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Spirometric Evaluation in Pulmonary Tuberculosis Sequelae

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Abstract:
BACKGROUND:*Tuberculosis is an ancient disease caused by Mycobacterium tuberculosis.airways may be involved in pulmonary tuberculosis, affecting the calibre of airways and a decline in overall lung capacity via the process of scar fibrosis. The abnormality after pulmonary tuberculosis treatment includes fibrosis, bronchiectasis, bronchial stenosis causing pulmonary function abnormalities.*
MATERIALS AND METHODS: *An observational study was conducted in 50 patients with pulmonary tuberculosis sequelae attending outpatient or admitted in GHCCD, Visakhapatnam from August 2021 to December 2021.the technique of spirometry was explained to patient ,and a minimum of three trials were done with an interval of 5 minutes between each trial and results were analyzed.*
RESULTS:*Most of the individuals had obstructive pattern (46%) followed by mixed (22%) and restrictive pattern (20%), normal spirometry was observed in (12%). Out of 15 smokers , 12 had obstructive spirometry , 2 had mixed pattern, none had restrictive spirometry and 1 had normal pattern out of 35 non-smokers , 11 had obstructive spirometry , 10 had restrictive , 9 had a mixed pattern and 5 had normal values .*
CONCLUSION: *The present study shows that due to marked residual changes in the lung caused by tuberculosis infection, there occurs a considerable and significant decline in lung function in the post treatment period with obstruction being the most common abnormality followed by mixed and restrictive pattern and the extent of impairment increases with number of treatment episodes .*
Key Words: *Spirometry, obstructive pattern , lung function , smokers , tuberculosis.*

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I. Introduction

Tuberculosis (TB) is an ancient disease – studies of human skeletons show that it has affected humans for thousands of years – but its cause remained unknown until 24 March 1882, when Robert Koch discovered the bacillus, subsequently named *Mycobacterium tuberculosis*. [1]

Pulmonary Tuberculosis (TB) causes parenchymal destruction by up-regulation of many proteases and dysregulation of the control of proteases. After undergoing TB therapy, approximately two-thirds of patients experience impaired pulmonary function, and the obstructive defect is the most prevalent.[2]

Airways may be involved in TB affecting the calibre of the airways, increasing their thickness and reducing airflow. There is a decline in overall lung capacity via the process of scar fibrosis.[3]The abnormalities after pulmonary TB treatment include fibrosis, bronchiectasis, and bronchial stenosis, causing pulmonary function abnormalities [4].

According to the Global Initiative for Chronic Obstructive Lung Disease guidelines, chronic bronchitis/bronchiolitis and emphysema can occur as complications of pulmonary Tuberculosis.[5]

In patients with pulmonary TB sequelae, obstructive ventilatory dysfunction is the most common condition, and the severity typically varies according to the extent of the lesion.[6] The aim of the study was toassess spirometry parameters in pulmonary tuberculosis sequelae patients and to study the radiographic presentation of pulmonary tuberculosis sequelae and its correlation with spirometry

II. Materials And Methods

The study group consisted of 50 patients with pulmonary tuberculosis sequelae attending as outpatient or admitted in theGovernment hospital for chest and communicable diseases, Visakhapatnam from August 2021 to December 2021 .

STUDY DESIGN : A Cross sectional observational study

STUDY SETTING : Government hospital for chest and communicable diseases , Visakhapatnam.

STUDY PERIOD : August 2021 to December 2021.

SAMPLE SIZE :50 patients

INCLUSION CRITERIA :

1.Patients with no history of active pulmonary Tuberculosis (sputum negative).

2. Patient with Pulmonary Tuberculosis who have completed Anti-tubercular therapy (full course)
3. Patients with age more than 18yrs.
4. Radiographic evidence of pulmonary tuberculosis sequelae changes.

EXCLUSION CRITERIA :

1. Patients with active pulmonary TB or MDR TB
2. HIV positive
3. Patients of age less than 18yrs
4. Patients with contraindications for spirometry-active hemoptysis, recent Myocardial Infractionsevere Hypertension, recent cerebrovascular accident uncooperative patients, recent ophthalmic surgery.

PROCEDURE METHODOLOGY :

After taking consent, data recorded in pre-designed forms, patients meeting the criteria are interviewed. 2 sputum samples before the procedure, and CBNAAT confirmed sputum negativity, chest x-ray pa view was taken. On the day of recording, the subject was advised to avoid full meals 2 hours before the test, avoid alcohol consumption 4 hours before the test. Avoid short-acting inhaled bronchodilators 6 hours before the test**,** Long-acting bronchodilators 12 hours before the test. Informed consent was obtained. Anthropometric measurements - The height and weight of the subject were measured.

The technique of spirometry was explained to the patient, and actual measurements were done after becoming familiar with the correct technique. a minimum of 3 trials were done with an interval of 5 min between each trial and best of three trials taken for analysis.

STATISTICAL ANALYSIS : Data was analyzed using Microsoft EXCEL sheet.

III. Results.

TABLE NO 1: AGE DISTRIBUTION**:**

Age	Frequency	Percent
≤30	4	8
31-40	6	12
41-50	12	24
51-60	18	36
>60	10	20
Total	50	100

The maximum number of patients belongs to the age group 51 – 60 The minimum number of patients belongs to age ≤30.

TABLE NO 2 : GENDER DISTRIBUTION

Sex	Frequency	Percent
Female	19	38
Male	31	62
Total	50	100

Among the 50 subjects who participated in this study, 62% were male subjects,
and 31% were female subjects.
Male: female ratio in this study was around 2:1.

TABLE NO 3 :FREQUENCY OF CLINICAL FEATURES

Clinical features	No. Of patients	Frequency
Dyspnea	29	58%
Cough	22	44%
Hemoptysis	0	0%
Fever	0	0%
Chest pain	0	0%

In this study, out of 50 patients, 58% had dyspnea, 44% had a cough.

TABLE NO 4:FREQUENCY OF SMOKING

Smoking	Frequency	Percent
No	35	70
Yes	15	30
Total	50	100

In this study, 15 individuals (30%) had a history of smoking, and 35 individuals (70%) were nonsmokers.

TABLE NO 5:DURATION BETWEEN TREATMENT OF TUBERCULOSIS AND PRESENTATION

Variable	N	Minimum	Maximum	Mean	SD
Duration after treatment	50	0.50	6.00	2.82	1.71

The minimum duration after treatment is 6 months, and the maximum duration is 6 years.

TABLE NO 6 :COMPARISON OF MEAN VALUES OF FVC, FEV1 AND FEV1/FVC BETWEEN DIFFERENT PATTERNS OF LUNG FUNCTION IMPAIRMENT

PARAMETERS	OBSTRUCTION	RESTRICTION	MIXED	NORMAL
FVC	80	63.20	56.73	88.83
FEV1	54.70	59.00	44.18	81.00
FEV1/FVC	0.60	0.87	0.60	0.84

TABLE NO 7:FREQUENCY DISTRIBUTION OF DIFFERENTPATTERNS OF LUNG FUNCTION IMPAIRMENT

Interpretation	Frequency	Percent
Obstruction	23	46
Restriction	10	20
Mixed	11	22
Normal	6	12
Total	50	100

Most of the individuals had the obstructive pattern (46%) followed by mixed(22%) and restrictive pattern(20%) in spirometry.

TABLE NO 8 :GENDER AND SPIROMETRY

Sex	Interpretation							
	Obstruction		Restriction		Mixed		Normal	
Female	9	47.4%	5	26.3%	1	5.3%	4	21.1%
Male	14	45.2%	5	16.1%	10	32.3%	2	6.5%
Total	23	46.0%	10	20.0%	11	22.0%	6	12.0%
P=0.09								

This table shows the distribution of the pattern of Lung Function Impairment among males and females.

TABLE NO 9: COMPARISON OF POST-BRONCHODILATOR SPIROMETRIC PARAMETERS AMONGSMOKERSAND NONSMOKERS

Smoking	**Interpretation**							
	Obstruction		**Restriction**		**Mixed**		**Normal**	
No	11	31.4%	10	28.6%	9	25.7%	5	14.3%
Yes	12	80.0%	0	0%	2	13.3%	1	6.7%
Total	23	46.0%	10	20.0%	11	22.0%	6	12.0%
P=0.012								

Out of the 15 smokers, 12 had obstructive spirometry, and none had restrictive spirometry, 2 had a mixed pattern, and 1 had a normal pattern. Out of the 35 nonsmokers, 11 had obstructive spirometry, 10 had restriction, 9 had a mixed pattern, and 5 had normal values.

TABLE NO 10 :RELATIONSHIP BETWEEN DURATION AFTER-TREATMENT AND PATTERN OF LUNG FUNCTION IMPAIRMENT

Variable	Interpretation								P-value
	Obstruction(n=23)		Restriction(n=10)		Mixed(n=11)		Normal(n=6)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Duration after treatment	2.56	1.17	3.25	1.90	3.99	1.96	0.94	0.55	**0.001**

Significant variation was seen between each pattern of damage and duration after treatment **(P 0.001)**. As the duration after treatment increases, lung function impairment's severity increased from obstructive to mixed pattern. Few subjects (n=6) showed normal study as duration after treatment increases. The analysis was done by ANOVA.

TABLE NO 11 : FREQUENCY OF NUMBER OF EPISODES OF TUBERCULOSIS TREATMENT

No. of Episodes	**Frequency (n)**	**Percentage (%)**
1	36	72
2	12	24
3	2	4

TABLE NO 12 :RELATIONSHIP BETWEEN NUMBER OF EPISODES AND PATTERN OF LUNG FUNCTION IMPAIRMENT

No. of episodes of ATT	Interpretation							
	Obstruction		Restriction		Mixed		Normal	
	Count	%	Count	%	Count	%	Count	%
1	13	36.1%	10	27.8%	7	19.4%	6	16.7%
2	8	66.7%	0	0.0%	4	33.3%	0	0.0%

3	0	0.0%	0	0.0%	2	100.0%	0	0.0%
Total	21	42.0%	10	20.0%	13	26.0%	6	12.0%
P=0.01								

The table shows ,as the number of episodes of Anti TB treatment increases , the severity of damage increases . this was statistically analyzed by chi square test . p- value is highly significant (P 0.01).

TABLE NO 13 :CORRELATION BETWEEN FVC, FEV1, FEV1 / FVC, AND NO. OF EPISODES

Variable	Correlations	
	No. of episodes of ATT	
	r-value	P-value
FEV1 Post	-0.522	**<0.001**
FVC Post	-0.354	**0.01**
FEV1/FVC Post	-0.554	**<0.001**

The analysis is done by Spearman's rho analysis.
A negative correlation was observed between FVC and No. of treatment episodes **(P 0.01)** . A significant correlation between FEV1 and No. of treatment episodes was found **(P<0.001).** A significant correlation between FEV1 / FVC and No. of Episodes of Treatment **(P<0.001)**.
The above numbers show that as the number of episodes increases, there is a decrease in FEV1, FEV1/FVC values.

TABLE NO 14:FREQUENCYOF RESIDUAL LESIONS IN CHEST X-RAY

RESIDUAL LESION	Frequency (n)	Percentage (%)
Fibrosis	43	86
Hyperinflation	12	24
Cavity	11	22
Cystic changes	10	20
Pleural thickening	08	16

Fibrosis is the most commonly seen residual lesion in tuberculosis sequelae (86%), followed by hyperinflation (24%), cavity, cystic changes, pleural thickening.

TABLE 15:RADIOLOGICAL EXTENT OF THE LESIONS

Chest x-ray extent	Frequency (n)	Percentage (%)
Degree 0	04	8
Degree 1	19	38
Degree 2	15	30
Degree 3	12	24

Degree I was the most common radiological extent of inactive TB found in 19 out of 50 (i.e., 38%), followed by Degree II (30%) and Degree III (12%).

TABLE 16: COMPARISON OF EXTENT OF RADIOLOGICAL LESION WITH PATTERN OF LUNG IMPAIRMENT

Chest x- ray extent	Interpretation							
	Obstruction		Restriction		Mixed		Normal	
Degree 0	0	0%	0	0%	0	0%	4	100.0%
Degree 1	9	47.4%	5	26.3%	3	15.8%	2	10.5%
Degree 2	6	40.0%	5	33.3%	4	26.7%	0	0%
Degree 3	8	66.7%	0	0%	4	33.3%	0	0%
Total	23	46.0%	10	20.0%	11	22.0%	6	12.0%
P<0.001								

Degree 1 was the most common radiological extent of inactive TB found in 19 out of 50 (38%), followed by Degree2 (30%) and Degree 3 (24%).
Obstructive pattern is the most commonly observed in Degree I (47.4%), followed by restrictive (26.3%), mixed pattern(15.8%). Obstructive is the most common pattern observed in Degree II (40%), followed by restrictive (33.3%) and mixed (26.7%). In Degree III, obstructive (66.7%) and mixed patterns (33.35) are observed.

The severity of airflow limitation was dependent on the extent of the radiological lesion, and this relationship was statistically significant (p<0.001, Chi-square test). It means a greater degree of the radiological lesion is associated with more severe airflow obstruction.

IV. Discussion

Pulmonary Tuberculosis affects almost all parts of the respiratory system, including bronchi, bronchioles, lung parenchyma, and lymph nodes.

Histopathological abnormalities occur even after successful treatment of the disease-causing sequelae changes in the lungs, which can be in the form of fibrosis, cavity formation, bronchial and bronchiolar obstruction, bronchiectasis, etc. These sequelae changes in the respiratory tract can cause the obstructive, restrictive, or mixed lung function impairment pattern.[7]

In the present study, the age group of selected subjects was between 30 – 70 years, but it was observed that more patients fall in the age group of 51 - 60 years (36%) compared to 24% who belonged to the age group 41-50 years. This may be because, normally, there is a gradual decline in pulmonary function after 30 years of age. [8]majority of study population were males (62%) , females (38%).

Frequency of clinical features:
In the present study, dyspnea was found out to be the most common symptom (in 58% of cases), followed by cough (44%). None of the patients had chest pain hemoptysis.
Frequency of Smoking:
In the present study, 15 individuals (30%) had a history of smoking (quit smoking since the diagnosis of Tuberculosis), and 35 individuals (70%) were nonsmokers.In the present study, smoking was not a significant predictor for lung function impairment. All the males who participated in the study had quitted smoking just after the diagnosis of pulmonary Tuberculosis. None of the women have a history of smoking before and after the attack of Tuberculosis
Comparison of post-bronchodilator spirometric parameters among smokers and nonsmokers:
In the present study, obstructive abnormality more common among smokers, nonsmokers also showed significant spirometric abnormalities which, were restrictive or mixed patterns. The restrictive pattern was more predominant in the nonsmoker group.
Pattern of lung function impairment:
The lung function impairment patterns observed in the study were an obstructive, restrictive pattern, and mixed pattern. There is concrete evidence that as the lag time increases, the extent of lung damage also increases. [9]Few subjects in the study (6 out of 50) had a normal pattern in spirometry. Due to different factors, such as they might have had a better pulmonary function before Tuberculosis compared to subjects who showed obstructive/ restrictive/ mixed patterns.
FEV1/FVC ratio:
The mean ratio is 0.60 in obstructive and mixed patterns. The severity of damage was assessed based on the FVC value. The mean ratio is 0.87 in a restrictive pattern. Statistically significant **(P < 0.01)** variation was noted in FEV1 / FVC values depending upon the pattern of lung function impairment.It was observed that there is a decline in FVC & FEV1 values depending upon the severity of lung impairment.**:**

FVC & FEV1:

In the present study, a significant decrease in FVC & FEV1 was noted among the different patterns of involvement. The decline in FEV1 value was more compared to the decline in FVC.

The mean FVC is 80 ± 6.36 in the obstructive pattern, 63.20 ± 7.47 in restrictive, and 56.73 ± 8.76 in mixed patterns. The value of FVC varies significantly in different patterns of lung function study.

The mean FEV1 is 54.70 ±14.74 in the obstructive pattern, 59.00 ± 6.45 in restrictive, and 44.18 ± 12.30 in the mixed pattern. The difference in the mean value of FEV1 between obstructive and restrictivepattern is much less compared to the difference in the mean value of FVC between obstructivestudy and mixed pattern.

Comparison of extent of the radiological lesion with the pattern of lung impairment:

In the present study, we demonstrated that the radiological evidence classified as degree III reflected greater functional severity and that chest X-rays presenting little alteration indicated that pulmonary function is likely to be normal or only slightly altered.

In the present study, Degree 1 was the most common radiological extent of inactive TB found in 19 out of 50 (38%), followed by Degree2 (30%) and Degree 3 (24%). Obstructive pattern is the most commonly observed in Degree I (47.4%), followed by restrictive (26.3%), mixed pattern (15.8%).

The obstructive pattern is the most common pattern observed in Degree II (40%), followed by restrictive (33.3%) and mixed (26.7%). In Degree III, obstructive (66.7%) and mixed pattern (33.35) were observed.

V. Conclusion

The present study shows that due to the marked residual changes in the lung caused by Tuberculosis infection, there occurs a considerable and significant decline in Lung function in the post-treatment period.

In the present study, most of the individuals had the obstructive pattern followed by a mixed and restrictive pattern in spirometry, and a normal pattern was observed in 12%.

Most of the smokers had obstructive pattern (80%), followed by mixed pattern. Among non-smokers, restrictive and mixed patterns are mostly observed.

There is decreased FEV1 and FEV1/FVC with an increase in the number of episodes of tuberculosis. Mixed pattern is observed in patients with three episodes of PTB, and obstructive pattern is predominant in patients with one or two episodes.

The severity of airflow limitation was found to be dependent on the extent of the radiological lesion, i.e., a greater degree of the radiological lesion is associated with more severe airflow obstruction. Proper counselling to PTB patients and regular follow up even after completion of anti-TB therapy is essential to detect post-TB OAD at its earliest to treat and to prevent progression of the disease.

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