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Evaluation of Pulmonary Status of Post-Tuberculosis Patients with Spirometry and Chest X-Ray

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Abstract: In 2022, 7.5 million new cases of tuberculosis were reported worldwide. Mycobacterium tuberculosis results in tuberculosis, an infectious disease mostly affecting the lungs. However, many completely treated post-tubercular patients experience persistent changes in lung anatomy (bronchial and parenchymal structure), Increasing their risk of lung complications and early death. These changes affect the airway's size, leading to higher resistance and decreased airflow. Our study aimed to assess the overall clinical status and lung function of treated post tuberculosis patients using spirometry. The study constituted patients over the age of 18 who presented to the Outpatient department of the Pulmonary Medicine Department, Chettinad Hospital and research institute, Kelambakkam, after receiving complete treatment and being certified cured. Convenience sampling technique was used, 87 patients participated in this trial. The Institutional Ethical Committee approved the study, which lasted 18 months. A proforma was used to collect a complete socio-demographic history and clinical history, particularly in terms of pulmonary symptomatology, and information about previous anti-tb treatment. Each of these patients had chest radiography, smear microscopy, and lung function testing. Mean age was 44.1± 15.2 years, mean BMI was 22.27 ± 3.66 kg/m2. There were 66.2% men and 33.8% females. 42% employed and 52% literate. In the current study, 41(53.25%) of the individuals reported dyspnea and 22(28.57%) had dry cough, cough with expectoration 12(15.58%), Fever 8(10.4%), Haemoptysis 7(9%), chest pain 2(2.6%). Following Post tuberculosis treatment, 38(44%) had normal chest radiographs, 31(35.6%) of the patients had fibrosis/Fibrotic strand, 8(9.1%) had consolidation, 5(5.7%) had ectatic changes, 3(3.4%) had fibrocavity, 1(1%) had calcification and cicatricial collapse. In the current study, we found that 31(40.25%) had normal spirometry followed by 23(29.87%) had mixed pattern and 12(15.6%) had restrictive pattern findings, 11(14.28%) had obstructive pattern findings. In spite of appropriate suggestions, the majority of post-tb pulmonary impairment individuals suffer in quiet or undergo poor medical care. As a result, comprehensive recommendations for patient follow-up following tuberculosis treatment are required in order to monitor lung function and provide appropriate care to improve quality of life.

Introduction

In India, tuberculosis remains a chronic infection and a major public health concern. In 2022, the incidence of tuberculosis in India was 176 per 1 lakh individuals (Gupta et al., 2023). In 2021, 82684 patients were notified in Tamil Nadu, with an 83.1% (68711) success rate, 6% (4966) mortality rate, and 2.8% (2318) lost to follow up. Although most pulmonary tuberculosis patients exhibit signs of microbiological cure, others acquire residual pulmonary sequelae and impairment, increasing the tuberculosis burden.

The First International Symposium on Post-TB Disease defines PTLD as evidence of persistent pulmonary abnormalities, with or without symptoms, caused at least

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partially by previous (pulmonary) tuberculosis. Post-tubercular lung disease is a collection of illnesses that affect the lung parenchyma, pulmonary vasculature, pleura, and both large & small airways. It can be worsened by haemoptysis and co-infection (Allwood et al., 2021). Multiple studies assessing pulmonary function after treatment for TB found that more than half of patients had reduced lung function. PFT changes can be restrictive, obstructive, or mixed variety, with variable degrees of lung function impairment (Willcox et al., 1989; Amaral et al., 2015; Meghji et al., 2020).

Despite the huge burden of illness and limited resources, the current emphasis will be on early identification and comprehensive treatment of affected people. However, many completely cured post-tubercular individuals remain with persistent abnormalities in lung structure and are at increased risk of pulmonary sequelae and early death (Long et al., 1998; Rajasekaran et al., 2001). They cause pulmonary sequelae, including airway and parenchymal structural abnormalities such as bronchovascular distortion, bronchiectasis, emphysema & fibrotic strands. In addition, these alterations persist in the lungs in antimicrobial treatment (Sarkar et al., 2021).

According to a global recommendation, early TB diagnosis may result in fewer post-tuberculosis sequelae (van Kampen et al., 2018). Seven TB guidelines have dealt with follow-up with patients following TB treatment, but only three have discussed the issue of TB sequelae. At the same time, four have mentioned the possibility of tuberculosis return or recurrence (Turnbull et al., 2017; Sadhu et al., 2022).

Post-tuberculosis (post-TB) lung disease (PTLD) often causes various long-term lung complications, making chest X-ray evaluation essential to assess the damage. The main imaging patterns and their clinical significance are:

Airway Lesions

-TB-associated Obstructive Lung Disease: Involves airflow obstruction, commonly found in chronic bronchitis and emphysema.

- Bronchiectasis: Persistent dilation of the bronchi due to chronic infection and inflammation, leading to frequent infections and sputum production.

Parenchymal Lesions

- Calcification: Calcium deposits in healed granulomas or lymph nodes, indicating a past TB infection.
- Parenchymal Destruction: Loss of lung tissue resulting in cavities or consolidated areas.
- Fibrotic Change: Scarring of lung tissue reduces lung elasticity and function.
- Aspergillus-related Lung Disease: Fungal infections like aspergilloma occurring in previously damaged lung areas.

Pleural Lesions

Chronic Pleural Disease: Long-term pleural involvement causing thickening or calcification of the pleura (Gai et al., 2023).

The relapse rate is higher even after Post TB treatment completion as per the recent National TB Prevalence Survey 2019-2021 done over 5 lakh general population. Hence, this study helps in identify those active TB cases among the treatment-completed/cured patients. Even after completion of treatment patients may be having residual structural damage leading to pulmonary function impairment which will lead to decreased quality of life and increased morbidity and mortality. Numerous studies and surveys provide information on Incidence, Prevalence, Resistance, Recurrence and Relapse among those receiving treatment; however, very few studies follow up on individuals who have completed or are cured of tuberculosis. This study aimed to determine lung function impairments and characteristics among individuals who had successfully cured pulmonary tuberculosis.

Materials and Methods

A prospective observational investigation was carried out in the Department of Pulmonary Medicine at Chettinad Hospital and Research Institute. The study comprised patients who registered for pulmonary TB treatment between Jan 1, 2021, and Dec 31, 2021. IHEC approval had been obtained before the start of the study (Ref No.: IHEC-I/1107/22). All patients who took part in the trial gave written consent.

Sample Size and Sampling Technique

Convenience sampling technique was used and 87 patients participated in this trial. The study comprised patients who had been treated for pulmonary tuberculosis at the Department of Pulmonary Medicine, Kelambakkam PHC, and Thiruporur PHC in 2021 and met the criteria for inclusion.

Inclusion criteria

1) Age > 18years

2) The sputum test for AFB was negative during the point of investigation.

3) Patients with or without symptoms

Exclusion criteria

1. Patient who are not willing to consent.
2. Smear positive for AFB.
3. Patients with contraindications to spirometry according to ATS/ERS recommendations.

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4. Pregnant women.
5. Patients who were hospitalised and treated for covid-19

The patient's particulars and medical history were recorded, followed by a comprehensive general examination using a predefined proforma. All relevant investigations were conducted to gather necessary data, including clinical, microbiological, and pulmonary function tests and radiological evaluations. All the patients were subjected to Sputum AFB. 10 patients were found to be sputum smear positive and excluded from the study. Those who were negative were offered Chest X-rays and Pulmonary function tests by spirometry.

Pulmonary function Test

Pulmonary function tests (PFTs) were performed out according to ATS & ERS guidelines for subject maneuver, method, and level of control. (Miller et al.,2005). The whole technique was demonstrated to the attendees. Subjects were instructed to take maximum inhalation & exhale into the mouthpiece as quickly, rapidly, and thoroughly as possible. To maximize effort, the participants were instructed to continue exhaling at the completion of the operation. Minimum of three acceptable Forced Vital Capacity (FVC) maneuvers was done, with the ideal manoeuvre chosen and accepted. The measurements included FVC, FEV1, and FEV1/FVC ratio.

Results

The mean age was 44.1± 15.2 years. mean BMI was 22.27 ± 3.66 kg/m2 . Males constituted 66.2%, while females constituted 33.8%. In the current study, the vast majority of patients were in the active age group (46.15% of patients aged 31-50 years), then followed by 30.76% in 51-70 years group) (table 1). Following tuberculosis treatment, 38(44%) of patients had a normal chest x-ray, 31(35.6%) had fibrotic strands/fibrosis, 5(5.7%) had ectatic changes, 3(3.4%) had fibro-cavitary lesions, 1% had cicatricial collapse and 1% had calcification (table-2 & figure-1).

Table 1. Socio-demographic profile.

Mean Age in years(mean ± S.D)	44.1± 15.2 years
Male	51(66.2%)
Female	26(33.8%)
Mean BMI in Kg/m2 (mean ± S.D)	22.27 ± 3.66 Kg/m2
Employment	42% employed
Literacy	52% litterate

Table 2. Chest x-ray findings Table 2. Chest x-ray findings.

Findings	N	%
Normal	38	44
Fibrotic strands	31	35.6
Consolidation	8	9.1
Ectatic changes	5	5.7
Fibrocavity	3	3.4
Calcification	1	1
Cicatricial collapse	1	1

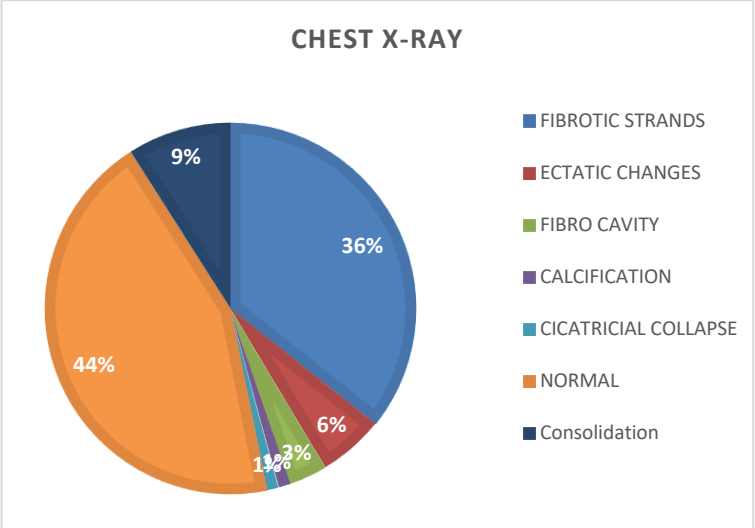

Figure 1. Chest X-ray distribution.

In the current study, 41(47%) of individuals experienced dyspnoea, 22(25.2%) had dry cough, 12(13.7%) had cough with expectoration, fever 8(9%), hemoptysis 7(8%), and chest pain 2(2.2%) (table-3).

Table 3. Symptoms of Participants. Symptoms of Participants.

SYMPTOMS	PRESENT NO. (%)	ABSENT NO. (%)
Breathlessness	41(47%)	46(53%)
Dry cough	22(25.2%)	53(60.9%)
Cough with expectoration	12(13.7%)	
Fever	8(9.19%)	69(89.6%)
Hemopysis	7(8%)	80(92%)
Chest pain	2(2.2%)	85(97.7%)

Out of 77 patients, 31(40.25%) of patients had normal spirometry, 23(29.87%) had a mixed pattern, 12(15.6%) had a restrictive pattern and 11(14.28%) had obstructive pattern (Table 4).

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Table 4. Post- tubercular treatment spirometric findings.

FINDINGS	N(%)
Normal	31(40.25%)
Mixed	23(29.8%)
Restriction	12(15.6%)
Obstruction	11(14.28%)

Table 5. Smoking history vs PFT distribution

Smoking H/O	**Present (N=38)**	**Absent(n=49)**
Restricted	6	6
Mixed	14	9
Obstruction	6	5
Normal	12	29
Chi-square	8.732	
P-value	0.002	

In 59.75% of patients, the spirometry pattern is abnormal. 23 had a mixed pattern, with (14 smokers and 9 non-smokers), 12 had restriction pattern, (6 smokers and 6 non-smokers) and 11 showed an obstruction pattern (6 smokers and 5 non-smokers) (table-5).

A chi-square test of independence was conducted to analyze the relationship between the smoking and PFT findings. The test resulted in chi-square statistic of 8.732, with p-value greater than 0.002. This indicates that there is a statistically significant relationship between smoking and PFT patterns.

Discussion

Demographic profile

In our analysis, nearly half of post-TB individuals (46.15%) were between the ages of 31 and 50, with 30.76% ranging among the ages of 51 to 70. Subjects' average age was 44.1 ± 15.2 years, compared to 42.84 ± 16.5 years reported by (Choi et al., 2016; Pandey et al., 2020). The average BMI was 22.27 ± 3.66.

Symptomology

In the present study, 53.25% of individuals had dyspnea, 28.57% had a dry cough, 15.58% had a cough with expectoration, 9% had hemoptysis, 10.4% had a fever and 2.6% had chest pain.

Radiological changes after post-tuberculosis

On the chest X-ray, 49% showed normal chest radiographs, 40% of the patients had fibrosis/fibrotic strand, 5% had ectatic changes 4% had fibrocavity, and 1% had calcification and collapse. Similar to our study (Pandey et al., 2020) had found that out of 100 patients, Fibrosis in 49 patients, Fibro-cavitary in 11 patients and Bronchiectasis in 9 patients. One comprehensive investigation used radiological imaging to investigate lung abnormalities in people with post-tuberculosis and found fibrosis prevalence rates ranging from 25.0% to 70.4%. (Kim et al., 2001; Meghji et al., 2016).

Post-tuberculosis respiratory function impairment

In the current study, 60% (46/77) individuals reported impaired pulmonary function on spirometry. Other studies have revealed reduced lung function, ranging from forty-six percent to eighty-two percent (Weiner et al., 1963; Snider et al.,1971; Maguire et al., 2009; Pasipanodya et al., 2010; Chung et al., 2011; Di Naso et al., 2011; Hwang et al., 2014; Mbatchou Ngahane et al., 2016; Manji et al., 2016; Ravimohan et al., 2018; Swain et al., 2021) In our study, the most common functional abnormalities on spirometry was mixed pattern, which was detected in 29.87% (23/77) of patients, followed by restrictive findings in 15.58% (12/77), obstructive in 14.28% (11/77), and normal in 40.25% (31/77). Another study was conducted by (Ramos et al., 2007). Patil et al. (1998) found that in five hundred people with symptoms, 150 (30%) showed normal spirometry, 210 (42%) showed obstructive pattern, 90 (18%) had mixed pattern, and 50 (10%) had restrictive pattern with respect to their spirometry, which matches to our findings. Regarding obstructive pattern, 9 patients (81.8%) had mild obstruction, 2 patients (18.18%) had moderate obstruction. Regarding restrictive pattern 3 patients (25%) had mild restriction, 7 patients (58.3%) had moderate restriction, 2 patients (16.66%) had severe restriction.

Many investigations have shown pulmonary restriction as the most common pattern, with varied proportions (Lee et al., 2003; Swain et al., 2021). (Báez-Saldaña et al., 2013) present a restrictive pattern characterized by lung parenchyma volume reduction, scarring, decreased pulmonary compliance, and increased elastic retraction pressure.

In contrast, many investigations indicated that airway obstruction was the most common defect (Menezes et al., 2007). It is not apparent how airflow restriction arises after pulmonary tuberculosis treatment. Bronchial narrowing was hypothesized as a result of extrinsic pressure of bigger lymph nodes around the bronchus in addition to endobronchial tb with considerable connective tissue loss and eventual fibrosis (Kim et al., 2001).

Furthermore, tuberculosis, like smoking, increases the expression of Matrix Metalloproteinases (MMP enzymes), which contribute to lung damage (Maiti and Samanta, 2018; Dey and Guha, 2020). According to Manji et al. (2016), the total prevalence of lung function abnormalities was 74%, with the most common being obstruction (42%), followed by mixed (19%) and restrictive (13%).

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Another study conducted in the United States discovered that the average percentage of pulmonary dysfunction of any sort was 59%, with the prevalence of specific subtypes of impairment for mixed, restrictive, and obstructive being thirty-one fifteen and thirteen percent, respectively, with the majority having a restrictive pattern (Pasipanodya et al., 2007). While our study found a pulmonary impairment prevalence of up to 60% (46/77), It is important to highlight that lung functions are abnormal in the vast majority of individuals following ATT. Mixed impairment was the most common category we found, accounting for 29.87% (23/77).

Conclusion

Despite the successful administration of anti-TB drugs, the residual pulmonary function impairment among tuberculosis patients remains a global burden, leading to increased economic burden and poor quality of life. Hence, screening and early diagnosis for the residual impairment and optimal management, including initiating early pulmonary rehabilitation, will improve the quality of life and prevent the cost and economic burden. Despite having more successful treatment outcomes. The majority of patients report chest symptoms such as breathlessness and cough, as well as significant residual pulmonary function impairment. 11.4% of patients have an active illness, whereas 59.75% have a pulmonary impairment. Radiological examinations, such as chest X-rays, show improved or resolved lung abnormalities associated with tuberculosis, such as infiltrates, cavities, or lesions. This suggests effective treatment and recovery of lung function. Assessment of pulmonary function indicates restoration or improvement in lung capacity and respiratory function among post-PTB patients. This implies that the lungs have recovered from the damage caused by tuberculosis and are functioning normally or at near-normal levels. As a result, proper recommendations for patient follow-up after tuberculosis therapy must be created to evaluate their lung function, offer adequate treatment, and improve their quality of life.

Limitations

-Sample size.

-Follow up period is very short for assessing clinical, radiological, microbiological and PFT

-Psychosocial, nutritional status were not addressed in this study.

-Due to cost factors, only chest X-ray assessment was done, and the CT assessment would have revealed more radiological abnormalities.

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Conflict of Interest

The authors declare no conflict of interest.

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