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Original Research Article

Correlation between pulmonary function and six minutes walk test with computed tomography severity score in post COVID patients

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ABSTRACT

Background: The current global pandemic of the coronavirus severe acute respiratory syndrome coronavirus 2 is the world's most critical ongoing healthcare problem, with 8.2% of critically ill patients developing acute respiratory distress syndrome and requiring Intensive care unit admission. Our study aimed to correlate CT severity score of the patient at the time of diagnosis with spirometry, 6-minute walk test and breath holding time at 12 weeks after discharge, to determine the nature of residual pulmonary dysfunction and if CT severity was a predictor of poor lung function post recovery.
Methods: Ambi-directional single center study conducted in Saveetha medical college Hospital, Chennai. Patients over the age of 18 with a positive COVID-19 RTPCR report and a CTSS>1 were enrolled into the study, and a sample size of 50 patients was taken after systematic random sampling. PFT, 6-minute walk test and Breath Holding Time were done at 12 weeks post discharge.
Results: Mean CT severity score was: 11.48. 26% of the patients had more than 50% lung involvement on CT. There was significant negative correlation observed between FVC and Severity score (r=-0.366, p=0.009) and Breath holding and Severity score (r=-0.339, p=0.016) while there was no significant correlation between 6-minute walk test and CT Severity.
Conclusions: Patients with significant lung involvement during SARS-COV-2 infection showed impaired pulmonary function test parameters in the form of a reduced FVC and breath holding time, 3 months following diagnosis. Long-term follow up and pulmonary rehabilitation is crucial to achieve respiratory recovery.

Keywords: Post-COVID, Long COVID, PFT, CT severity score

INTRODUCTION

The global pandemic is a result of the coronavirus severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) leading to the world's most critical ongoing healthcare problem. To date there have been over 758,390,564 confirmed cases of coronavirus disease 2019 (COVID-19) worldwide including 6,859,093 deaths, reported to WHO.[1] While the advent of the vaccine offers some hope with over 13 billion doses administered, the virus continues to be a global burden. Early evidence suggested over 8.2% of critically ill patients with COVID-19 infection presented with progressive respiratory failure, eventually developing acute respiratory distress syndrome (ARDS), and requiring admission into the intensive care unit (ICU) The lungs remain the most affected organ by the virus.[2] A characteristic finding is the injury to alveolar epithelium and endothelium with secondary fibroproliferation followed by chronic vascular and alveolar remodeling eventually resulting in fibrosis of the lungs, with or

without pulmonary hypertension.[3,4] Computed Tomography (CT) of the chest remains a valuable tool in assessing disease severity and follow up ; the most common CT features in patients affected by COVID-19 being bilateral ground glass opacities and consolidation in a peripheral distribution.[5] Recent guidelines suggest following up a patient with severe Covid with a PFT 12 weeks after discharge.[6] Early reports suggested that COVID-19 survivors after discharge, had a predominantly restrictive defect with small airway dysfunction, which was not associated with disease severity.[7] Our study aimed to compare and correlate the CT severity score (CTSS) of the patient with spirometry and 6-minute walk test at 12 weeks after discharge to determine the nature of the residual pulmonary dysfunction and to determine if CT severity was a predictor of poor lung function post recovery.

METHODS

Patients over the age of 18 with a positive Covid-19 RTPCR report and a CTSS>1 admitted in Saveetha Medical College Hospital from Feb 2021 to May 2021 were enrolled into the study and a sample size of 50 patients was taken after systematic random sampling. Patients were evaluated at the time of diagnosis and then after a median of 12 weeks for respiratory function in an outpatient setting.

Inclusion and exclusion criteria

Inclusion criteria was COVID-19 diagnosis by polymerase chain reaction (PCR) on pharyngeal swab with evidence of pneumonia on CT Thorax at the time of admission. Exclusion criteria were asymptomatic patients with no evidence of pneumonia, pregnant women, age<18 years and previous diagnosis of structural lung disease. Data on the evolution of Covid 19 and patient details were collected retrospectively from hospital records. Pulmonary functional tests and measurement of 6-min walk tests (6-MWT) were performed using established protocols.[8-10] HRCT thorax was done at the time of admission in clinically symptomatic patients.

Pulmonary function tests

Outpatient pulmonary function tests were performed using EasyOnePro® spirometer system and were performed by technicians at the pulmonary function laboratory. Forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, forced expiratory flow (FEF) and peak expiratory flow (PEF) were included in the analysis. For each patient, parameters were expressed as percentage of a theoretical value calculated by Global Lung Function 2012 equations.[11]

Six-min walking test

6-MWT was performed in room air under the supervision of respiratory therapists according to the American Thoracic Society guidelines; Pulse oximetry was used to assess oxygen saturation.

Image analysis

All available CT scans were collected from the local image archiving system (PACS). The CT-score was derived from extent of lobar involvement based on a 5-point scale 0:0%; 1, <5%; 2:5-25%; 3:26-50%; 4:51-75%; 5>75%; range 0-5; Global score ranged from (0-25).[13] CT Severity was termed (Mild Score<8); (Moderate Score 9-15) or (Severe Score >15).

Statistical analysis

Descriptive statistics are reported as mean standard deviation (SD) or median interquartile range (IQR). Karl Pearson Coefficient of correlation is applied to identify the relationship between Pulmonary function parameters, breath holding time, 6-minute walk test and CT Severity score. Statistical analysis was carried out by SPSS V.26 statistical software package SPSS for Windows V26, (SPSS Inc., Chicago, IL, USA) and a p value of 0.05 or less was considered statistically significant.

RESULTS

A sample of 50 patients was investigated, 30% of the patients were female and 70% of the patients were male. Majority of the patients 40%) were between the ages of 51-60 years old. The most common comorbidities encountered in this study were Systemic hypertension (52%) and Type 2 diabetes mellitus (40%). 64% patients presented with complaints of cough, 68% of the patients complained of shortness of breath and 20% had fever at the time of diagnosis.

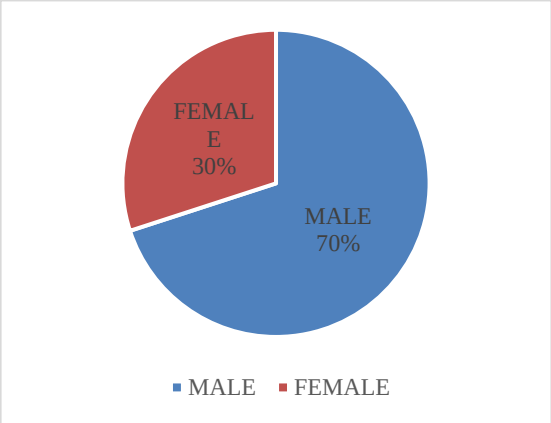

Figure 1: Pie chart representing the sex ratio.

CT Severity

Of the 50 patients included in the study, Median CT severity score was: 10.5, Mean 11.48 with a SD of 6.28. 26% of the patients had more than 50% lung involvement on CT.

Pulmonary function

Patients were evaluated after a period of 12 weeks. Mean FVC was 71.12L, SD (4.36), Mean FEV1 was 70.22 SD (17.45), Mean FEV1/FVC 98.84 SD (5.48), Mean FEF_{25-75} 75.68 SD (40.71), Mean PEF was 65.00 SD (23.53). Mean Breath holding: 31.18 SD (10.45).

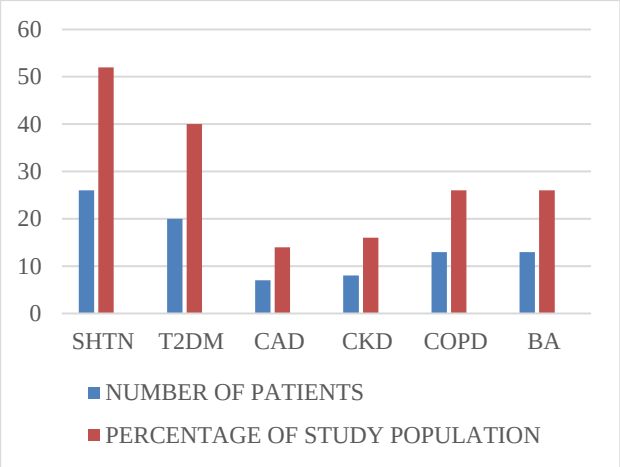

Figure 2: Study population and comorbidities.

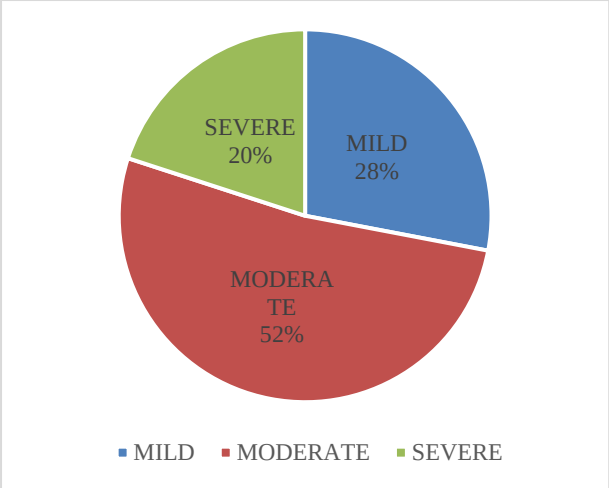

Figure 3: Distribution of CT severity scores.

Table 1: Correlation between pulmonary function parameters and CT severity score.

Pulmonary function parameters	CT severity score	
	R value	P value
FVC	-0.366	0.009
FEV1	-0.223	0.119
FEV1/FVC	0.115	0.426
FEF	0.064	0.661
PEF	0.027	0.852

FVC forced vital capacity; FEV1 forced expiratory volume exhaled in the first second; FEV1/FVC forced vital capacity/forced expiratory volume exhaled in the first second; FEF forced expiratory flow; PEF peak expiratory flow

6-MWT

Mean Distance covered: 376.20 meters SD (67.73) with a mean saturation drop of 2.67% SD (1.66).

Table 2: Correlation between pulmonary function parameters and distance covered.

Pulmonary function parameters	CT severity score	
	R value	P value
FVC	0.337	0.017
FEV1	0.357	0.011
FEV1/FVC	0.082	0.571
FEF	0.104	0.473
PEF	0.368	0.009

Table 3: Correlation between breath holding time and CT severity score.

Breath holding	CT severity score	
	R value	P value
	-0.339*	0.016

Table 4: Correlation between 6 min walk test and CT severity score.

6 min walk test	CT severity score	
	R value	P value
Oxygen saturation drop %	0.047	0.748
Distance covered	-0.200	0.163

Breath holding time

Mean Breath holding time was 31.18SD (10.45).

DISCUSSION

The lungs remain the most commonly affected organ, with over 8.2% of critically ill patients with COVID-19 infection presenting with progressive respiratory failure, eventually developing acute respiratory distress syndrome , and requiring ICU care.[2] Studies on Coronavirus lung involvement of severe acute respiratory syndrome and Middle East respiratory syndrome (MERS) have shown that radiologic abnormalities, impaired pulmonary functions and reduced exercise capacity may persist for months to years, but on average, improve over time.[14-16]

Studies have also shown CT showed persistent fibrotic changes in the lung, beyond 6 months, in more than 1/3rd of patients who survived severe COVID-19 pneumonia.[14-16] These changes were linked to an older age, tachycardia, longer hospital stays, non-invasive mechanical ventilation, acute respiratory distress syndrome and a higher initial chest CT score.[14-16] The proposed mechanisms include the extensive alveolar epithelial and endothelial cell injury with secondary fibroproliferation leading to chronic

vascular and alveolar remodelling eventually resulting in lung fibrosis with or without pulmonary hypertension.[3,4] Our results show a reduction of respiratory functions and breath holding time secondary to SARS-COV-2 pneumonia, in patients who had significant lung involvement, in the form of a high CT severity score at the time of diagnosis. In this study 28% of patients had mild CT Severity score, 52% of the patients had moderate and 20% of the patients had a severe CT Severity score. The study carried by Zhao et al found that out of 55 patients, 7.27% had mild score, 85.45% had moderate and 7.27% had severe CT severity score, the majority having a moderate CT Severity score, which was comparable to this study.[17] In this study, the correlation between CT severity score and pulmonary function test of post covid cases shows significant negative correlation between FVC and Severity score with a p value of 0.009. It is concluded that there was a significant decrease in the FVC level among patients with an initial high CT severity score. Alessia et al, observed an overall improvement in pulmonary function after 6 weeks of recovery but FVC was still lower than LLN, which suggest that COVID-19 pneumonia may result in clinically relevant alterations in pulmonary function, with a predominantly restrictive pattern.[18] Another study done by Balbi et al. found that the most common PFT abnormalities were impaired FVC% which was significantly lower in patients with CT abnormalities while no such differences were found for FEV1/FVC%. On comparing six-minute walk test of post covid cases with CT severity score there was no significant correlation. To the researcher's knowledge, there haven't been any other studies assessing breath holding time as a means of pulmonary function in post covid patients. However, in our study there is significant negative correlation observed between Breath holding and CT Severity score (r= -0.339, p=0.016)

Limitations

Limitations of current study were; Single centric study, Limited sample size, DLCO not being included as part of Pulmoary function testing and Lack of data on Corticosteroids and antifribrotic therapy.

CONCLUSION

Patients with significant lung involvement during SARS-CoV-2 infection, int ehf orm of a high CT severity score showed impaired pulmonary function test parameters such as reduced FVC and breath holding time, 3 months following diagnosis. Breath holding time may thus serve as a simple, bedside, point of care test to assess lung function, along with spirometry, in post COVID patients. Long-term follow up along with pulmonary rehabilitation is crucial to achieve near complete respiratory recovery.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. COVID-19. Available at: https://covid19.who.int/. Accessed on 20 November 2022.
2. Ñamendys-Silva SA. ECMO for ARDS due to COVID-19. Heart Lung. 2020;494:348-9.
3. Venkataraman T, Frieman MB. The role of epidermal growth factor receptor (EGFR) signaling in SARS coronavirus-induced pulmonary fibrosis. Antiviral Res. 2017;143:142-50.
4. Frija-Masson J, Debray MP, Gilbert M. Functional characteristics of patients with SARS-CoV-2 pneumonia at 30 days post-infection. Eur Respir J. 2020;562:754.
5. Bao C, Liu X, Zhang H, Li Y, Liu J. Coronavirus Disease 2019 (COVID-19) CT Findings: A Systematic Review and Meta-analysis. J Am Coll Radiol. 2020;176:701-9.
6. Thoracic. Available at: https://www.brit-thoracic.org.uk/document-library/quality-improvement/covid-19/resp-follow-up-guidance-post-covid-pneumonia/. Accessed on 20 November 2022.
7. You J, Zhang L, Ni-Jia-Ti MY. Anormal pulmonary function and residual CT abnormalities in rehabilitating COVID-19 patients after discharge. J Infect. 2020;812:e150-2.
8. Graham BL, Steenbruggen I, Miller MR, Barjaktarevic IZ, Cooper BG, Hall GL, et al. Standardization of Spirometry 2019 Update. Am J Respir Crit Care Med. 2019;2008):e70-88.
9. Wanger J, Clausen JL, Coates A, Pedersen OF, Brusasco V, Burgos F, et al. Standardisation of the measurement of lung volumes. Eur Resp J. 2005;263): 511-22.
10. ATS committee on proficiency standards for clinical pulmonary function laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;1661:111-7.
11. Multi-ethnic reference values for spirometry for the 3–95-yr age range: the global lung function 2012 equations. Eur Resp Soc. 2021,9:21-8.
12. Francone M, Iafrate F, Masci GM, Coco S, Cilia F, Manganaro L, et al. Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis. Eur Radiol. 2020;3012):6808-17.
13. Das KM, Lee EY, Singh R. Follow-up chest radiographic findings in patients with MERS-CoV after recovery. Indian J Radiol. 2017; 27:342-9.
14. Hui DS, Joynt GM, Wong KT. Impact of severe acute respiratory syndrome SARS) on pulmonary function, functional capacity and quality of life in a cohort of survivors. Thorax. 2005;60:401-9.
15. Zhang P, Li J, Liu H. Long-term bone and lung consequences associated with hospital-acquired severe acute respiratory syndrome: a 15-year follow-up from a prospective cohort study. Bone Res. 2020;8:8.
16. Zhao YM, Shang YM, Song WB, Li QQ, Xie H, Xu QF, et al. Follow-up study of the pulmonary function and related physiological characteristics of COVID-19

survivors three months after recovery. E-Clin Med. 2020;25:100463.
17. Fumagalli A, Misuraca C, Bianchi A, Borsa N, Limonta S, Maggiolini S, et al. Pulmonary function in patients surviving to COVID-19 pneumonia. Infection. 2021;491:153-7.
18. Balbi M, Conti C, Imeri G, Caroli A, Surace A, Corsi A, et al. Post-discharge chest CT findings and pulmonary function tests in severe COVID-19 patients. Eur J Radiol. 2021;138:676.

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