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Original Article

Internal Medicine Section

Cardiopulmonary Functions and Quality of Life in Patients with Pulmonary Tuberculosis: A Cross-sectional Study from Pune, Maharashtra, India

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ABSTRACT

Introduction: Pulmonary Tuberculosis (PTB) treatment can improve health, but patients may experience sequelae of cardiopulmonary complications. PTB can contribute to complications in the cardiovascular system, including abnormal Electrocardiogram (ECG) readings, and the pulmonary system can be damaged, leading to reduced lung capacity and difficulty in breathing. It may cause a combined impact on Quality of Life (QoL). Understanding this is crucial for optimising patient care and identifying potential complications early.

Aim: To assess cardiopulmonary functions and QoL in patients undergoing PTB treatment.

Materials and Methods: This cross-sectional study was conducted at a tertiary care hospital in Pune, Maharashtra, India from August 2019 to October 2019. Total of 32 patients (20-50 years old) receiving PTB treatment for six months were included. Haematological tests and Chest X-ray (CXR) were conducted, and QoL was measured using the St. George's Respiratory Questionnaire (SGRQ). Exercise capacity was evaluated by measuring Oxygen Saturation (SpO_2) before and after the 6-Minute Walk Test (6MWT).

Results: In this study, anaemia was prevalent in 24 patients (75%). ECG abnormalities were detected in 20 (62.5%) patients, and Echocardiography (ECHO) revealed Pulmonary Arterial Hypertension (PAH) in 2 (6.25%) patients. Exercise capacity, measured by a 6MWT, decreased SpO_2 in most patients 27 (84.37%), with a greater decline in females and older individuals. All patients reported significant QoL impairment, with worse activity scores in males.

Conclusion: PTB treatment may impact cardiovascular function and QoL. Regular screening for complications and potentially tailored treatment plans are warranted for PTB patients.

Keywords: Oxygen saturation, Saint george's respiratory questionnaire, Six-minute walk test

INTRODUCTION

The PTB, caused by *Mycobacterium tuberculosis*, remains a significant global health threat even with effective treatment regimens. While these treatments aim to eradicate the bacteria, they may also have unintended consequences for patients' cardiopulmonary health. PTB itself can negatively impact various aspects of cardiopulmonary function. The inflammatory response triggered by the infection can affect the blood (haematological parameters), such as haemoglobin level [1,2]. Additionally, PTB can contribute to complications in the heart and blood vessels (cardiovascular system), including abnormal ECG readings [3-6]. Furthermore, the lungs (pulmonary system) can be damaged, leading to reduced lung capacity and difficulty breathing [7-9]. While some studies have explored the independent effects of PTB and treatment on cardiopulmonary function [5,6], limited research [4,9] exists on the combined impact on QoL, particularly in patients actively undergoing treatment. Understanding this combined effect is crucial for optimising patient care and identifying potential complications early. Thus, this study aimed to assess cardiopulmonary functions and QoL in patients undergoing treatment for for PTB by addressing aim, this study hopes to contribute valuable information to optimise treatment strategies and improve patient outcomes in PTB management, specifically focusing on patients actively undergoing treatment in the Indian subcontinent.

MATERIALS AND METHODS

This cross-sectional study was conducted at a tertiary care hospital in Pune, Maharashtra, India from August 2019-October 2019. Institutional Ethics Committee (IEC) approval was duly obtained (IESC/C-109/2019). Informed consent from all patients under study was obtained.

Inclusion criteria: Bacteriologically confirmed cases of PTB between the ages of 20-50 years (under treatment for six months as prescribed under Directly Observed Therapy Short Course (DOTS) issued by the Revised National Tuberculosis Control Program (RNTCP). Patients in both the intensive and maintenance phases were included in the study.

Exclusion criteria: Patients with miliary or extra PTB were excluded. Patients with pre-existing cardiovascular, pulmonary, or haematological conditions and a history of smoking and alcoholism were excluded from the study.

Study Procedure

Based on a previous study by Guessogo WR et al., the sample size of this study was taken as 32 patients [9]. The study was conducted in three phases:

Phase I: Two blood samples labelled 'Sample A' and 'Sample B' were collected in separate vacutainers where 'Sample A' was subjected to a Complete Blood Count (CBC) (EDTA whole blood, automated cell counter) to evaluate Haemoglobin (Hb), Total Leukocyte Count (TLC), platelet count, and Haematocrit (HCT). The same sample was used to evaluate the Erythrocyte Sedimentation Rate (ESR) (EDTA whole blood, Wintrobe Method). 'Sample B' was subjected to a Liver Function Test (LFT) for Serum Glutamic Oxaloacetic Transaminase (SGOT) (Serum by Enzymatic Method) to test for myocardial pathology, if any.

Phase II: All patients underwent CXR tests to assess lung impairment. An ECG was recorded and read to look for any abnormal findings.

Patients with abnormal ECG findings were evaluated further by 2-Dimensional (2-D) Echocardiogram (ECHO) to assess 'Ejection Fraction' (EF) and 'Regional Wall Motion Abnormalities' (RWMA) [5]. Right Ventricular Systolic Pressure (RVSP) was used to measure pulmonary hypertension.

Phase III: Patients were asked to fill 'SGRQ. The SGRQ had 50 questions scored on a scale of 0 (no impairment) to 100 (maximum impairment) with three subscales (symptoms, activity, impacts). Higher scores indicate greater impairment in a patient's health due to respiratory problems. The data entered by patients in the questionnaire are entered in the SGRQ template. The SGRQ template is a part of the SGRQ calculator, which is Excel-based software that calculates the component scores and total score for each patient [10]. Patients, in the same setting, were asked to take the 6MWT. SpO_2 was measured both before and after the test.

STATISTICAL ANALYSIS

All the data obtained were meticulously entered into Microsoft Excel and analysed using percentages and other appropriate functions wherever necessary. SGRQ Scores were calculated using an Excel template of the SGRQ questionnaire.

RESULTS

A total of 32 patients were included, comprising 16 males and 16 females with a mean age of 35.4±5.73 years. Twelve patients (37.5%) were in the age group of 20-30 years, seven patients (21.9%) were in the age group of 31-40 years, and 13 patients (40.6%) were in the age group of 41-50 years. The mean Hb level was 10.9±1.06 g/dL. In 19 patients (59.38%), Hb was ≤10 gm/dL [Table/Fig-1] [11]. Contrary to the presence of active infection, 26 (81.25%) patients had normal Leukocyte Count, while only 4 (12.5%) patients showed Leukocytosis as a response to infection [Table/Fig-2] [12]. The mean platelet count was 340,725±118,238 cells/µL and ranged from 735,000 to 38,200 cells/µL. Sixteen (50%) patients showed a normal count, whereas 11 (34.3%) showed Thrombocytosis. The mean hematocrit value was 33.4±7.8% (Range 43.2-23.3%). In 29 (90.6%) cases, the haematocrit value was less than 41.5%. The study showed ESR values ranging from 9-44 mm/hour. Twenty-six patients (81.25%) had increased ESR, and only six patients (18.75%), all females, had normal ESR. Mean ESR values for both males and females were quite close, i.e., 22.3±4.2 and 22.4±10.8, respectively. Evaluation of LFT revealed the mean value of SGOT was 77.13±42.9 U/Lt (Range 13-485 U/L). Fourteen patients (43.75%) had SGOT well above 38 U/L, and 18 patients (56.25%) had SGOT in the normal range of 12-38 U/L [Table/Fig-3]. After the six MWT, the males had a desaturation of 2.5%, while females had a desaturation of 3.1% compared to pretest values [Table/Fig-4]. The age group of 20 to 40 years had a desaturation of 2.58%, while those in the 41 to 50 years age group had a desaturation of 3.23% [Table/Fig-5]. Exercise capacity, measured by a 6MWT, decreased SpO_2 in most patients 27 (84.37%). Evaluation of SGRQ revealed the overall mean to be 69.57±17.72 (Range 28.03- 98.04), while in males and females separately was 73.29±16.04 (Range 43.82-98.04) and 65.86±18.53 (Range 28.03-92.56), respectively. Mean scores of various components of the SGRQ were close to each other in both groups. However, a concerning observation was the mean activity scores of males i.e., 78.26±24.13 and females i.e., 59±32.69, with a considerable difference of 19.26 [Table/Fig-6]. CXR PA-view of the patients showed abnormal findings in 28 patients. Of all X-rays of 32 patients, 13 (40.62%) showed Fibrocavitatory lesions, 6 (18.75%) showed consolidation, and 6 (18.75%) showed pleural effusion [Table/Fig-7]. ECG showed abnormal findings in

Haemoglobin (Hb) (g/dL)		Males n (%)	Females n (%)	Total n (%)
Normal		2 (6.25)	6 (18.75)	8 (25.00)
Anaemia	Mild	4 (12.50)	1 (3.13)	5 (15.63)
	Moderate	8 (25.00)	9 (28.13)	17 (53.13)
	Severe	2 (6.25)	0	2 (6.25)
Total		16 (50.00)	16 (50.00)	32 (100.00)
Mean		10.4±0.92	11.3±1.2	10.9±1.06

[Table/Fig-1]: Haemoglobin (Hb) concentration (g/dL)- gender-wise and total.
Mild anaemia: Hb 10.0 g/dL to 13.5 g/dL for men and 10.0 to 12.0 g/dL women; Moderate anaemia: Hb 8.0 g/dL to 10.0 g/dL; Severe anaemia: Hb less than 8.0 g/dL [11]

TLC (cells/µL) 4000-11000 [12]	Males n (%)	Females n (%)	Total n (%)
Decreased <4000	1 (3.13)	1 (3.13)	2 (6.25)
Normal 4000-11000	14 (43.75)	12 (37.50)	26 (81.25)
Increased >11000	1 (3.13)	3 (9.38)	4 (12.50)
Total	16 (50.00)	16 (50.00)	32 (100.00)
Mean	9369.0±2247.4	9956.0± 1823	10900±1126.2

[Table/Fig-2]: Total leukocyte count (cells/µL)- gender-wise and total.

SGOT (AST) (U/L)	Males n (%)	Females n (%)	Total n (%)
Normal 8-38	10 (31.25)	8 (25.00)	18 (56.25)
>38	6 (18.75)	8 (25.00)	14 (43.75)
Total	16 (50.00)	16 (50.00)	32 (100.00)
Mean	53.06±41.1	101.00±44.7	77.13±42.9

[Table/Fig-3]: Serum Glutamate Amino Transferase (SGOT) i.e., Aspartate Aminotransferase (AST) (U/L)- gender-wise and total.

Males			Females		
SpO_2 (%) Pre-6MWT	SpO_2 (%) Post-6MWT	Desaturation	SpO_2 (%) Pre-6MWT	SpO_2 (%) Post-6MWT	Desaturation
97*±1.86	94.5*±3.14	2.5*±1.63	96.9*±1.65	93.8*±3.47	3.1*±2.80

[Table/Fig-4]: Gender-wise distribution of SpO_2 (in %) of patients before (i.e., Pre-6MWT) and after (i.e., Post- 6MWT) performing the 6-Minute Walk Test (6MWT) and desaturation (in %) calculated.
(* indicates mean value +SD of respective columns)

Age 20-40			Age 41-50		
SpO_2 (%) Pre-6MWT	SpO_2 (%) post-6MWT	Desaturation	SpO_2 (%) Pre-6MWT	SpO_2 (%) post-6MWT	Desaturation
97.42±1.054	94.84±1.881	2.58±0.54	96.31±1.49	93.08±3.30	3.23±2.45

[Table/Fig-5]: Age-wise distribution of mean SpO_2 (in %) of patients before (i.e., Pre- 6MWT) and after (i.e., Post- 6MWT) performing the 6-Minute Walk Test (6MWT) and mean desaturation (in %) +SD calculated.

SGRQ	Symptoms score	Activity score	Impacts score	Total score
Overall				
Range	6.98-100.00	0.00-100.00	16.25-100.00	28.03-98.04
Mean	73.93	68.63	68.72	69.57
SD	23.42	30.3	19.05	17.72
Males				
Range	6.98-100.00	17.32-100.00	39.83-100.00	43.82-98.04
Mean	75.22	78.26	69.83	73.29
SD	24.48	24.13	17.53	16.04
Females				
Range	6.98-97.48	0.00-100.00	16.25-100.00	28.03-92.56
Mean	72.65	59.00	67.62	65.86
SD	22.24	32.69	20.39	18.53

[Table/Fig-6]: Overall and gender-wise distribution of range and mean of individual component of the St. George's Respiratory Questionnaire (SGRQ) i.e., Symptoms Score, Activity Score and Impact score; and Total Score with Standard Deviations for each.

20 patients (62.5%) [Table/Fig-8]. It is vital to mention here that 6 patients (18.75%) had ST-T changes and one patient (3.125%) had right axis deviation. Out of those who had abnormal ECG changes and who were suspected to have any cardiac abnormality, six were selected to undergo 2-D ECHO. One patient (3.12%) had moderate Pulmonary Artery Hypertension (PAH), one patient (3.12%) had severe PAH, and one patient (3.12%) had RWMA. The other three patients had normal findings on ECHO.

	Males	Females	Total
CXR findings	n (%)	n (%)	n (%)
Normal CXR	1 (3.13)	3 (9.38)	4 (12.51)
Fibrocavitatory lesions	7 (21.88)	6 (18.76)	13 (40.62)
Consolidation	1 (3.13)	5 (15.63)	6 (18.76)
Fibronodular lesions	1 (3.13)	0	1 (3.13)
Lung destruction	2 (6.25)	0	2 (6.25)
Prominent BVM	1 (3.13)	1 (3.13)	2 (6.26)
Emphysema	1 (3.13)	1 (3.13)	2 (6.26)
Pleural effusion	3 (9.38)	3 (9.38)	6 (18.76)
Bronchopneumonia	3 (9.38)	0	3 (9.38)
Pneumothorax	1 (3.13)	1 (3.13)	2 (6.26)
Hydropneumothorax	1 (3.13)	0	1 (3.13)
Tubular heart	1 (3.13)	0	1 (3.13)

[Table/Fig-7]: Distribution of cases depending upon the Chest X-ray (CXR) findings- gender-wise and total.
BVM: Broncho vascular markings

	Males	Females	Total
ECG findings	n (%)	n (%)	n (%)
Normal	6 (18.75)	6 (18.75)	12 (37.5)
Left ventricular hypertrophy (LVH)	3 (9.375)	1 (3.125)	4 (12.5)
ST-T changes	1 (3.125)	5 (15.625)	6 (18.75)
Lt. axis deviation	2 (6.25)	1 (3.125)	3 (9.375)
Rt. axis deviation	1 (3.125)	0	1 (3.125)
Sinus tachycardia	3 (9.375)	3 (9.375)	6 (18.75)
Sinus arrhythmia	0	1 (3.125)	1 (3.125)

[Table/Fig-8]: Distribution of cases depending upon the ECG findings- gender-wise and total.

DISCUSSION

This study found significant effects on cardiopulmonary functions and QoL in patients undergoing PTB treatment. The first haematological parameter under study was haemoglobin concentration to assess for anaemia. Total of 75% of patients were found to be anaemic, with 43.75% being males and only 31.25% being females. The lowest peak of haemoglobin was found to be 7.0 g/dL in males, whereas it was found to be 8.0 g/dL in females. This revelation was surprising considering the general tendency of females to be more anaemic than males, especially in India [13]. Haematocrit values were well below normal levels in 90.63% of patients, indicative of a microcytic blood picture. In the study by Singh KJ et al., normocytic normochromic anaemia was the most common abnormality observed in all the groups and subgroups [14].

Although the total leukocyte count ranged from leukopenia to leukocytosis, paradoxically 81.25% of patients had a normal TLC and another 6.25% had leukopenia despite active infection. Both males and females seemed to be almost equally affected in each respect. These results were similar to those reported by Singh KJ et al., [14].

Thrombocytosis was seen in only 34.3% of patients, which corresponds with the findings of Yaranal PJ et al., and Singh KJ et al., who reported 26% and 32% of patients with thrombocytosis, respectively [1,14]. Further studies with larger sample sizes might help reveal the prevalence of reactive thrombocytosis in PTB and further understanding of its pathophysiology.

A change in ESR value indicates alteration in tuberculous focus [14]. In this study, 81.25% of patients had raised ESR, and this proportion corresponds well with those reported by Yaranal PJ et al., Chaudhari P and Chaudhari R, and Singh KJ et al., [1,2,14]. This study also suggested the presence of a greater tendency of males to have raised ESR (100% males) than females (62.5% females). This could be due to the narrower range of normal ESR levels in males than in females.

SGOT values were elevated in nearly half, i.e., 43.75% of patients, which could indicate some underlying myocardial pathology. 62.5% of patients showed several ECG changes, of which six patients (18.75%) showed ST-T changes, four patients (12.5%) showed LVH, and one patient (3.125%) had right axis deviation. This correlated well with the findings of Vijayan V et al., where ST-T changes could be an indicator of myocardial ischaemia, infarction, or any other pathological process [3]. Right axis deviation could indicate LVH, and LVH could indicate PAH. A 2-D ECHO revealed the presence of PAH in two patients (6.25%), one of moderate grade and the other severe. Additionally, a 2-D Echo revealed RWMA in one patient (3.125%). The possible causes for the development of PAH in these patients could be the destruction of the vascular bed due to parenchymal abnormalities, vasculitis, and endarteritis, leading to a reduced cross-sectional area of the pulmonary vasculature [15].

The most common radiological patterns seen on CXR were fibrocavitatory lesions (40.62%), consolidation (18.76%), and pleural effusion (18.76%). Pleural infection is usually caused by the rupture of a subpleural caseous focus into the pleural space [16].

Pre-6MWT and post-6MWT values of SpO_2 differed substantially in 27 patients (84.37%), which was expected as a result of the disease. The mean pre-6MWT values of SpO_2 for both males and females were very close, i.e., 97% for males and 96.9% for females. An important point to highlight was that the mean values of desaturation after performing 6MWT in females were 3.1%, which was higher than in males. This study also found that the mean desaturation was lower in the younger group of 20-40 years (2.58%) than in the older group of 41-50 years (3.23%). The possible reason is better lung capacity in males and younger age groups. In the study by Guessogo WR et al., which assessed physical and functional follow-up of tuberculosis patients in the initial intensive phase of treatment using the 6MWT, it was observed that the baseline cardiorespiratory parameters and performance characteristics of TB patients were lower than the control group, but they improved after two months of treatment [9]. The same study concluded that the 6MWT can be a useful tool in the assessment of physical parameters and cardiorespiratory functional capacity rehabilitation of TB patients during the treatment.

The mean scores of various components of SGRQ on interpretation revealed that all patients had significant effects on QOL. Scores in SGRQ are expressed as a percentage of overall impairment where 100 represents the worst possible health status and 0 indicates the best possible health status. Mean values for the symptoms score, which was concerned with the effect of respiratory symptoms, their frequency, and severity; and the impacts score, which covers a range of aspects concerned with social functioning and psychological disturbances resulting from airways disease, were similar in males and females, indicating a similar effect on QOL. The mean activity score, which was concerned with activities that cause or are limited by breathlessness, was higher in males (78.26) than in females (59.00). This indicates the loss of functional capacity in males due to their disease, causing limitations in physical work. Even the mean of the total score, i.e., 73.29 in males and 65.86 in females, indicates a greater effect on the QoL of males than females. Pasipanodya JG et al., validated the SGRQ in a diverse population microbiologically cured of tuberculosis and found a mean 13.5-U difference in SGRQ score between these patients and a comparison group with similar risk factors (p-value <0.001) [15].

Limitation(s)

The small sample size of the study was a major limitation. A follow-up questionnaire after treating anaemia and cardiac conditions, or one during the intensive phase and one during the maintenance phase, would have provided robust data.

CONCLUSION(S)

Patients undergoing treatment for PTB are susceptible to a range of cardiopulmonary complications and a significant decline in QoL. Regular monitoring of haematological parameters, ECG, and QoL scores is crucial for the early detection and management of these issues. Further research with larger cohorts is needed to establish definitive associations and treatment strategies to optimise patient outcomes.

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