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Original Article

Outcome of Lung Functions in Covid-19 Patients at a Tertiary Care Center of Eastern Nepal

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Abstract

Background
Novel coronavirus infection has myriad clinical manifestations, such as headache, respiratory failure, and long coronavirus disease syndrome. A common cause for admission is pneumonia, and such patients have shown longer periods of respiratory symptoms and exercise intolerance after discharge. The study aimed to determine short-term and long-term lung function outcomes in coronavirus disease patients.

Materials and Methods
The prospective, cross-sectional study was conducted in coronavirus disease facility of Birat Medical College Teaching Hospital. A structured proforma including symptoms, modified medical research council dyspnea scale, 6-minute walk test and portable spirometry were recorded during 3 months follow up.

Results
A total of 58 coronavirus disease patients were admitted, 4 expired. Common symptoms were dyspnea (98.28%), fever (94.8%), dry cough (86.2%), myalgia (17.2%). Mean Forced expiratory volume in 1 second to forced vital capacity ratio was normal. The mean forced vital capacity was 46.52% at admission, 53.33% at 3 months. The mean forced expiratory flow at 25% to 75% of forced vital capacity was 56.91% at admission, 59.31% at 3 months. Mean values of forced expiratory volume predicted was 47.40% at admission, 51.69% at 3 months. Mean 6-minute walk test distance did not improve during follow-up (240.09m at 1 month, 239.35m at 3 months) and there was no improvement in oxygen saturation at 3 months compared to the first month.

Conclusion
Short-term lung function outcome demonstrated persistent dyspnea and development of mixed airways disease in all the survivors. Long-term lung function outcome observed was persistence of dyspnea, mixed airways disease, and low exercise capacity.

Keywords: *COVID-19, Lung Function Test, Pneumonia*

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Introduction

COVID-19 disease may present as mild headache or as pneumonia, acute respiratory distress syndrome (ARDS) and post-COVID syndrome. In Nepal, data indicates confirmed cases of COVID-19 infected persons numbering 10,01,369 as of March, 2023, with mortality of 12,020 [1]. Koshi state has shown high burden of COVID-19 cases. Pneumonia is a common cause for admission [2]. Most complained of dyspnea and fatigue even after two months from admission [3]. In few studies, 4.1% had forced vital capacity less than 81% predicted and 23.7% had abnormal diffusion capacity one year on [4,5]. Another study noted half had abnormal pulmonary function tests at 3 months [6]. In a prospective cohort, lung structural and functional abnormalities was noted to be high in COVID-19 ARDS patients at three months [7].

Large study data on lung function outcomes of COVID-19 survivors in Nepal are limited, and respiratory complications are not established.

The study aimed to determine short-term and long-term lung function outcomes in patients infected with SARS-COV-2.

Materials and Methods

The study was hospital-based, prospective, quantitative, cross sectional and analytical. It was conducted at COVID-19 unit of department of Internal Medicine, Birat Medical College Teaching Hospital, Biratnagar, Nepal from May 2021 to April 2022, after approval by Institutional Review Committee of Birat Medical College Teaching Hospital (IRC-PA-129/2077-78), and after due consent from the patients. COVID-19 patients, diagnosed by positive Real Time PCR test for SARS-CoV-2, aged 14 years and above, providing written informed consent were included. Patients on mechanical ventilation, unable to consent owing to severity of symptoms and those unwilling to be enrolled were excluded. Fifty eight COVID 19 patients attending COVID unit of Department of Internal Medicine were enrolled through total enumeration technique method. COVID-19 infection was inferred when a patient was diagnosed as such with positive Real Time-PCR test for SARS-CoV-2. Short-term lung function outcome referred to lung function status based on mMRC scores and spirometry values at admission and discharge. Long-term lung function outcome referred to lung function status based on mMRC scores, 6-Minute Walk Test and spirometry values at 1 month and 3 months from discharge. Obstructive airways disease was defined as FEV1 and/or FEV1/FVC ratio less than lower limit of normal. Restrictive airways disease was defined as FVC less than lower limit of normal, with normal to high FEV1/FVC ratio, and normal FEV1 value. Mixed airways disease was defined as spirometry values depicting both obstructive and restrictive airways diseases. Small airways disease was defined as $FEF_{25-75\%}$ of FVC lower than lower limit of normal. The mMRC (modified Medical Research Council) scale is a tool to measure patient's disability due to breathlessness on daily activities using a self-rated scale of 0 to 4. Scale 0 is no breathlessness except on strenuous exercise; scale 1 is breathlessness when hurrying on level or walking up slight hill; scale 2 is breathlessness causes the patient to walk slower than people of same age on level, or if patient has to stop to catch breath when walking at own pace on level; scale 3 is when patient stops for breath after walking approximately 100 meters or after few minutes on level; and scale 4 is state when patient is too breathless to leave house, or breathless when dressing or undressing [8, 9]. Dyspnea was defined as mMRC dyspnea scale of ≥1 point. The 6-minute walk test (6MWT) is a clinical exercise test to assess functional status of patient, performed in a 100 feet hallway, where patient is instructed to walk on flat, hard surface for 6 minutes, supervised by trained technician, as per guidelines of American Thoracic Society [10]. A structured proforma recorded data on socio demography, travel history, symptoms and mMRC score. Hand-held portable spirometer Easy One® Air designed by NDD Medical Technologies was used to document FEV1, FVC, FEV1/FVC ratio and $FEF_{25-75\%}$. Patients were evaluated by structured proforma and portable spirometry upon admission, at discharge, 1 month, and 3 months. 6-MWT was performed at 1 month and 3 months. Data were entered in Microsoft Excel 2007 and statistically analyzed by SPPS software version 25. Descriptive statistical data were presented as mean, standard deviation and percentages, and presented in tabular format.

Results

There were 58 patients, 45 male and 13 females. 35 were admitted to intensive care unit (ICU) and 23 in ward. 4 with ARDS expired in ICU, 54 were followed up. The mean duration of hospital stay was 12.78 days (± 4.4). Mean duration of ICU stay was 6.67 days (± 4.81) and mean ward stay was 6.11 days (± 4.07).

Table 1: Baseline socio-demography characteristics of patients.

Characteristic	Frequency (n=58)	Percentage (%)
Age	48.8 years (± 13.4)	
Gender		
Male	45	77.6
Female	13	22.4
Occupation		
Business	18	31
Farmer	16	27.6
Homemaker	10	17.2
Others	14	24.14
BMI (kg/m2)		
Normal	14	24.14
Overweight	44	75.86
Travel History		
Present	14	24.1
Absent	44	75.9
Transmission Contact History		
Present	14	24.1
Absent	44	75.9
Smoking History		
Smoker	14	24.14
Nonsmoker	44	75.86
Comorbidities		
Diabetes Mellitus	12	20.7
Hypertension	5	8.6
Diabetes Mellitus and Hypertension	4	6.9

By occupation there were 3 engineers, 2 bankers, 2 healthcare personnel, and 1 each student, driver, army personnel, teacher, priest, policeman and builder.

Table 2: Symptoms of COVID-19 patients.

Symptom	Time of admission (n=58))	Time of discharge (n=54)	1st month (n=54)	3rd month (n=54)
Fever	55	1	0	0
Nonproductive cough	50	35	16	14
Productive cough	6	8	21	3
Chest pain	4	4	8	0
Diarrhea	2	0	0	0
Headache	5	0	3	3
Myalgia	10	16	16	14
Fatigue	0	42	49	52

On admission, common symptoms were dyspnea (98.28%), fever (94.8%), dry cough (86.2%) and myalgia (17.2%). Symptoms at 1 month were dyspnea (100%), fatigue (90.7%), productive cough (38.8%), nonproductive cough and myalgia (29.6% respectively). At 3 months, all patients had dyspnea (100%), 96.3% fatigue and 25.9% had myalgia and dry cough respectively.

Table 3: Dyspnea presentation and severity in COVID-19 patients.

Category	Time of Evaluation			
	Admission (n=58))	Discharge (n=54)	1st month (n=54)	3rd month (n=54)
Dyspnea	57	53	54	54
mMRC				
Grade 0	3	2	1	1
Grade 1	1	7	7	11
Grade 2	6	14	16	11
Grade 3	8	14	26	23
Grade 4	40	17	4	8

Most patients at 1 month (48%) and at 3 months (42.6%) complained of mMRC grade 3 dyspnea.

Table 4: 6-Minute Walk Test scores of COVID-19 patients.

Time of Test	6-Minute Walk Test ((n=mean (Standard Deviation))				
	Distance (m)	Baseline O_2 saturation (%)	Post-test O_2 saturation (%)	Baseline PR (beats/minute)	Post-test PR (beats/minute)
1st month (n=54)	240.09 (±68.66)	93.78 (±3.25)	86.02 (±6.99)	113.39 (±12.34)	135.59 (±15.05)
3rd month (n=54)	239.35 (±66.38)	94.17 (±2.49)	87.83 (±5.04)	105.54 (±12.17)	124.48 (±15.72)

Table 5: Spirometry values of patients with COVID-19 infection.

Parameter	Time of Test			
	Admission (n=58)	Discharge (n=54)	1 month follow-up (n=54)	3 months follow-up (n=54)
FEV1 (%)	47.40 (±16.81)	44.85 (±13.59)	49.69 (±13.2)	51.69 (±12.23)
FVC (%)	46.52 (±15.67)	46.33 (±13.35)	50.28 (±12.76)	53.33 (±12.94)
FEV1/FVC (%)	101.55 (±14.63)	98.11 (±16.57)	99.94 (±17.51)	98.91 (±19.79)
FEF_{25}-FEF_{75} (%)	56.91 (±36.27)	54.43 (±28.15)	59.54 (±27.18)	59.31 (±19.85)

n=mean (Standard Deviation)

Spirometry performed on the patients detected a decline in lung function with mean FEV1/FVC remaining normal. The mean forced vital capacity (FVC) consistently remained low at 46.52% at admission, to 53.33% at 3 months. The mean FEV1 values were 47.40% at admission and 51.69% at 3 months. The mean FEF25-75 values were 56.91% at admission and 59.31% at 3 months.

Discussion

Information on short-term and long-term lung function outcomes in COVID-19 patients in Nepal

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are limited. This study is arguably the first in eastern Nepal to observe the consequences of SARS-CoV-2 infection on lung function. Most patients were younger males (mean age 48.8 years), and nonsmokers, which compares with a study by Gonzalez J et al [7]. Diabetes Mellitus was the most common comorbidity as in other studies [7,11,12]. With predominance of dyspnea (100%), number of patients with worsening of dyspnea increased to mMRC scales 2 and 3 during follow-up. In a study, dyspnea proportion increased from 23.3% at 6 months to 27.9% at 1 year [12]. The symptom presentation in the study compared similarly with contemporary studies. In a cohort of 478 survivors followed for 4 months, common symptoms were fatigue (31%), cognitive symptoms (21%), and new-onset dyspnea (16%) [13].

The mean distance in the 6MWT did not improve with 240.09m at 1 month and 239.35m at 3 months. There was no improvement in oxygen saturation at 3 months (mean 94.17% at pretest to 87.83% posttest) compared to 1 month (mean 93.78% pretest to 86.02% posttest). In a study, exercise capacity showed continual improvement from 500m at 6 months to 525m at 2-years [12]. In the study of 62 patients at 3 months, the median distance walked was 400m, with decrease in oxygen saturation of <88% observed in 1 patient only [7]. This trajectory of change in functional status implied a gradual improvement of lung function over several months after discharge. Other studies have also found improvement in 6-MWT distance during follow-up [15].

There was normal FEV1/FVC with mean 101.55% predicted on admission, 98.11% at discharge, 99.94% at 1 month and 98.91% at 3 months. Zhang H et al noted that value of FEV1/FVC remained stable at 79% predicted over two years [12]. Where the mean FVC% predicted was 46.52% at admission, it improved to mean 50.28% predicted at 1 month, and 53.33% predicted at 3 months. This trajectory of FVC% values conform with improvement in 6-MWT at 1 month and 3 months. The study by Zhang H et al notes that FVC% initially elevates but starts decreasing by 2 years [12]. Restrictive ventilatory impairment was observed in present study even at 3 months.

The mean values of FEV1% predicted ranged from 47.40% at admission to 51.69% at 3 months. A Copenhagen study noted decline in FEV1 and FVC values on follow-up [16]. Abnormal pulmonary function in present study conforms with studies showing obstructive lung impairment (7.7%) and restrictive pattern (16.4%) at 3 months [17,18]. Small airways involvement is noted with decrease in mean values of $FEF_{25-75\%}$ predicted from admission at 56.91% to 59.31% at 3 months, like a study in children [19]. In contrast, a study observed pulmonary function test within normal limits, with only 10% having low values of FVC and FEV1. Even ICU patients were not noted to have reduced 6MWT distance, oxygen desaturation [14].

There is decrease in lung function and exercise capacity at 3 months. There was mixed lung disease. 6MWT noted no increase in absolute value of mean distance and no improvement in exercise-induced oxygen saturation. Exercise capacity limitation with presence of mixed airways disease is probably due to lung interstitial and alveolar injury as part of inflammatory pathogenic process of SARS-CoV-2 infection [20]. Deconditioned state and presence of fatigue may cause poor exercise capacity.

A limitation of study is that total lung capacity (TLC) and diffusion capacity of lung for carbon monoxide (DL_{CO}) could not be measured. Pulmonary function test values prior to the infection were not known. A correlation between lung function, radiologic images and biochemical parameters could not be made.

Conclusion

Lung function is affected by COVID-19. The short-term lung function outcomes were predominant dyspnea and development of mixed airways disease in all patients. Long-term lung function outcomes were persistence of dyspnea, presence of mixed airways disease and low exercise capacity.

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Conflict of interest: None

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