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Original Research Article

A correlation of the spirometric outcomes of follow up patients of COVID-19 pneumonia with their admission time computed tomography severity score on high resolution computed tomography thorax

Sucharita Patra*, Rajesh Khyalappa

Department of Medicine, D. Y. Patil Medical College, Kolhapur, Maharashtra, India

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***Correspondence:**
Dr. Sucharita Patra,
E-mail: patrasucharita@yahoo.co.in

ABSTRACT

Background: Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. Most people who fall sick with COVID-19 experience mild to moderate symptoms and recover without any special treatment. However, some become seriously ill and require serious medical attention. The respiratory system has been the main organ affected by COVID-19 along with other organs such as heart, kidneys and liver. Spirometry is the most common of the pulmonary function tests. Spirometry is helpful in assessing respiratory outcomes that identify conditions such as asthma, pulmonary fibrosis, cystic fibrosis, and COPD.
Methods: A total of 100 COVID-19 pneumonia patients coming for follow-up 6-10 weeks post-discharge in OPD at Department of General Medicine, Dr. D. Y. Patil Medical College Hospital and Research Institute, Kolhapur, Maharashtra, satisfying the inclusion criteria and exclusion criteria were enrolled. High resolution computed tomography (HRCT) thorax reports during their admission were collected and Computed tomography severity score (CTSS) was noted. Their spirometry was done and pattern of spirometric outcome noted. Admission-time CTSS and spirometric outcome were correlated.
Results: In majority of the patients, CT severity score during course of illness had strong correlation with spirometric outcome after 6 weeks of follow up and the association was statistically significant.
Conclusions: CT severity score during course of illness had strong correlation with spirometry findings after 6 weeks of follow up. Higher age and higher HRCT score are good predictors for impaired pulmonary function after discharge.

Keywords: Spirometry, COVID-19, Respiratory system, HRCT, Pulmonary function test

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 is the major emerging infectious illness known as coronavirus disease 2019 (COVID-19) (SARS-CoV-2). This virus was found to be the culprit behind a spate of pneumonia cases in Wuhan, China, in December 2019.[1] In March 2020, the WHO proclaimed COVID-19 to be a pandemic.[2] Patients with COVID-19 may exhibit a wide range of signs and symptoms, from asymptomatic, minor upper respiratory symptoms to severe pneumonia and multi-organ failure. Infection with SARS-CoV-2 most frequently affects the lung. Ground-glass opacity is the most common pattern of lung abnormality during disease. Additionally, a lot of patients had persistent opacity on their chest CT scans, with ground-glass opacity being the primary pattern at the time of discharge.[3] Patients with COVID-19 have diffuse alveolar damage, bronchiolitis, alveolitis, and interstitial fibrosis as part of their lung pathology.[4,5] As a result, patients with SAR-CoV2 infection may experience

restrictive or obstructive defects on a spirometry test while they are recovering. In a few studies, mostly from China, patients who recovered from SARS-CoV-2 infection had impaired lung function and failed the six-minute walk test (6MWT) The respiratory system has been the main organ affected by COVID-19.[6] COVID-19 also affects other organs such as the heart, kidneys, and liver.[7,8] In respiratory illnesses, particularly COVID-19, which is impacted by contaminants and infectious infections, the lung is the most important organ.[9] The most significant consequences are hyaline membrane damage, haemorrhage, capillary damage, and increased alveolar fibrosis, which finally results in fibrosis and elevated pulmonary blood pressure.[10] Even patients who have healed and been released are concerned about these clinical signs and findings.

Even after being discharged, some individuals may continue to have lung problems for months or even years. Spirometry is among the most significant and popular techniques pulmonologists have employed in recent years to assess patients and carry out pulmonary function testing (PFT).[10] During spirometry, significant pulmonary function indices, such as forced expiratory volume (FEV1), forced vital capacity (FVC), and FEV1/FVC, are evaluated. The pulmonary function of patients with severe COVID-19 has been carefully examined in the present study 6 to 12 weeks after recovery and discharge because PFT is crucial for evaluating respiratory health and diagnosing situations like asthma, chronic obstructive pulmonary disease (COPD), and severe respiratory failure.

The parameters of maximum inspiratory pressure (PI max) and maximum expiratory pressure (PE max), diffusion capacity of carbon monoxide (DLCO), residual volume (RV), total lung capacity (TLC), RV/TLC, COPD assessment test (CAT) score, MRC score, airway obstruction pressure (P=0.1), and oxygen saturation percentage were also looked at. Since there is limited information on the respiratory function in individuals with symptomatic COVID-19 pneumonia after recovery, we intend to analyse the PFT results, trends of lung involvement and finding the correlation of spirometric findings with CTSS values in patients having COVID-19 pneumonia following discharge.

METHODS

The study type was prospective observational study conducted at the OPD, Department of Medicine at Dr. D. Y. Patil Medical College Hospital and Research Institute, Kolhapur, Maharashtra from November 2020 to August 2022. All the necessary ethical permissions were taken from the IRC (Institutional Research Committee). Written informed consent was taken from the patient in their own language. The sample size taken for the study was 100 patients. Patients with COVID-19 diagnoses who had at least one positive RT-PCR swab and specific COVID-19 pneumonic abnormalities on imaging, older than 18 years of age were included for the study.

Patients with pre-existing heart conditions causing LVF, PAH, or CCF, those who have chronic pulmonary diseases that coexist or are being treated, having a long history of smoking, occupational lung illness, using medications that are known to interfere with lung function or induce pulmonary fibrosis (sulfasalazine, methotrexate, amiodarone, azathioprine, cyclophosphamide, bleomycin, phenytoin, carbamazepine etc.) collagen vascular disease patients were excluded from the study.[4] During the course of in-hospital therapy, pertinent laboratory tests, imaging results (including CT severity score), and medicines were documented in the study. Following hospital discharge, all research participants underwent pulmonary function tests assessing FVC, FEV1 and FEV1/FVC Ratio at interval of 6 to 10 weeks.[5] In order to perform the pulmonary function test, the subjects were prohibited from consuming whole meals two hours before the test, drinking alcohol four hours before the test, using bronchodilators with a rapid action six hours before the test, extended-release bronchodilators twelve hours before the test.

Spirometry

Flow volume loop

The patient was requested to take a relaxing seat in an armchair with a straight back. The process was demonstrated to the subject. Then the patient was instructed to take a deep breath with a nose clip with in place. Spirette was held in the mouth of the patient with lips securely shut. The individual was instructed to blow out air as quickly and forcefully as they could for at least six seconds. Then, the patient was asked to take a big breath while the spirette was still in their mouth (to form a loop). 3 minimum trials were completed, with a 5-minute gap. The most acceptable of three trials were selected for analysis.[10] There should be no more than a 0.2 L difference between the two largest FVCs from permissible movements. There shouldn't be a difference between the two manoeuvres' greatest FEV1 values of more than 0.2 L.[10,11]

Table 1: Spirometry value interpretation.

PFT parameters	Restrictive	Obstructive
FVC	<80% of predicted	Normal <80% of predicted
FEV1	Normal <80% of predicted	<80% of predicted
FEV1/FVC	≥Predicted	<Predicted

The averages for a participant's age, sex, build, and race were compared to the participant's FVC, FEV1, and FEV1/FVC measurements.[11]

Severity of restrictive patern (based on FVC%)

The severity of restrictive pattern 60-80%: mild restriction; 45 to 59%: moderate to severe restriction; and 45%: severe restriction.[11,12]

RESULTS

The expected values for FEV1, FVC, FEV1/FVC, and FEF 25%-75% were utilized as a percentage for the analysis. The SPSS 22 version of software was used to analyse the data, which was put into a Microsoft excel data sheet. Chi square for testing the relevance of qualitative data, exact tests were employed. After taking into account all the guidelines of statistical testing, a p value (probability that the result is true) of 0.05 was deemed to be statistically significant.

In majority of the patients, CT severity score during course of illness had strong correlation with spirometry findings after 6-10 weeks of follow up and the association was statistically significant (p value=0.000). Mean values of FEV_1 in patients with mild, moderate and severe disease were 99.90±21.00, 75.05±19.83 and 61.96±25.69 respectively. Mean values of FVC in patients with mild, moderate, and severe disease were 89.93±15.06, 73.76±13.17 and 61.36±16.20 respectively. Both values in patients with severe disease were significantly low as compared to mild and moderate lung disease (both p values<0.05). Mean FEV1/FVC ratio was also low in patients with severe disease (97.81±24.02) compared to mild and moderate disease (111.11±15.65 and 101.03±14.66 respectively) but lacks statistical significance (p value=0.665).

Table 2: Severity (on HRCT) and grades on spirometry.

PFT findings	Severity (based on HRCT score)			Total	Chi square, P value
	Mild	Moderate	Severe		
Mild	4	27	2	33	45.65, 0.000
Moderate	1	16	5	22	
Severe	0	1	3	4	
Normal	22	18	1	41	
Total	27	62	11	100	

Table 3: Severity (on HRCT) and mean FEV1, FVC, FEV1/FVC ratio.

Severity	FEV1		FVC		FEV1/FVC ratio mean	
	Mean	SD	Mean	SD	Mean	SD
Mild	99.90	21.00	89.93	15.06	111.11	15.65
Moderate	75.05	19.83	73.76	13.17	101.03	14.66
Severe	61.96	25.69	61.36	16.20	97.81	24.02
P value	0.001	<0.01	0.655	0.001	<0.01	15.65

DISCUSSION

Association between CTSS (on HRCT) during course of illness and grades on spirometry (on follow up after discharge)

In majority of the patients, HRCT severity score during course of illness had strong correlation with spirometric findings after 6-10 weeks of follow up and the association was statistically significant (p value 0.000). 33% had mild, 22% had moderate and 4% patients had severe lung disease. 41% patients had normal findings on spirometry. Correlations exist between the severity of a disease or persistent imaging alterations and the deterioration of lung function, with studies by Wan et al and Wu et al showing comparable results.[13-15]

Severity (on HRCT) during course of illness and mean FEV1, FVC, FEV1/FVC ratio (on follow up)

Mean values of FEV1 and FVC in patients with severe disease on HRCT were significantly low as compared to mild and moderate lung disease (both p values<0.05), mean FEV1/FVC. Ratio was also low in patients with severe disease (97.81±24.02) compared to mild and moderate disease (111.11±15.65 and 101.03±14.66 respectively) but lacks statistical significance (p value=0.665).

Limitation of the study

According to a recent study, since COVID-19 spread worldwide, approximately half of the patients who were discharged from hospital still showed persistent abnormalities in their HRCT thorax scans. However, in our study, spirometry was done only once. Hence any deterioration / improvement in lung function post 10 weeks of discharge could not be assessed.

Regarding the assessment of injury in individuals who have been discharged, worries have been raised on a global scale. Because there is limited information on the pulmonary function in individuals with symptomatic COVID-19 pneumonia after recovery, we seek to evaluate

the pulmonary function findings and characteristics of lung involvement in individuals with COVID-19 pneumonia after discharge in this study.

Furthermore, it's critical to keep an eye on these patients and perform extensive evaluations in order to identify any persisting or newly appearing long-term consequences in the radiographic and physiological domains and to manage them effectively.

CONCLUSION

Impaired lung imaging showed 1/3rd of the patients had mild score, around 2/3rd had moderate and very few (11%) had severe score. On follow up, spirometric abnormalities were seen in almost half of the patients. HRCT severity score during course of illness had strong correlation with abnormal spirometric findings after 6-10 weeks of follow up. Long-term studies are needed to address whether these deficits are persistent and should be performed to follow-up COVID-19. Therefore, there is requirement for similar studies with a larger statistical population and in an integrated manner to include HRCT severity score, pulmonary function assessment might present as useful tools with ongoing research. Identifying a variety of predictors of pulmonary outcome from such studies will help specialists strategize outlook in terms of identification, risk-stratification, and early pulmonary rehabilitation of high-risk patients.

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

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