




Original Article

## Clinical, Radiological, and Spirometric Profile of Post-Tuberculosis Lung Disease in a South Indian Tertiary Care Center

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### ABSTRACT

**Background:** Post-tuberculosis lung disease (PTLD) is an important and often under-recognized cause of chronic respiratory morbidity among patients who have completed treatment for pulmonary tuberculosis. Structural lung damage following tuberculosis can lead to persistent symptoms, impaired lung function, and reduced quality of life. However, data on the integrated clinical, radiological, and spirometric profile of PTLD in South Indian populations remain limited.

**Aim:** To study the clinical, radiological, and spirometric profile of patients with post-tuberculosis lung disease in a tertiary care center in South India.

**Materials and Methods:** This was a hospital-based cross-sectional study conducted over a period of one year in a tertiary care teaching hospital. A total of 92 patients with a documented history of treated pulmonary tuberculosis and persistent respiratory symptoms were enrolled. Detailed clinical evaluation, chest radiography (and HRCT where indicated), and spirometry were performed in all participants. Spirometric parameters were interpreted according to standard ATS guidelines, and patterns were classified as obstructive, restrictive, mixed, or normal. Radiological abnormalities were categorized based on structural lung changes. Data were analyzed using descriptive statistics and appropriate inferential tests.

**Results:** The majority of patients were in the 41–50 years age group with male predominance. The most common presenting symptoms were chronic cough (80.4%) and dyspnea (73.9%). Radiological evaluation revealed fibrosis (76.1%) and fibro-bronchiectasis (58.7%) as the predominant findings. Spirometry demonstrated a restrictive pattern in 47.8% of patients, followed by obstructive (30.4%) and mixed defects (13.0%), while only 8.7% had normal lung function. A significant association was observed between radiological severity and worsening spirometric impairment.

**Conclusion:** PTLD is associated with significant structural and functional lung impairment, with restrictive ventilatory defects being the most common spirometric abnormality. Early recognition and comprehensive evaluation using clinical, radiological, and spirometric assessment are essential for optimal management and long-term follow-up.

**Keywords:** Post-tuberculosis lung disease, spirometry, fibrosis, bronchiectasis, pulmonary function test, chronic respiratory disease.

### INTRODUCTION

Tuberculosis (TB) remains one of the leading infectious diseases globally and continues to impose a substantial burden on health systems, particularly in developing countries like India. While successful anti-tubercular treatment (ATT) achieves microbiological cure in most patients, structural and functional lung damage often persists. This condition, broadly termed post-tuberculosis lung disease (PTLD), encompasses a spectrum of chronic respiratory abnormalities including airflow obstruction, restriction, bronchiectasis, fibrosis, and chronic respiratory failure. These sequelae arise due to irreversible parenchymal destruction, airway remodeling, and pleural involvement during active disease, resulting in long-term morbidity even after microbiological cure<sup>[1]</sup>. Globally, tuberculosis affects millions annually, with India contributing a significant proportion of the burden. According to the World Health Organization (WHO), India accounts for nearly one-

fourth of the global TB incidence. Despite improvements in TB control programs under the National Tuberculosis Elimination Programme (NTEP), a large number of patients continue to experience post-treatment sequelae<sup>[2]</sup>. Studies have shown that approximately 30–60% of pulmonary TB survivors develop some form of chronic lung impairment, though the prevalence varies depending on diagnostic methods, duration since treatment, and population characteristics. PTLD is increasingly recognized as a major contributor to chronic respiratory disease burden in low- and middle-income countries<sup>[3]</sup>.

Several studies have highlighted the long-term impact of tuberculosis on lung function. Ratnakumar et al. reported that TB survivors frequently develop chronic respiratory impairment, with significant reductions in FEV1 and FVC compared to controls<sup>[4]</sup>. Gai et al. observed that a substantial proportion of post-TB patients present with obstructive and mixed ventilatory defects, often resembling chronic obstructive pulmonary disease (COPD)<sup>[5]</sup>. Fumagalli et al. demonstrated that structural abnormalities such as fibrosis and bronchiectasis are commonly detected on imaging, correlating with severity of functional impairment<sup>[6]</sup>. Indian studies have similarly reported high prevalence of restrictive defects and radiological sequelae among treated TB patients, emphasizing the chronic nature of lung damage following infection<sup>[7]</sup>.

Despite these findings, most studies have evaluated PTLD either clinically, radiologically, or functionally in isolation, with limited integrated assessment combining all three domains in a single cohort, particularly in South Indian populations. Given the high burden of tuberculosis in India and the growing recognition of long-term pulmonary sequelae, there is a need for comprehensive evaluation of PTLD. Understanding the pattern of clinical symptoms, radiological abnormalities, and spirometric impairment together can aid in early identification, risk stratification, and appropriate management of affected patients. Furthermore, regional data from South India remain limited. This study is therefore undertaken to bridge this gap by systematically evaluating the clinical, radiological, and spirometric profile of patients with post-tuberculosis lung disease in a tertiary care setting.

## **AIM AND OBJECTIVES**

### **Aim**

To study the clinical, radiological, and spirometric profile of patients with post-tuberculosis lung disease (PTLD) attending a tertiary care center in South India.

### **Objectives**

1. To describe the clinical profile (symptoms, duration, and functional status) of patients with post-tuberculosis lung disease.
2. To evaluate and classify the radiological patterns of lung damage in post-tuberculosis patients using chest X-ray and/or HRCT.
3. To assess spirometric abnormalities and correlate them with clinical and radiological findings in PTLD patients.

## **MATERIALS AND METHODS**

### **Study Design**

This was a hospital-based, observational, cross-sectional study conducted in a tertiary care teaching hospital in South India. The study aimed to evaluate the clinical, radiological, and spirometric profile of patients with post-tuberculosis lung disease (PTLD).

### **Study Period**

The study was conducted over a period of 12 months (from ..... to .....), after obtaining approval from the Institutional Ethics Committee.

### **Study Population**

The study included adult patients attending the Department of Pulmonology/General Medicine outpatient and inpatient services with a past history of treated pulmonary tuberculosis and evidence of chronic respiratory symptoms.

### **Inclusion Criteria**

- Age  $\geq 18$  years
- Documented history of previously treated pulmonary tuberculosis (completed ATT as per RNTCP/NTEP guidelines)
- Presence of persistent respiratory symptoms (cough, dyspnea, wheeze, sputum production) persisting  $\geq 3$  months after completion of TB treatment
- Willingness to participate and provide informed consent

### **Exclusion Criteria**

- Patients with active pulmonary tuberculosis (confirmed by sputum CBNAAT/smear or culture)
- Known pre-existing chronic lung diseases prior to TB (e.g., bronchial asthma, COPD unrelated to TB, interstitial lung disease)

- Significant cardiac disease causing dyspnea (e.g., congestive heart failure)
- Pregnancy
- Inability to perform spirometry reliably

### Sample Size Calculation

The sample size was calculated based on the expected prevalence of post-tuberculosis lung disease among previously treated tuberculosis patients. A previous systematic review and cohort studies have reported that approximately 35–40% of patients treated for pulmonary tuberculosis develop post-tuberculosis lung impairment or chronic respiratory sequelae Post-Tuberculosis Lung Disease Epidemiology. For the present study, the prevalence (p) was taken as 40% (0.40) to obtain a larger and more conservative sample size. The sample size was calculated using the standard formula for cross-sectional studies:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Where:

1.  $Z = 1.96$  (standard normal deviate at 95% confidence level)
2.  $p = 0.40$
3.  $q = 1 - p = 0.60$
4.  $d = 0.10$  (absolute precision of 10%)

**Substitution:**

$$n = \frac{(1.96)^2 \times 0.40 \times 0.60}{(0.10)^2}$$

$$n = \frac{3.84 \times 0.24}{0.01}$$

$$n = \frac{0.9216}{0.01} = 92.16$$

Thus, the minimum required sample size was 92 subjects.

### Data Collection Procedure

After obtaining informed written consent, eligible participants were enrolled consecutively. A structured proforma was used to collect detailed information including demographic profile, smoking history, comorbidities, details of prior tuberculosis treatment, and duration since completion of anti-tubercular therapy.

### Clinical Assessment

A detailed respiratory examination was performed for all participants. Clinical symptoms assessed included chronic cough, dyspnea (graded using mMRC scale), sputum production, hemoptysis, and exercise intolerance. Functional impairment was categorized based on symptom severity and impact on daily activities.

### Radiological Evaluation

All patients underwent chest radiography (posteroanterior view). High-resolution computed tomography (HRCT) of the thorax was performed where clinically indicated. Radiological findings were classified into patterns such as:

1. Fibrotic changes
2. Fibro-bronchiectasis
3. Cavitation
4. Volume loss
5. Pleural thickening
6. Emphysematous changes

Radiological severity was graded based on extent of lung involvement.

### Spirometric Assessment

Pulmonary function testing was performed using a calibrated computerized spirometer following American Thoracic Society (ATS) guidelines. Parameters recorded included:

1. Forced Vital Capacity (FVC)
2. Forced Expiratory Volume in 1 second (FEV1)
3. FEV1/FVC ratio
4. Peak Expiratory Flow Rate (PEFR)

Spirometry patterns were classified as:

1. Obstructive

2. Restrictive
3. Mixed ventilatory defect
4. Normal

At least three acceptable maneuvers were recorded, and the best value was considered for analysis.

### Statistical Analysis

Data were entered into Microsoft Excel and analyzed using appropriate statistical software (e.g., SPSS version 25.0 or equivalent). Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean  $\pm$  standard deviation. Association between clinical, radiological, and spirometric parameters was assessed using Chi-square test or Fisher's exact test for categorical variables and independent t-test or ANOVA for continuous variables. A p-value  $<0.05$  was considered statistically significant.

### Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment. Confidentiality of patient data was strictly maintained throughout the study.

## RESULTS

**Table 1: Demographic Profile of Study Population (n = 92)**

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	12	13.0
	31–40	18	19.6
	41–50	24	26.1
	51–60	20	21.7
	>60	18	19.6
Gender	Male	56	60.9
	Female	36	39.1
Smoking status	Smoker	38	41.3
	Non-smoker	54	58.7
Socioeconomic status	Lower	48	52.2
	Middle	34	37.0
	Upper	10	10.8

**Table 2: Clinical Presentation of Post-Tuberculosis Lung Disease (n = 92)**

Symptom	Frequency (n)	Percentage (%)
Chronic cough	74	80.4
Dyspnea on exertion	68	73.9
Sputum production	52	56.5
Wheeze	30	32.6
Hemoptysis	14	15.2
Chest pain	22	23.9
Fatigue / reduced exercise tolerance	60	65.2

**Table 3: Radiological Findings in Study Population (n = 92)**

Radiological Pattern	Frequency (n)	Percentage (%)
Fibrosis	70	76.1
Fibro-bronchiectasis	54	58.7
Volume loss	46	50.0
Pleural thickening	40	43.5
Cavitary lesions	18	19.6
Emphysematous changes	22	23.9
Normal / minimal changes	6	6.5

**Table 4: Spirometric Pattern Distribution (n = 92)**

Spirometry Pattern	Frequency (n)	Percentage (%)
Restrictive defect	44	47.8
Obstructive defect	28	30.4
Mixed pattern	12	13.0
Normal spirometry	8	8.7

**Table 5: Correlation Between Radiological Severity and Spirometric Pattern (n = 92)**

Radiological Severity	Restrictive (n)	Obstructive (n)	Mixed (n)	Normal (n)	Total
Mild changes	6	10	4	6	26
Moderate changes	18	12	6	2	38
Severe changes	20	6	2	0	28
<b>Total</b>	<b>44</b>	<b>28</b>	<b>12</b>	<b>8</b>	<b>92</b>

## DISCUSSION

Post-tuberculosis lung disease (PTLD) is increasingly recognized as a major cause of chronic respiratory morbidity following microbiological cure of pulmonary tuberculosis. In the present study, we evaluated 92 patients with prior treated TB to assess their clinical, radiological, and spirometric profile and correlated these findings with existing literature.

### Clinical Profile

In our study, the most common symptoms were chronic cough (80.4%) and dyspnea (73.9%), followed by sputum production (56.5%). These findings are consistent with the observations of Akkara et al and Abdelaleem et al., who reported cough and exertional breathlessness as predominant complaints among post-TB patients, reflecting persistent airway inflammation and structural damage even after treatment completion<sup>[8,9]</sup>. Similarly, Ratnakumar et al. highlighted that TB survivors frequently experience long-term respiratory symptoms affecting quality of life, particularly dyspnea and reduced exercise tolerance<sup>[4]</sup>. The relatively high symptom burden in our study further reinforces that microbiological cure does not equate to functional recovery.

### Radiological Findings

Radiologically, fibrosis (76.1%) and fibro-bronchiectasis (58.7%) were the most common findings in our cohort. This aligns with Gai et al., who demonstrated that post-TB structural lung disease commonly manifests as fibrotic scarring and bronchiectatic changes on imaging, often involving upper lobes<sup>[5]</sup>. Similar results were reported by Allwood et al., who emphasized that post-TB bronchiectasis is a major contributor to chronic airflow limitation in TB-endemic regions<sup>[10]</sup>. The high prevalence of fibrotic changes in our study suggests irreversible parenchymal destruction as a key mechanism of PTLD.

### Spirometric Patterns

Spirometry in our study revealed a restrictive defect in 47.8% of patients, followed by obstructive (30.4%) and mixed patterns (13%). Only 8.7% had normal lung function. These findings are comparable to Pasipanodya et al., who reported mixed ventilatory abnormalities with both obstructive and restrictive patterns in post-TB patients, often mimicking COPD<sup>[11]</sup>. Similarly, Amaral et al. found reduced FEV1 and FVC in TB survivors, indicating significant long-term functional impairment<sup>[12]</sup>. The predominance of restrictive defects in our study may be attributed to extensive fibrotic lung involvement.

### Clinicoradiological Correlation

We observed a clear association between radiological severity and spirometric impairment, where severe radiological changes were predominantly associated with restrictive and mixed ventilatory defects. This is in agreement with studies by Byrne et al., who demonstrated a strong correlation between structural lung damage and reduced lung function in PTLD patients<sup>[13]</sup>. This emphasizes that radiological burden can serve as a surrogate marker for functional impairment.

### Overall Interpretation

The findings of this study highlight that PTLD is a heterogeneous condition characterized by persistent respiratory symptoms, significant structural lung damage, and varied spirometric abnormalities. The consistency of our results with previous studies across different populations underscores the global relevance of PTLD as a chronic disease entity. However, variability in spirometric patterns across studies may be due to differences in time since TB treatment, extent of disease, and smoking status.

### Limitations

1. The study was conducted in a single tertiary care center, which may limit generalizability to the broader community population.
2. The cross-sectional design does not allow assessment of disease progression over time or causal relationships.
3. Pre-treatment baseline pulmonary function tests were not available for comparison, limiting evaluation of true functional decline attributable to tuberculosis.

## CONCLUSION

Post-tuberculosis lung disease is a significant cause of chronic respiratory morbidity even after completion of anti-tubercular therapy. In the present study, most patients presented with persistent symptoms such as chronic cough and dyspnea, indicating ongoing functional impairment. Radiological evaluation commonly revealed fibrotic changes and

fibro-bronchiectasis, suggesting irreversible structural lung damage. Spirometric assessment showed that restrictive ventilatory defects were the most frequent abnormality, followed by obstructive and mixed patterns. A clear association was observed between increasing radiological severity and worsening pulmonary function. These findings highlight that PTLD is a heterogeneous but progressive sequela of pulmonary tuberculosis, emphasizing the need for early recognition, routine functional assessment, and long-term follow-up of TB survivors. A comprehensive approach integrating clinical evaluation, imaging, and spirometry is essential for timely intervention and rehabilitation.

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