expressed as **mean ± standard deviation (SD).** Association between imaging patterns and microbiological findings was assessed using the **Chi-square test.** A **p-value < 0.05** was considered statistically significant

Ethical Considerations

The study protocol was reviewed and approved by the **Institutional Ethics Committee**. Written informed consent was obtained from all participants prior to enrolment.

RESULTS:

A total of **150 patients** with clinically and radiologically suspected pulmonary tuberculosis were included in the final analysis. All patients underwent chest imaging and microbiological evaluation.

The study population predominantly consisted of middle-aged adults, with a higher proportion of males compared to females as shown in table 1.

Table 1: Demographic Characteristics of the Study Population

Variable	Mean ± SD / Number, %
Total patients	150
Mean age (years)	42.3 ± 13.6
Age range (years)	18–72
Male	96 (64.0%)
Female	54 (36.0%)

Cavitary lesions were the most frequently observed imaging pattern, followed by non-cavitary infiltrates as shown in table 2.

Table 2: Distribution of Chest Imaging Patterns

Chest Imaging Pattern	Number (%)
Cavitary lesions	57 (38.0%)
Non-cavitary infiltrates	46 (30.7%)
Consolidation	24 (16.0%)
Fibrotic changes	13 (8.7%)
Miliary pattern	10 (6.6%)
Total	**150 (100%)**

CBNAAT demonstrated the highest diagnostic yield compared to sputum smear microscopy and culture as shown in table 3.

Table 3: Microbiological Test Positivity

Microbiological Test	Positive n (%)
AFB smear microscopy	86 (57.3%)
CBNAAT	118 (78.7%)
Mycobacterial culture	92 (61.3%)

AFB smear positivity was significantly higher in patients with cavitary disease compared to other imaging patterns as shown in table 4.

Table 4: Correlation Between Chest Imaging Pattern and AFB Smear Positivity

Chest Imaging Pattern	AFB Positive n (%)	AFB Negative n (%)	Total (n)	p-value
Cavitary lesions	47 (82.5%)	10 (17.5%)	57	**< 0.001***
Non-cavitary infiltrates	20 (43.5%)	26 (56.5%)	46	
Consolidation	10 (41.7%)	14 (58.3%)	24	
Fibrotic changes	6 (46.2%)	7 (53.8%)	13	
Miliary pattern	3 (30.0%)	7 (70.0%)	10	
Total	**86**	**64**	**150**	

* Significance

CBNAAT detected *Mycobacterium tuberculosis* in a high proportion of patients across all imaging patterns, including those with low smear positivity as shown in table 5.

Table 5: Correlation Between Chest Imaging Pattern and CBNAAT Positivity

Imaging Pattern	CBNAAT Positive n (%)
Cavitary lesions	54 (94.7%)
Non-cavitary infiltrates	38 (82.6%)
Consolidation	18 (75.0%)
Fibrotic changes	5 (38.5%)
Miliary pattern	3 (30.0%)

Increasing radiological severity was associated with higher microbiological positivity rates as shown in table 6.

Table 6: Association Between Imaging Severity and Microbiological Positivity

Disease Extent	AFB Positive n (%)	CBNAAT Positive n (%)	p value
Minimal (n = 42)	16 (38.1%)	30 (71.4%)	**< 0.001***
Moderate (n = 58)	32 (55.2%)	46 (79.3%)	
Extensive (n = 50)	38 (76.0%)	42 (84.0%)	

* Significance.

DISCUSSION:

The present study evaluated the correlation between chest imaging patterns and microbiological findings in patients with pulmonary tuberculosis and demonstrated a significant association between radiological features and bacillary burden. The findings highlight the complementary role of imaging and microbiological tests in improving diagnostic accuracy and disease assessment.

In this study, cavitary lesions were the most common radiological pattern and showed the highest sputum smear positivity rate. AFB positivity was observed in more than four-fifths of patients with cavitary disease, indicating a strong association between cavitation and high bacillary load. This observation is consistent with earlier studies, which have shown that cavitary lesions provide an oxygen-rich environment that favors rapid multiplication of *Mycobacterium tuberculosis*, resulting in increased sputum bacillary counts and higher infectivity[11,12].

Non-cavitary infiltrates and consolidation demonstrated comparatively lower smear positivity rates in the present study. However, CBNAAT positivity remained high in these patterns, underscoring the limitations of sputum smear microscopy in patients with paucibacillary disease. Similar findings have been reported in previous studies, where molecular diagnostic techniques significantly improved detection rates in smear-negative pulmonary tuberculosis[13]. These results reinforce the importance of CBNAAT as an essential diagnostic tool, particularly in patients with non-cavitary or atypical radiological presentations.

The present study also demonstrated a significant association between the extent of radiological disease and microbiological positivity. Patients with extensive disease showed higher AFB smear and CBNAAT positivity compared to those with minimal or moderate involvement. This correlation between disease extent and bacillary burden has been documented in earlier studies and reflects advanced disease with increased bacterial replication and dissemination[14].

Miliary tuberculosis showed the lowest microbiological positivity rates in the present study. This finding may be attributed to the disseminated and paucibacillary nature of the disease, where bacilli are unevenly distributed and sputum samples may not adequately represent pulmonary involvement[15]. These patients often require a high index of clinical suspicion and reliance on radiological features and molecular diagnostics for confirmation.

From a clinical perspective, the strong correlation between cavitary disease and smear positivity emphasizes the public health significance of early identification of such patients, as they represent a major source of transmission. Conversely, patients with non-cavitary disease may be falsely labeled as microbiologically negative if molecular tests are not employed, leading to diagnostic delays and ongoing disease transmission[16].

In high tuberculosis burden settings such as India, chest radiography continues to play a central role in initial screening due to its accessibility and cost-effectiveness. Understanding the relationship between imaging patterns and microbiological yield can help clinicians prioritize appropriate diagnostic tests, anticipate smear negativity, and initiate timely treatment[17]. The findings of this study support a combined diagnostic approach integrating radiological assessment with microbiological confirmation.

CONCLUSION:

Chest imaging patterns show a significant correlation with microbiological findings in pulmonary tuberculosis. Cavitary lesions are strongly associated with higher bacillary load and increased sputum smear positivity. Non-cavitary patterns often show lower smear positivity but are effectively detected by molecular tests such as CBNAAT. Integrating chest imaging with

microbiological evaluation improves diagnostic accuracy and timely management of pulmonary tuberculosis.

Declaration:

Conflicts of interests: The authors declare no conflicts of interest.

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REFERENCES:

1. World Health Organization. *Global tuberculosis report 2023*. Geneva: WHO; 2023.
2. Long R, Maycher B, Dhar A, et al. Pulmonary tuberculosis treated with directly observed therapy: serial changes in lung structure and function. *Chest*. 1998;113(4):933–943.
3. Andreu J, Cáceres J, Pallisa E, Martinez-Rodriguez M. Radiological manifestations of pulmonary tuberculosis. *Eur J Radiol*. 2004;51(2):139–149.
4. Steingart KR, Ramsay A, Pai M. Optimizing sputum smear microscopy for the diagnosis of pulmonary tuberculosis. *Expert Rev Anti Infect Ther*. 2007;5(3):327–331.
5. Pfyffer GE, Wittwer F. Incubation time of mycobacterial cultures. *J Clin Microbiol*. 2012;50(2):418–420.
6. Boehme CC, Nabeta P, Hillemann D, et al. Rapid molecular detection of tuberculosis and rifampin resistance. *N Engl J Med*. 2010;363(11):1005–1015.
7. Palaci M, Dietze R, Hadad DJ, et al. Cavitary disease and quantitative sputum bacillary load in pulmonary tuberculosis. *J Clin Microbiol*. 2007;45(12):4064–4066.
8. van Crevel R, Ottenhoff TH, van der Meer JW. Innate immunity to *Mycobacterium tuberculosis*. *Clin Microbiol Rev*. 2002;15(2):294–309.
9. Toman K. *Tuberculosis: case detection, treatment, and monitoring*. 2nd ed. Geneva: WHO; 2004.
10. Salvi S, Agrawal A. India needs a national tuberculosis strategy beyond diagnostics. *Lung India*. 2019;36(5):373–375.
11. Palaci M, Dietze R, Hadad DJ, et al. Cavitary disease and quantitative sputum bacillary load in pulmonary tuberculosis. *J Clin Microbiol*. 2007;45(12):4064–4066.
12. Perrin FM, Woodward N, Phillips PPJ, et al. Radiological cavitation, sputum mycobacterial load and treatment response in pulmonary tuberculosis. *Int J Tuberc Lung Dis*. 2010;14(12):1596–1602.
13. Steingart KR, Schiller I, Horne DJ, et al. Xpert® MTB/RIF assay for pulmonary tuberculosis and rifampicin resistance in adults. *Cochrane Database Syst Rev*. 2014;(1):CD009593.
14. Ralph AP, Ardian M, Wiguna A, et al. A simple, valid, numerical score for grading chest x-ray severity in adult smear-positive pulmonary tuberculosis. *Thorax*. 2010;65(10):863–869.
15. Sharma SK, Mohan A. Miliary tuberculosis. *Microbiol Spectr*. 2017;5(2):TNMI7-0013-2016.
16. Pai M, Behr MA, Dowdy D, et al. Tuberculosis. *Nat Rev Dis Primers*. 2016;2:16076.
17. Salvi S, Agrawal A. India needs a national tuberculosis strategy beyond diagnostics. *Lung India*. 2019;36(5):373–375.