Original Research Paper

Volume - 16 | Issue - 07 | July - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Pulmonary Medicine

PULMONARY SEQUELAE OF MODERATE TO SEVERE COVID-19 PNEUMONIA: A SIX-MONTH RETROSPECTIVE OBSERVATIONAL FOLLOW-UP STUDY

Dr. Vipul Durga Shankar — Senior Resident, Department of Pulmonary Medicine, Bhopal Memorial Hospital and Research Centre (BMHRC), Bhopal, Madhya Pradesh

Dr. Arisha Javed — Senior Resident, Department of Pulmonary Medicine, Bhopal Memorial Hospital and Research Centre (BMHRC), Bhopal, Madhya Pradesh

ABSTRACT **Background:** Moderate and severe COVID-19 pneumonia may be followed by persistent pulmonary functional and radiological abnormalities, but the short-term natural course of these sequelae remains important for clinical follow-up planning. **Objective:** To evaluate pulmonary function and high-resolution computed tomography (HRCT) changes up to six months after moderate to severe COVID-19 pneumonia. **Methods:** This single-centre retrospective observational study included adults with RT-PCR-confirmed moderate to severe COVID-19 pneumonia who were admitted to Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Mumbai, and had routine post-discharge pulmonary follow-up. Pulmonary function tests were performed at serial follow-up visits, and HRCT thorax was assessed at approximately three and six months. **Results:** Fifty patients were analysed. Mean age was 57.5 ± 15.2 years, 44 (88%) were male, and 43 (86%) had severe COVID-19 pneumonia. Forty-nine patients had all three pulmonary function assessments. Mean FVC improved from 2.25 ± 0.55 L at first follow-up to 2.62 ± 0.56 L at second follow-up and 2.76 ± 0.56 L at third follow-up. Mean FVC percentage predicted increased from 72.5 ± 15.2% to 88.3 ± 12.4%, while mean DLCO increased from 54.1 ± 15.6% to 70.5 ± 20.1%. Fibrotic interlobular/intralobular septal changes on follow-up HRCT decreased from 89.5% at three months to 68.8% at six months. **Conclusion:** Functional and radiological recovery was observed over six months after moderate to severe COVID-19 pneumonia. Diffusion impairment was the most prominent abnormality, but serial improvement in FVC, DLCO and HRCT findings suggests a largely non-progressive recovery pattern in this cohort.

KEYWORDS : COVID-19; Pulmonary Sequelae; Pulmonary Function Test; DLCO; HRCT; Post-COVID Fibrosis

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2, has a broad respiratory spectrum ranging from asymptomatic infection to severe pneumonia and acute respiratory distress syndrome (ARDS) [1]. As survival after acute COVID-19 improved, attention shifted towards post-acute symptoms, persistent breathlessness and residual lung damage [2]. Because the lung is the most commonly affected organ, structured respiratory follow-up is clinically important, particularly after moderate and severe pneumonia. The British Thoracic Society recommended respiratory review after COVID-19 pneumonia, including assessment of breathlessness, oxygen requirement, rehabilitation needs and further evaluation at later time points when indicated [3].

Experience from previous viral outbreaks supports this approach. Follow-up studies after Middle East respiratory syndrome coronavirus and H1N1 influenza reported persistent radiological or pulmonary function abnormalities in subsets of survivors [4,5]. COVID-19-associated ARDS may also differ from typical ARDS in timing, compliance and radiological patterns, making direct extrapolation from older ARDS cohorts imperfect [6]. Computed tomography studies during COVID-19 have shown ground-glass opacities, consolidation, fibrous stripes and temporal evolution of lung lesions during recovery [7]. Pulmonary function tests, particularly forced vital capacity (FVC) and diffusing capacity for carbon monoxide (DLCO), therefore provide functional correlation with structural abnormalities.

A practical challenge after COVID-19 pneumonia is distinguishing resolving inflammatory or organising changes from abnormalities that may represent persistent post-inflammatory fibrosis. This distinction affects patient counselling, rehabilitation planning, oxygen follow-up and selection of patients for closer surveillance. Serial assessment is therefore more informative than a single post-discharge test. The present study was undertaken to assess the natural course of pulmonary sequelae after moderate to severe COVID-19 pneumonia. The objective was to evaluate serial changes in pulmonary function and HRCT thorax findings up to approximately six months after the onset of illness.

MATERIALS AND METHODS

This was a single-centre, retrospective, non-interventional observational study conducted at Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Mumbai. Patients were enrolled from June 2020 to May 2021 and followed for approximately six months after onset of COVID-19 symptoms. The study population included male and female patients aged 18 years and above with moderate to severe COVID-19 pneumonia diagnosed by positive nasopharyngeal SARS-CoV-2 RT-PCR and chest radiology. Moderate disease was defined by pneumonia with hypoxaemia and SpO2 90-94%, while severe disease included pneumonia with SpO2 below 90% or respiratory rate above 30/min.

Patients were eligible if they had undergone at least two pulmonary function tests and at least one HRCT thorax during routine follow-up. Patients with known pre-existing interstitial lung disease, unwillingness for follow-up, pregnancy, or initiation of antifibrotic medication after COVID-19 were excluded. All enrolled patients were advised outpatient pulmonary follow-up after discharge. Follow-up assessments were scheduled at 4-6 weeks, 10-12 weeks and approximately six months after symptom onset, based on the British Thoracic Society approach for post-COVID pneumonia follow-up [3].

Pulmonary function testing included spirometry and DLCO assessment. Tests were performed using a Jaeger Master Screen PFT system with JLAB software version 5.7. HRCT chest scans were performed in supine position on a 64-slice dual-source CT scanner. Images were reviewed on a PACS workstation using standard lung and mediastinal windows. Two diagnostic radiologists independently reviewed HRCT findings using conventional morphologic descriptors based on Fleischner Society nomenclature. The primary functional outcomes were serial FVC, FVC percentage predicted and DLCO percentage predicted. Radiological outcomes included the pattern and frequency of HRCT abnormalities at approximately three and six months.

Data were analysed using SPSS version 25. Continuous variables were assessed for normality using the Shapiro-Wilk test. Paired sample t test was used for normally distributed paired data and Wilcoxon signed-rank test for non-normally distributed data. Categorical variables were summarised as numbers and percentages. A p value below 0.05 was considered statistically significant. Patient confidentiality was maintained by coding and anonymising the data. Institutional Ethics Committee approval was obtained before starting the study.

RESULTS

Fifty patients with moderate to severe COVID-19 pneumonia were included. The median follow-up period was 6.5 months. Mean age was 57.5 ± 15.2 years, with 26 (52%) patients below 60 years and 24 (48%) aged 60 years or older. The cohort was predominantly male, with 44 (88%) men and six (12%) women. Severe COVID-19 pneumonia accounted for 43 (86%) cases, while seven (14%) patients had moderate pneumonia. Hypertension and diabetes mellitus were the

most frequent comorbidities, present in 20 (40%) and 18 (36%) patients, respectively. High-flow nasal oxygen was the commonest oxygen delivery modality, required by 21 (42%) patients; eight (16%) patients required ventilatory support through non-invasive ventilation or intubation.

Table 1. Baseline Clinical Profile, Disease Severity, Oxygen Support and Comorbidities of Study Participants

Characteristic	Category	n (%) / value
Sociodemographic profile		
Age group	<30 years	3 (6)
	31-40 years	5 (10)
	41-50 years	7 (14)
	51-60 years	11 (22)
	61-70 years	14 (28)
	71-80 years	7 (14)
	>81 years	3 (6)
	<60 years	26 (52)
	≥60 years	24 (48)
Sex	Male	44 (88)
	Female	6 (12)
Disease severity and oxygen support		
COVID-19 severity	Moderate	7 (14)
	Severe	43 (86)
Oxygen source	HFNO	21 (42)
	NRBM	14 (28)
	Face mask	5 (10)
	NIV	4 (8)
	Intubated	4 (8)
	Nasal prong	2 (4)
Comorbidities		
Comorbidity	Hypertension	20 (40)
	Diabetes mellitus	18 (36)
	Ischaemic heart disease	5 (10)
	Prostate cancer	2 (4)
	Bronchial asthma	2 (4)
	Chronic kidney disease	1 (2)
	Depressive disorder	1 (2)
	Dyslipidaemia	1 (2)
	Fatty liver	1 (2)
	Glaucoma	1 (2)
	Migraine	1 (2)
	Neuromyelitis optica	1 (2)
	Polycythaemia vera	1 (2)
	Hypothyroidism	1 (2)
	Psoriasis	1 (2)
	Subdural haematoma	1 (2)
	Spondylolisthesis	1 (2)
	Allergic bronchitis/tuberculosis	1 (2)

Forty-nine patients had all three pulmonary function assessments; one patient was unable to perform pulmonary function testing at the first follow-up visit. The dominant functional abnormality was diffusion impairment, with a greater fall in DLCO than FVC. Mean FVC increased from 2.25 ± 0.55 L at first follow-up to 2.62 ± 0.56 L at second follow-up and 2.76 ± 0.56 L at third follow-up. Mean FVC percentage predicted increased from 72.5 ± 15.2% to 84.5 ± 13.6% and 88.3 ± 12.4% across the same visits. Mean DLCO improved from 54.1 ± 15.6% at first follow-up to 65.9 ± 16.5% at second follow-up and 70.5 ± 20.1% at third follow-up. Improvements in FVC, FVC percentage predicted and DLCO were statistically significant between serial visits. At the second visit, 67% of patients showed at least 5% improvement in FVC and 62% showed at least 5% improvement in DLCO. Six patients had worsening lung function during follow-up, underlining the need for individualised surveillance despite overall cohort improvement.

Table 2. Serial Pulmonary Function Parameters During Follow-up

Follow-up visit	FVC (L) Mean ± SD Median (min-max) P value*	FVC (% predicted) Mean ± SD Median (min-max) P value*	DLCO (% predicted) Mean ± SD Median (min-max) P value*
First follow-up	n=49 2.25 ± 0.55 2.07 (1.18-3.62) Reference	n=49 72.5 ± 15.2 68.1 (44.4-105.2) Reference	n=49 54.1 ± 15.6 51.4 (22.2-97.5) Reference
Second follow-up	n=50 2.62 ± 0.56 2.54 (1.32-3.76) p=0.001	n=50 84.5 ± 13.6 84.1 (60.9-117.1) p=0.001	n=49 65.9 ± 16.5 62.6 (35.7-102.1) p=0.001
Third follow-up	n=50 2.76 ± 0.56 2.75 (1.48-3.73) p=0.001	n=50 88.3 ± 12.4 89.4 (62.0-118.5) p=0.001	n=50 70.5 ± 20.1 68.5 (47.4-134.9) p=0.003

*P value is in comparison with the previous follow-up value. DLCO: diffusing capacity for carbon monoxide; FVC: forced vital capacity; SD: standard deviation.

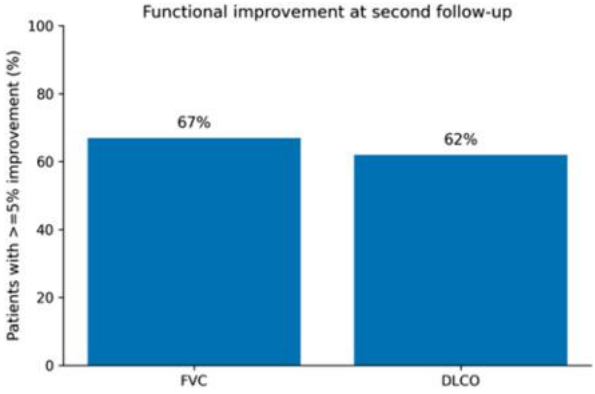

Figure 1. Proportion of Patients with at Least 5% Improvement in FVC and DLCO at Second Follow-up

DLCO: diffusing capacity for carbon monoxide; FVC: forced vital capacity.

Initial CT chest findings were dominated by ground-glass opacity in 47 (94%) patients, subpleural sparing and septal bands in 42 (84%) each, septal thickening and consolidation in 41 (82%) each, mediastinal lymphadenopathy in 26 (52%) and organising pattern in 25 (50%). Follow-up HRCT was available in 38 patients at three months and 48 patients at six months. Fibrotic interlobular/intralobular septal changes decreased from 34/38 (89.5%) at three months to 33/48 (68.8%) at six months; in the paired comparison of 36 patients, this reduction was statistically significant (p=0.031). Architectural distortion and septal bands decreased from 29/38 (76.3%) to 25/48 (52.1%), tractional bronchiectasis from 10/38 (26.3%) to 7/48 (14.6%) and honeycombing from 4/38 (10.5%) to 3/48 (6.3%). Normal HRCT increased from 4/38 (10.5%) to 13/48 (27.1%). Air trapping increased from 24/38 (63.2%) at three months to 39/48 (81.3%) at six months and was significant in the paired comparison (p=0.039).

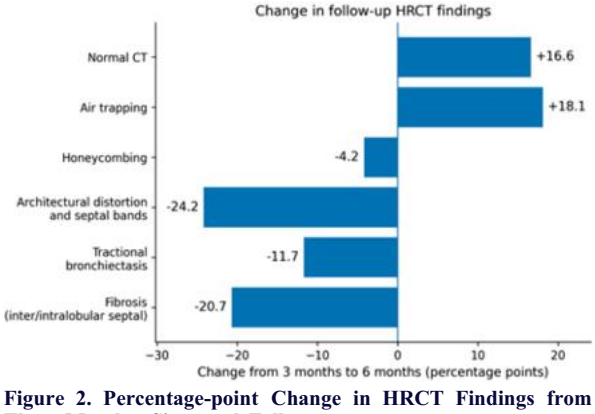

Figure 2. Percentage-point Change in HRCT Findings from Three-Month to Six-month Follow-up

Positive values indicate increased frequency at six months; negative values indicate reduced frequency at six months. HRCT: high-resolution computed tomography.

DISCUSSION

This six-month follow-up study showed a consistent trend towards

pulmonary recovery after moderate to severe COVID-19 pneumonia. The principal functional abnormality was impaired diffusion capacity, while FVC was relatively less affected and improved steadily over time. The largest gains in FVC and DLCO occurred between the first and second follow-up visits, with continued improvement by the third visit. Radiological recovery followed a similar direction, with reduction in fibrotic-appearing septal abnormalities, tractional bronchiectasis, architectural distortion and honeycombing, and an increase in scans reported as normal at six months.

Persistent symptoms and rehabilitation needs have been reported after COVID-19 hospitalisation [8]. In ARDS survivors, pulmonary function impairment has been associated with health-related quality of life, and longer-term ARDS cohorts have shown that residual physiological abnormalities may persist despite overall recovery [9-12]. The present findings are consistent with that broader recovery pattern: residual impairment was present, especially in DLCO, but serial measurements suggested improvement rather than progressive decline. The serial design is important because a single abnormal early post-COVID test may overestimate the burden of fixed disease.

The findings also align with previous viral pneumonia follow-up data. SARS survivors had residual diffusion abnormalities in a minority of patients at six months, while long-term follow-up showed that many radiological lesions decreased substantially after the first year and then remained relatively stable [13,14]. In COVID-19, impaired diffusion capacity has been reported as one of the commonest pulmonary function abnormalities after discharge [15]. Larger follow-up cohorts have also described continued improvement in severe COVID-19 survivors over six to twelve months [16]. A Belgian six-month follow-up study reported ongoing improvement in FVC and DLCO, although some patients retained restrictive defects [17]. Similarly, serial respiratory outcomes after COVID-19 hospitalisation showed that residual abnormalities were common, with DLCO remaining the most frequent abnormality [18]. The present results therefore add supportive data from an Indian tertiary-care cohort in which most patients had severe pneumonia and required substantial oxygen support.

The HRCT findings provide structural support for the functional recovery. Initial CT abnormalities such as ground-glass opacities, consolidation and septal changes are well-recognised features of COVID-19 pneumonia [19]. Follow-up CT studies have demonstrated gradual absorption of lesions during recovery [20]. In this cohort, fibrotic-appearing septal changes and architectural distortion decreased by six months, and established progressive fibrosis was not suggested by the overall pattern. The increase in air trapping requires cautious interpretation, particularly because it occurred alongside improvement in other HRCT findings and pulmonary function parameters. Longer follow-up would be needed to determine whether this represents small-airway sequelae, residual recovery-phase change or a clinically persistent abnormality.

None of the patients received antifibrotic therapy at discharge. The observed improvement without antifibrotics is clinically relevant because the role of antifibrotic treatment in post-COVID interstitial lung disease remains uncertain [21]. These findings support a careful follow-up strategy using symptoms, pulmonary function and HRCT rather than assuming irreversible progressive fibrosis in all patients with residual CT abnormalities. They also help identify the subgroup that may need closer observation, particularly patients with persistent diffusion impairment, worsening physiology or persistent fibrotic-appearing radiological change.

LIMITATIONS

This study has limitations. It was a small single-centre pilot study, and larger multicentre cohorts are required for confirmation. Pre-COVID pulmonary function data were not available; therefore, the exact magnitude of functional decline after infection could not be determined. Health-related quality of life was not assessed using a respiratory-specific questionnaire such as the St George's Respiratory Questionnaire. The study also had relatively few patients at the extreme end of severe disease, including those requiring invasive ventilation, and the findings may not fully apply to patients with pre-existing interstitial lung disease because such patients were excluded. Follow-up was limited to six months, so late persistence or progression of abnormalities could not be evaluated. Despite these limitations, the paired functional and radiological follow-up provides useful information on the early natural course of post-COVID pulmonary recovery.

CONCLUSION

Moderate to severe COVID-19 pneumonia was followed by measurable functional and radiological improvement over six months. Diffusion impairment was the most prominent pulmonary function abnormality, but both DLCO and FVC improved significantly on serial follow-up. HRCT abnormalities also decreased, with significant reduction in fibrotic-appearing septal changes and an increase in normal scans at six months. The findings support structured post-COVID respiratory follow-up and suggest that many residual abnormalities after moderate to severe pneumonia may improve without antifibrotic therapy during the first six months..

Declarations

Ethical Approval: Institutional Ethics Committee approval was obtained for this retrospective observational study.
Conflict of Interest: Nil.
Source of Funding: Nil.
Acknowledgement: Nil.

REFERENCES

1. Yuki K, Fujiogi M, Koutsogiannaki S. COVID-19 pathophysiology: A review. Clinical Immunology. 2020;215:108427.
2. Carfi A, Bernabei R, Landi F; Gemelli Against COVID-19 Post-Acute Care Study Group. Persistent symptoms in patients after acute COVID-19. JAMA. 2020;324(6):603-605.
3. British Thoracic Society Guidance on Respiratory Follow Up of Patients with a Clinico-Radiological Diagnosis of COVID-19 Pneumonia. May 11, 2020. Accessed December 27, 2020.
4. Das KM, Lee EY, Singh R, Enani MA, Al Dossari K, Van Gorkom K, Larsson SG, Langer RD. Follow-up chest radiographic findings in patients with MERS-CoV after recovery. Indian J Radiol Imaging. 2017;27(3):342-349.
5. Liu W, Peng L, Liu H, Hua S. Pulmonary function and clinical manifestations of patients infected with mild influenza A virus subtype H1N1: A one-year follow-up. PLoS. 2015;10(7).
6. Li X, Ma X. Acute respiratory failure in COVID-19: is it typical ARDS? Crit Care. 2020;24(1):198.
7. Pan Y, Guan H, Zhou S, et al. Initial CT findings and temporal changes in patients with novel coronavirus pneumonia (2019-nCoV): A study of 63 patients in Wuhan, China. Eur Radiol. 2020;30:3306-3309.
8. Halpin SJ, McIvor C, Whyatt G, et al. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: A cross-sectional evaluation. J Med Virol. 2021;93(2):1013-1022.
9. Heyland DK, Groll D, Caeser M. Survivors of acute respiratory distress syndrome: Relationship between pulmonary dysfunction and long-term health-related quality of life. Crit Care Med. 2005;33(7):1549-1556.
10. Orme J Jr, Romney JS, Hopkins RO, et al. Pulmonary function and health-related quality of life in survivors of acute respiratory distress syndrome. Am J Respir Crit Care Med. 2003;167(5):690-694.
11. Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. N Engl J Med. 2003;348(8):683-693.
12. Herridge MS, Tansey CM, Matte A, et al. Functional disability 5 years after acute respiratory distress syndrome. N Engl J Med. 2011;364(14):1293-1304.
13. Hui DS, Joynt GM, Wong KT, et al. Impact of severe acute respiratory syndrome (SARS) on pulmonary function, functional capacity and quality of life in a cohort of survivors. Thorax. 2005;60(5):401-409.
14. Zhang P, Li J, Liu H, et al. Long-term consequences in lung and bone associated with hospital-acquired severe acute respiratory syndrome: A 15-year follow-up from a prospective cohort study. Lancet. 2018;392(S11):1-8.
15. Mo X, Jian W, Su Z, et al. Abnormal pulmonary function in COVID-19 patients at time of hospital discharge. Eur Respir J. 2020;55(6):2001217.
16. Huang L, Yao Q, Gu X, et al. 1-year outcomes in hospital survivors with COVID-19: A longitudinal cohort study. Lancet. 2021;398(10302):747-758.
17. Stylemans D, Smet J, Hanon S, et al. Evolution of lung function and chest CT 6 months after COVID-19 pneumonia: Real-life data from a Belgian University Hospital. Respir Med. 2021;182:106421.
18. Wu X, Liu X, Zhou Y, et al. 3-month, 6-month, 9-month, and 12-month respiratory outcomes in patients following COVID-19-related hospitalisation: A prospective study. Lancet Respir Med. 2021;9(7):747-754.
19. Bernheim A, Mei X, Huang M, et al. Chest CT findings in coronavirus disease-19 (COVID-19): Relationship to duration of infection. Radiology. 2020;295:685-691.
20. Han X, Cao Y, Jiang N, et al. Novel coronavirus disease 2019 pneumonia progression course in 17 discharged patients: Comparison of clinical and thin-section computed tomography features during recovery. Clin Infect Dis. 2020;71(15):723-731.
21. George PM, Wells AU, Jenkins RG. Pulmonary fibrosis and COVID-19: The potential role for antifibrotic therapy. Lancet Respir Med. 2020;8:807-815.