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Brief Article

Assessment of pulmonary function of post-COVID-19 patients of a tertiary hospital at three months following discharge

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Abstract

In this cross-sectional study from October 2020 to September 2021, pulmonary function was assessed in 40 (24 severe and 16 non-severe) post-COVID-19 patients at three months following hospital discharge by convenient sampling in post-COVID follow-up clinic at Department of Respiratory Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka. Among 40 subjects, 17 (42.5%) had restrictive defect, 1 (2.5%) had obstructive defect and 22 (55%) had normal spirometry. There was reduced total lung capacity (TLC) in 17 (42.5%) subjects and reduced diffusing lung capacity for carbon monoxide (DLCO) in 20 (50%) subjects. Mean six minutes walking distance (6MWD) was low (387.6±99.4 meters). Oxygen desaturation was in 4 (10%) cases. Frequency of restrictive defect was higher in severe than non-severe subjects (54.2% vs. 25%). Reduced TLC was in 62.5% of severe and 12.5% of non-severe cases. There was higher frequency of reduced DLCO in severe than non-severe casese (62.5% vs. 31.3%). 6MWD was lower in severe than non-severe group (354.0±134.9 vs. 438.2±51.4 meters, *P*=0.02). Pulmonary function was found significantly impaired in post-COVID patients which was more prominent in severe disease group.

Keywords: Pulmonary function test, Post-COVID-19

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Introduction

Moderate to critical and few mild COVID-19 patients with co-morbidities need hospitalization.[1] COVID-19 has three phases - acute phase (first 3 weeks), post acute phase (3rd - 12th weeks) and chronic post-COVID-19 phase (beyond 12th weeks).[2] Similarities in pathogenesis and spectrum of lung damage between COVID-19 and SARS emerged in 2003 have been reported.[3] Approximately 20% of SARS patients had impaired pulmonary function beyond eight weeks.[4] SARS patients had reduced exercise capacity beyond one year.[5] These evidences raised possibility of adverse pulmonary consequence in COVID-19. Approximately 25.4% post-COVID-19 patients had abnormal pulmonary function at three months following hospital discharge.[6] Restrictive lung defect was in 50% of post-COVID-19

patients.[7] Another study showed 42% post-COVID-19 patients had impaired lung function after three months of hospital discharge.[8] Only 6.4% post-COVID-19 patients had restrictive defect in another study.[9] Such conflicting results necessitated more studies. The objective of this study was to assess the chronic impact of COVID-19 on lung function [spirometry, lung volumes, diffusing lung capacity for carbon monoxide (DLCO) and 6 minutes walk test (6MWT)] at three months following hospital discharge.

Methods

This cross sectional study was done from October 2020 to September 2021. Study population were post-COVID -19 patients of post-COVID follow-up clinic on an out patient basis at department of Respiratory Medicine, BSMMU. Inclusion criterias were age 18-80 years, h/o RT-PCR confirmed COVID-19 treated in BSMMU three months (90±15 days) before. Exclusion criterias were known COPD, bronchial asthma, DPLD, bronchiectasis, pulmonary tuberculosis, lung resection, neuropathy, myopathy, ankylosing spondylitis, kypho-scoliosis, systemic sclerosis, acute coronary syndrome, active haemoptysis, arrhythmia, heart failure. Sample size was 40 in a total including non-severe and severe cases. Convenient sampling was done. Number of enrolled subjects was 55. With informed written consent enrolled patients were subjected to pulmonary function tests. First 40 subjects were taken as sample who completed spirometry, lung volume, DLCO, 6MWT in available centres including BSMMU. A questionnaire with coding response was used for collecting data. Data of previous COVID-19 illness were collected from discharge note. Data were kept confidential and used only for this study.

Ethical Clearance

The protocol was approved with ethical clearance by Institutional Review Board, BSMMU (BSMMU/2020/11546, date-30/12/2020). Minor change in title was approved later bearing the same number and date (Registration no- 3316).

Statistical analysis was done using SPSS-22. Data were normally distributed. Quantitative data were analyzed by 'unpaired t-test'. Categorical data were analyzed by chi- squared test. 'Pearson's correlation co-efficient test' was done to see correlation. Value of P ≤0.05 was statistically significant.

Results

Mean age of the 40 participants was 51.5±10.1 years (range: 27-69 years). Mean interval between hospital discharge and pulmonary function test was 86.9±7.2 days (range: 77-103 days). Among 40 participants, in spirometry, there were restrictive abnormality [defined as FEV1/FVC ratio >70% and forced vital capacity (FVC) <80% predicted] in 17 (42.5%), obstructive airway defect [defined as FEV1/FVC <70% and forced expiratory volume in 1st second (FEV1) <80% predicted] in 1(2.5%) participant and 22 (55%) cases were normal. Mean forced vital capacity (FVC) was 2.6±0.6 litres (80.0±16.0% predicted). Among all, 17 (42.5%) subjects had reduced total lung capacity (TLC) (defined as TLC <80% predicted). Mean TLC was 4.6±1.2 litres (80.1±18.3% predicted). Reduced DLCO (defined as DLCO <80% predicted) was in 20 (50%) cases. Mean DLCO was 17.7±4.9 ml/min/mmHg (75.3±20.6% predicted).

In six minutes walk test (6MWT) oxygen desaturation was in 4 (10%) cases and all were severe cases. Mean six minutes walking distance (6MWD) was 387.6±99.4 meters. Lung function was not significantly affected by gender. Smokers had lower FVC, TLC and DLCO (P<0.05). TLC was lower in obese than in non-obese patients (73.7±13.1 vs. 85.3±20.5% predicted; P=0.04). Pearson's correlation coefficient test showed DLCO and 6MWD had significant negative correlation with length of hospital stay during acute illness (P=0.03 and P=0.03 respectively). **Table 1** shows the demographic and clinical characteristics pulmonary function test results of the study participants. **Figure 1** shows comparison of frequency of abnormal pulmonary function between severe and non-severe cases.

TABLE 1 Demographic and clinical characteristics and pulmonary function test results of the post-COVID-19 participants

Variables	Total (n=40)	Non-severe (16)	Severe (24)	*P*
Age (years)				
18-50	18 (45.0)	11(%)	07 (%)	0.52
51-70	22 (55.0)	05 (%)	17 (%)	
Sex				
Men	29 (72.5)	12 (%)	17 (%)	0.004
Women	11 (27.5)	04 (%)	07 (%)	
Body mass index (Kg/m^2)				
<25 (non-obese)	22 (55.0)	12 (%)	10 (%)	0.34
>25 (obese)	18 (45.0)	04 (%)	14 (%)	
Smoking				
Smoker	7 (17.5)	03 (%)	04 (%)	0.001
Non-smoker	33 (82.5)	13 (%)	20 (%)	
Duration of hospital stay during acute illness (days)	14.7±8.3	10.3±3.8	17.5±9.3	0.02
Spirometry				
FEV1 in litre	2.2±0.5	2.4±0.4	2.1±0.6	0.05
FEV1 (% predicted)	85.6±17.6	89.4±12.6	83.1±20.2	0.27
FVC in litre	2.6±0.6	2.9±0.5	2.5±0.7	0.06
FVC (% predicted)	80.0±16.0	86.1±9.2	76.0±18.4	0.05
FEV1/FVC ratio	0.8±0.0	0.84±0	0.86±0	0.56
PEF in litre/min	6.0±1.8	6.6±1.6	5.6±1.9	0.10
PEF (% predicted)	89.5±25.7	94.2±13.1	86.4±31.4	0.35
Lung volumes				
TLC in litre	4.6±1.2	5.2±0.7	4.3±1.3	0.01
TLC (% predicted)	80.1±9.2	90.9±9.2	72.9±19.5	0.00
FRC in litre	2.5±0.7	2.8±0.6	2.3±0.6	0.01
FRC (% predicted)	82.2±19.5	88.8±12.2	77.9±22.4	0.08
DLCO				
DLCO (ml/min/mmHg)	17.7±4.9	19.7±3.3	16.4±5.4	0.03
DLCO (% predicted)	75.3±20.6	85.5±13.7	68.5±21.8	0.00
Six minutes walk test (6MWT)				
Six minutes walking distance (6MWD) in meter	387.6±99.4	438.2±51.4	354.0±134.9	0.02
Lowest oxygen saturation (SpO2) in %	96.1±1.9	97.0±1.4	95.6±2.0	0.02

FEV1 indicates Forced expiratory volume in 1st second; FVC, Forced vital capacity; PEF, Peak expiratory flow rate; TLC, Total lung capacity; FRC, Functional residual capacity; DLCO, Diffusing lung capacity of carbon monoxide

Discussion

In this study, the characteristic spirometric abnormality was restrictive defect which was more in severe cases. COVID-19 pneumonia can progress through fibrotic changes[10] which develops restrictive lung defect. In most of the cases restrictive lung defect was mild. Restrictive lung defect occurs in association with reduced lung volume and reduced DLCO in parenchymal pathology. Frequency of reduced TLC was high and reduced DLCO was the commonest abnormality in this study. It signified the magnitude of residual parenchymal pathology in lung after recovery from acute illness and excluded any explanation of extraparenchymal cause of restrictive lung defect. The results were consistent with results of a systematic review that showed 40% of post COVID-19 patients had reduced DLCO after three months of recovery.[11] The present study showed advanced age, obesity, smoking, longer duration of hospital stay were significantly associated with lower DLCO. These factors might be good indicators of long term lung function outcome in COVID-19.

In Bangladeshi healthy individuals mean six minutes walking distance and mean lowest SpO_2 during six minutes walk test were found as 466.7±69.4 meters and

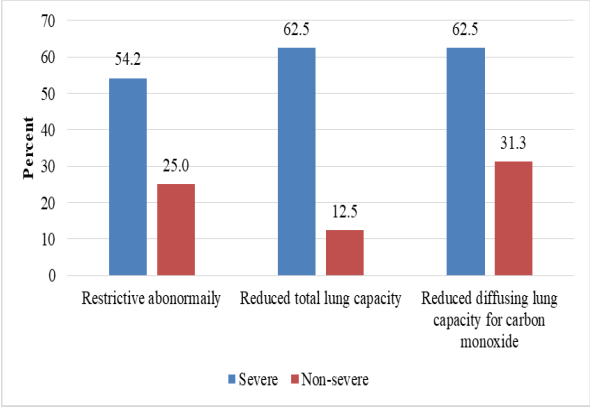

FIGURE I Bar diagram showing camparison of frequency of abnormal pulmonary function between severe and non-severe group of post-COVID-19 study subjects

96.8±1.5% respectively.[12] In the present study, both mean 6MWD and mean SpO_2 in post-COVID-19 patients were lower than those reference values. Moreover, among 24 severe cases 4 (16.6%) had oxygen desaturation during test. In another study in India, 84.9% severe post-COVID patients had oxygen desaturation during test.[13] It signifies that the extent of exercise induced oxygen desaturation in post-COVID patients could be much high. More studies in Bangladesh in this aspect can explore the actual scenario. It should be kept in consideration that lung function in post COVID-19 patients might gradually be improved in a proportion of patients.

The strength of this study was that, the major pulmonary functions were assessed in both severe and non-severe post-COVID-19 patients. All of them were from same COVID-19 centre having standardized treatment protocol. There were few limitations. The sample size was small. There was lack of baseline data of pulmonary function before COVID-19 illness. So the results could not be compared with the function of healthy lung of their COVID-19 illness.

Conclusion

This study gave alarming picture on pulmonary consequence in post-COVID-19 patients that should be addreesed with a high index of suspicion. Long term follow-up of post-COVID-19 patients will be crucial for their better outcome. Pulmonary rehabilitation should be considered in the management to hasten recovery.

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Author Contribution

Md. Ahad Murshid conceptualized the study, designed the research methods, completed data acquisition, data analysis and manuscript writing. AKM Mosharraf Hossain guided this research. Mohammed Atiqur Rahman Shamim Ahmed, Samprity Islam, and Rajashish Chakraborty critically reviewed the manuscript. All authors approved the submission.

Conflict of Interest

Authors declare no conflict of interest

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