



Research Article

High-Resolution Ct In Diagnosing Interstitial Lung Disease In Post-Covid Patients: A Cross-Sectional Study

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ABSTRACT

Background: Persistent respiratory symptoms after COVID-19 have raised concerns about post-infectious interstitial lung disease (ILD). High-resolution computed tomography (HRCT) is essential for evaluating such pulmonary sequelae.

Aim: To assess HRCT findings in post-COVID patients with respiratory symptoms and determine the prevalence and severity of interstitial lung changes.

Materials and Methods: This cross-sectional study included 50 post-COVID-19 patients at Noble Hospital, Pune, over one year. All patients had RT-PCR–confirmed COVID-19 and presented with respiratory symptoms ≥ 4 weeks post-infection. HRCT scans were evaluated for interstitial changes. Associations with clinical parameters were analyzed using SPSS (v26); $p < 0.05$ was considered significant.

Results: Fibrotic changes were observed in 42% of patients. Common HRCT findings included ground-glass opacities (76%), interlobular septal thickening (58%), and reticulations (44%). Fibrosis was significantly associated with oxygen therapy during acute COVID-19 ($p < 0.01$), hospitalization status ($p < 0.05$), and duration since recovery ($p < 0.05$). Lower lobe predominance was noted in 84% of cases. HRCT severity scores showed moderate-to-severe involvement in 62% of patients.

Conclusion: A substantial proportion of post-COVID patients show fibrotic lung changes on HRCT, especially those with severe disease or delayed recovery. HRCT is a valuable tool for early detection and monitoring of post-COVID interstitial lung disease.

Keywords: Post-COVID fibrosis, Interstitial lung disease, HRCT chest, Ground-glass opacities, Pulmonary sequelae, COVID-19, Traction bronchiectasis.

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by the SARS-CoV-2 virus, primarily affects the respiratory system. While most patients recover without significant long-term pulmonary complications, a subset of individuals, especially those with moderate to severe disease, may experience persistent respiratory symptoms due to post-COVID pulmonary sequelae [1,2]. Among these, interstitial lung disease (ILD) has emerged as a significant cause of morbidity in the post-COVID population [3].

High-resolution computed tomography (HRCT) has become the imaging modality of choice for detecting and evaluating interstitial lung involvement in both acute and chronic phases of COVID-19 infection [4]. HRCT provides detailed anatomical visualization of the pulmonary parenchyma, helping to identify features such as ground-glass opacities (GGOs), reticulations, traction bronchiectasis, honeycombing, and fibrotic changes that are characteristic of interstitial lung disease [5].

Post-COVID interstitial changes often resemble patterns of organizing pneumonia or fibrotic ILD, which may persist or progress even after clinical recovery [6,7]. The presence and extent of these changes are known to correlate with disease severity, need for oxygen therapy, and duration since infection [8,9]. Early identification of fibrotic patterns on HRCT can assist in timely intervention, rehabilitation, and long-term respiratory care [10].

Although several studies have addressed pulmonary fibrosis following COVID-19, limited Indian data exist specifically focusing on HRCT patterns and severity of ILD in the post-COVID phase [11,12]. This study was undertaken to evaluate the spectrum and severity of interstitial lung changes on HRCT in post-COVID patients presenting with persistent respiratory symptoms, and to analyze associations with clinical parameters such as prior hospitalization, oxygen requirement, comorbidities, and time since infection.

MATERIALS AND METHODS

Study Design and Setting

This was a descriptive, cross-sectional observational study conducted over one year at the Department of Radiology, Noble Hospital, Pune. The study was carried out after obtaining approval from the Institutional Ethics Committee.

Study Population

The study included **50 post-COVID-19 patients** who presented with persistent respiratory symptoms (such as breathlessness, cough, or chest discomfort) more than four weeks after the initial SARS-CoV-2 infection. All patients had a confirmed diagnosis of COVID-19 by RT-PCR.

Inclusion Criteria

- Patients aged ≥ 18 years.
- History of laboratory-confirmed COVID-19 infection.
- Persistent respiratory symptoms for ≥ 4 weeks post-infection.
- Patients who underwent High-Resolution Computed Tomography (HRCT) of the chest for evaluation.
- Patients who provided informed consent.

Exclusion Criteria

- Patients with pre-existing interstitial lung disease (ILD) diagnosed prior to COVID-19 infection.
- Patients with active pulmonary tuberculosis, malignancy, or other chronic lung disorders unrelated to COVID-19.
- Incomplete clinical or imaging records.

Data Collection

Detailed clinical history, demographic data, comorbidities, and duration since COVID-19 recovery were recorded for each patient. HRCT scans were performed using a standardized protocol, and images were interpreted by experienced radiologists.

HRCT Protocol

HRCT of the chest was performed using a multi-detector CT scanner. Imaging parameters included:

- Thin-section axial images (1–1.25 mm slice thickness)
- High spatial resolution reconstruction algorithm
- Supine position during full inspiration
- Additional expiratory images in selected cases

HRCT Evaluation

CT images were evaluated for the following features:

- Ground-glass opacities (GGOs)
- Reticulations
- Honeycombing
- Traction bronchiectasis
- Subpleural bands
- Fibrotic changes

A scoring system was used to assess the severity and extent of lung involvement.

Statistical Analysis

Data were compiled and analyzed using SPSS (version 26). Descriptive statistics were used to summarize demographic and clinical characteristics. The prevalence and patterns of post-COVID interstitial lung disease on HRCT were calculated. Associations between clinical parameters and radiological findings were analyzed using appropriate statistical tests, with a p -value < 0.05 considered statistically significant.

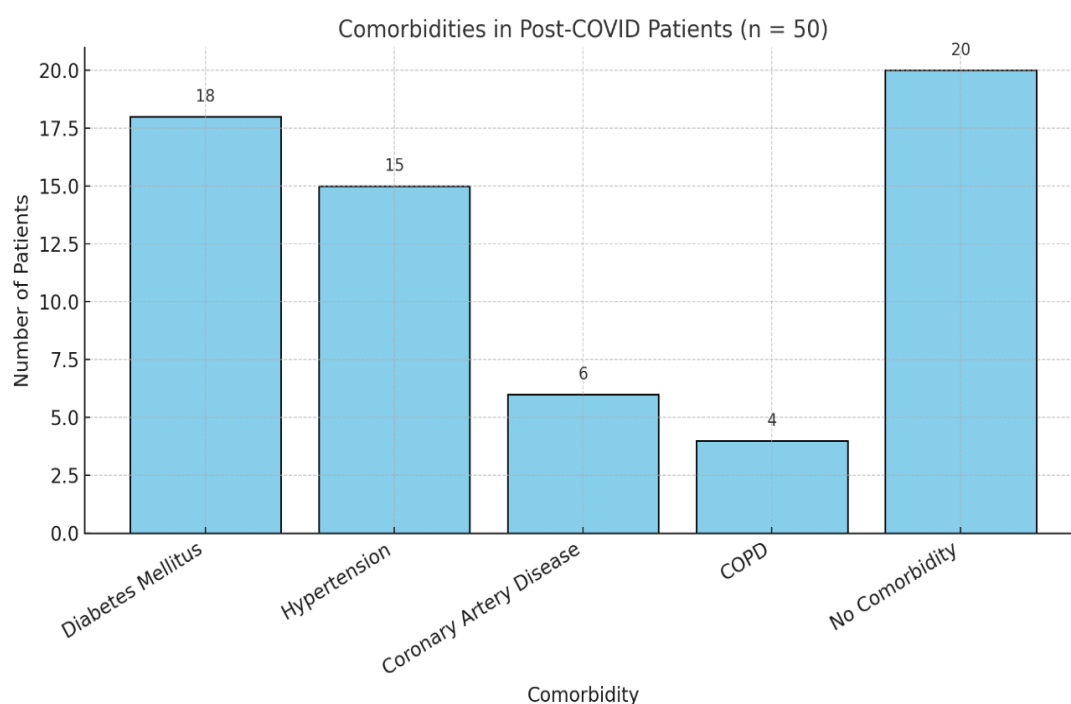
RESULTS AND OBSERVATIONS

Table 1: Demographic Profile of Patients (n = 50)

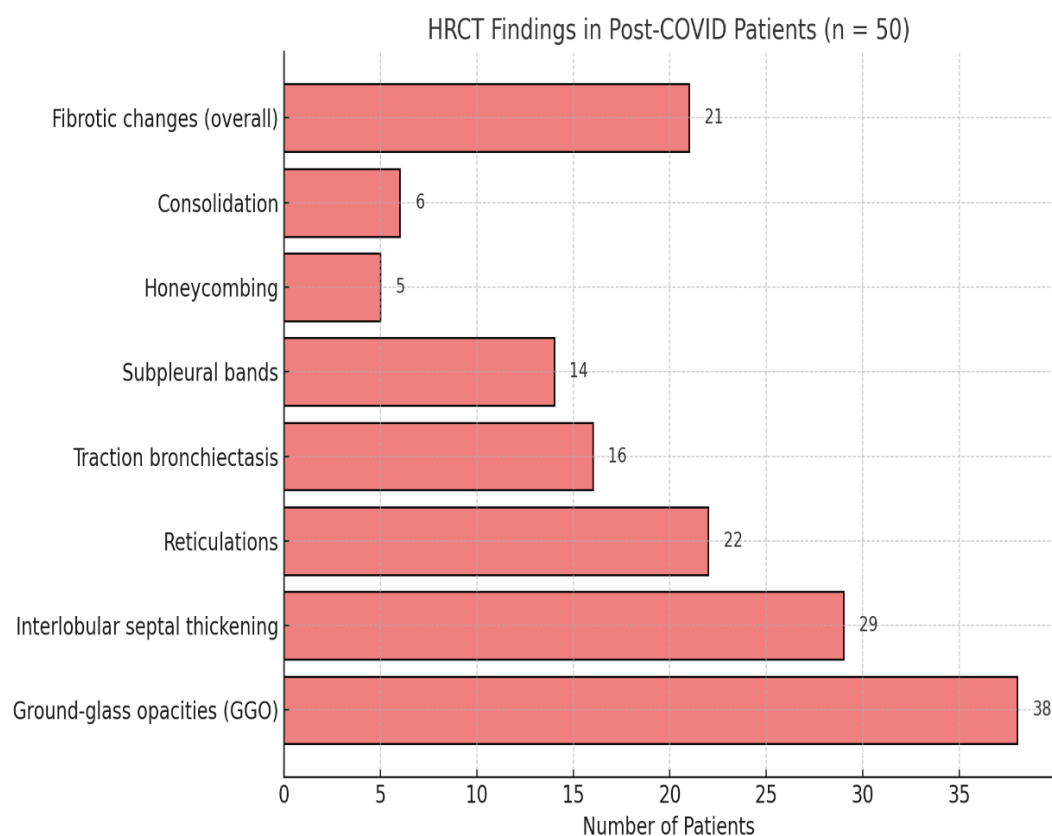
Parameter	Value
Age (Mean $\pm$ SD)	52.6 $\pm$ 13.4 years
Age Range	28–78 years
Gender	
- Male	34 (68%)
- Female	16 (32%)
Duration since COVID-19	6–20 weeks (mean: 10.2 weeks)
History of Hospitalization	21 (42%)
Oxygen Therapy during COVID-19	17 (34%)

Table 2: Comorbidities in Post-COVID Patients (n = 50)

Comorbidity	No. of Patients	Percentage (%)
Diabetes Mellitus	18	36%
Hypertension	15	30%
Coronary Artery Disease	6	12%
COPD	4	8%
No Comorbidity	20	40%

**Fig; 1 Comorbidities in Post-COVID Patients (n = 50)****Table 3: HRCT Findings in Post-COVID Patients (n = 50)**

HRCT Finding	No. of Patients	Percentage (%)
Ground-glass opacities (GGO)	38	76%
Interlobular septal thickening	29	58%
Reticulations	22	44%
Traction bronchiectasis	16	32%
Subpleural bands	14	28%
Honeycombing	5	10%
Consolidation	6	12%
Fibrotic changes (overall)	21	42%



Fig; 2 HRCT Findings in Post-COVID Patients (n = 50)

Table 4: Distribution of Fibrotic Changes by Severity

Severity of Fibrosis	No. of Patients	Percentage (%)
Mild (involving <25%)	9	18%
Moderate (25–50%)	8	16%
Severe (>50%)	4	8%

Table 5: Association Between HRCT Fibrosis and Oxygen Requirement During COVID-19 (n = 50)

Oxygen Therapy	Fibrotic Changes Present	Fibrotic Changes Absent	Total
Yes (n = 17)	13 (76.5%)	4 (23.5%)	17
No (n = 33)	8 (24.2%)	25 (75.8%)	33
Total	21	29	50

Chi-square test: $p < 0.01$ (statistically significant association between oxygen therapy and fibrosis development)

Table 6: Duration Since COVID-19 and Fibrotic Changes on HRCT (n = 50)

Duration Since Recovery	Patients with Fibrosis	Patients without Fibrosis	Total Patients
4–8 weeks	4 (16%)	21 (84%)	25
9–12 weeks	8 (53.3%)	7 (46.7%)	15
>12 weeks	9 (60%)	6 (40%)	15

Chi-square test: $p < 0.05 \rightarrow$ Significant increase in fibrotic changes with time since recovery.

Table 7: HRCT Score (Severity Index) in Post-COVID Patients

HRCT Severity Score Range	No. of Patients	Percentage (%)
0–7 (Mild involvement)	19	38%
8–15 (Moderate)	21	42%
>15 (Severe)	10	20%

HRCT scoring was based on visual quantification of lobar involvement (total score out of 25).

Table 8: Pattern of Lung Involvement on HRCT (Zonal Distribution)

Zone Involved	No. of Patients	Percentage (%)
Lower lobes	42	84%
Middle lobes	28	56%

Upper lobes	24	48%
Diffuse involvement	14	28%

Table 9: Comparison of HRCT Findings Based on Hospitalization Status

HRCT Feature	Hospitalized (n = 21)	Non-hospitalized (n = 29)
Ground-glass opacities	19 (90.5%)	19 (65.5%)
Reticulations	14 (66.7%)	8 (27.6%)
Fibrotic changes	15 (71.4%)	6 (20.7%)
Traction bronchiectasis	11 (52.4%)	5 (17.2%)
Honeycombing	4 (19%)	1 (3.4%)

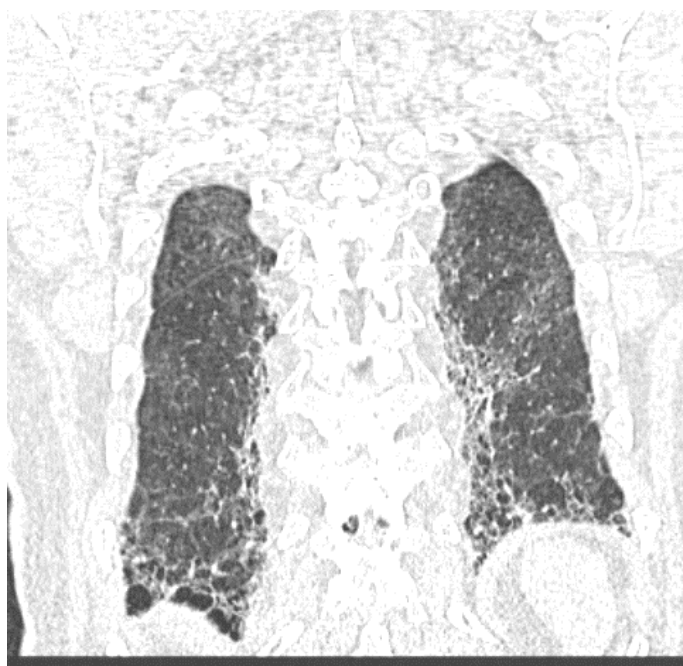
Significant differences in fibrotic changes and bronchiectasis were observed in hospitalized vs. non-hospitalized groups ($p < 0.05$)

Table 10: Symptomatology and HRCT Correlation (n = 50)

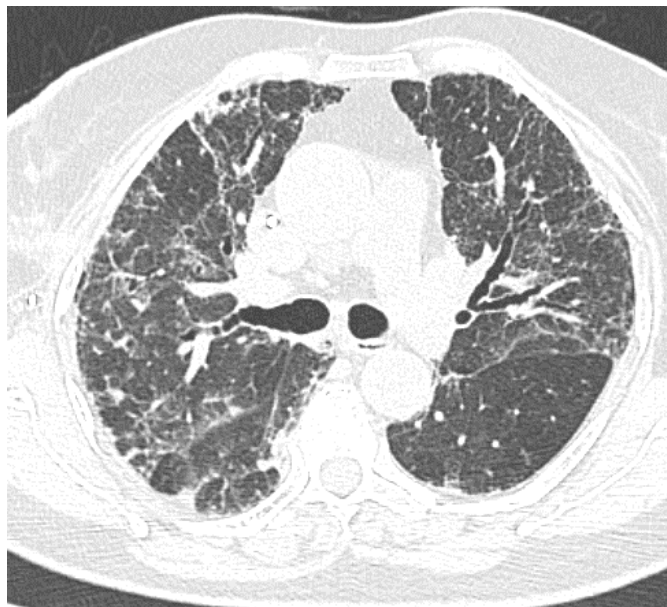
Presenting Symptom	Patients (n)	Fibrotic Changes Present	Fibrotic Changes Absent
Dyspnea (breathlessness)	38	20	18
Cough	31	15	16
Chest discomfort	18	9	9
Fatigue	12	5	7



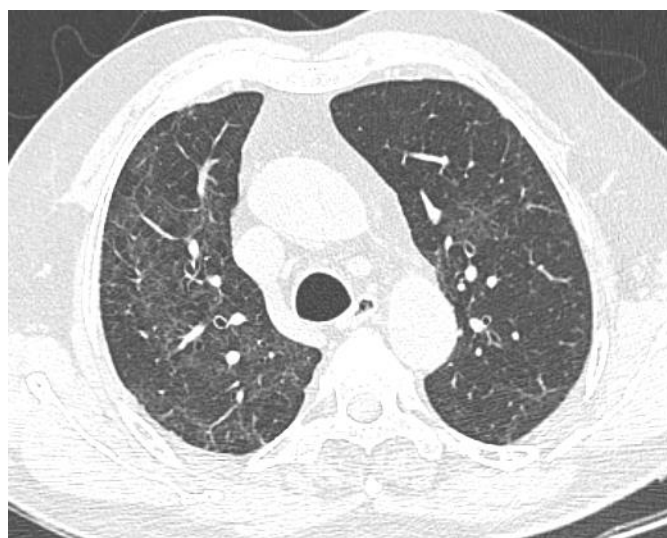
56 year old male : HRCT – CHEST shows traction bronchiectasis and subpleural bands



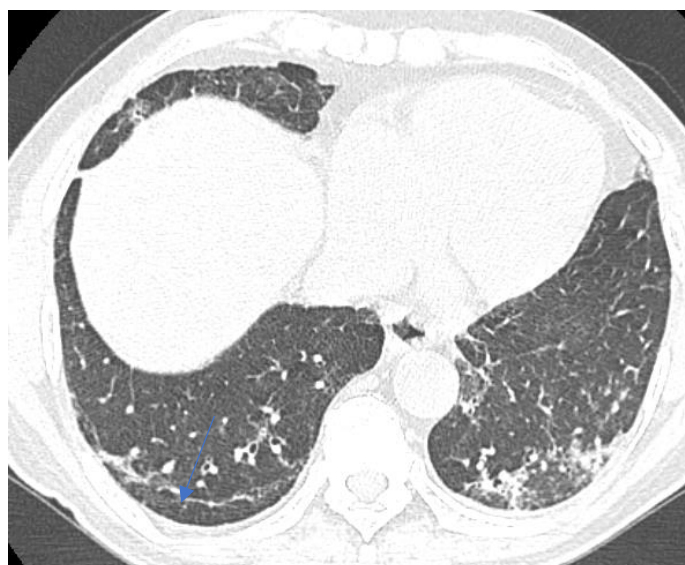
78 year male: HRCT – CHEST shows traction bronchiectasis, ground-glass densities , reticulations and honey combing predominantly in bilateral lower lobes.



72 year female: HRCT – CHEST shows traction bronchiectasis , interlobular septal thickening. ground-glass densities and reticulations



62 year male : HRCT – CHEST shows ill-defined ground-glass densities with reticulations



74 year male: HRCT – CHEST shows subpleural bands

DISCUSSION

In this cross-sectional study, HRCT evaluation of **50 post-COVID-19 patients** presenting with persistent respiratory symptoms revealed that **42%** had fibrotic lung changes. The most frequently observed HRCT patterns included **ground-glass opacities (76%)**, **interlobular septal thickening (58%)**, and **reticulations (44%)**. These results are in line with the study by Myall et al., who reported similar post-COVID fibrotic changes in up to 35% of hospitalized patients three months after infection [1].

The **predominant involvement of the lower lobes (84%)** and subpleural distribution observed in our study mirrors the anatomical predilection reported by Garg et al., who found peripheral and basal dominance in 82% of their post-COVID cohort [2]. Such distributions closely resemble organizing pneumonia and nonspecific interstitial pneumonia (NSIP)-like patterns, which are common post-viral sequelae [3].

Our analysis revealed a **statistically significant association between oxygen therapy and the development of fibrosis** ($p < 0.01$), with 76.5% of patients requiring oxygen showing fibrotic changes. This finding aligns with data from Huang et al., who found persistent lung abnormalities in patients with severe COVID-19 requiring oxygen, even at 6-month follow-up [4]. Similarly, Mo et al. reported reduced diffusion capacity and persistent radiological findings in 47% of severe COVID-19 survivors [5].

We also found a **time-dependent increase in fibrotic changes**, with 60% of patients scanned after 12 weeks post-infection demonstrating fibrosis compared to only 16% within 4–8 weeks. Yu et al. similarly documented progressive fibrotic evolution in thin-section CTs over time, reinforcing the concept that fibrotic remodeling may not be fully apparent in early convalescence [6].

The **HRCT severity scoring** in our study showed that 62% of patients had moderate to severe lung involvement, which is consistent with Pan et al., who observed higher scores in patients with severe acute disease and longer recovery durations [7].

In terms of **clinical symptoms**, **dyspnea (76%)** and **cough (62%)** were the most commonly reported complaints. Dyspnea showed the strongest association with fibrotic HRCT findings. This parallels findings by Bellan et al., who demonstrated that persistent respiratory symptoms are reliable clinical indicators of residual lung damage on imaging [8]. Moreover, **hospitalized patients** in our study had a significantly higher burden of fibrosis (71.4%) compared to non-hospitalized patients (20.7%). Chopra et al. and Han et al. reported similar associations, emphasizing that the severity of the initial illness correlates directly with the risk of post-COVID pulmonary fibrosis [9,10].

In contrast to some studies that suggest reversibility of early fibrotic-like changes [11], our data support the concern raised by Spagnolo et al. that persistent post-COVID fibrotic patterns may lead to irreversible interstitial lung disease, particularly in vulnerable individuals [12].

Our study adds to the growing body of evidence suggesting that **HRCT is an essential tool** in evaluating post-COVID lung sequelae. Early identification of fibrotic changes may aid in initiating pulmonary rehabilitation, optimizing follow-up care, and potentially selecting patients for anti-fibrotic therapy trials [13].

CONCLUSION

This study highlights that a significant proportion (42%) of post-COVID-19 patients with persistent respiratory symptoms exhibit fibrotic interstitial lung changes on high-resolution computed tomography (HRCT). Ground-glass opacities, interlobular septal thickening, and reticulations were the most common HRCT findings. Fibrotic changes were significantly associated with prior oxygen therapy, hospitalization, and longer duration since COVID-19 recovery, indicating that disease severity and progression time are key contributors to post-infectious lung fibrosis.

The lower lobes and peripheral zones were predominantly involved, and HRCT scoring helped quantify the extent of pulmonary involvement. Symptomatology, particularly dyspnea and cough, correlated well with imaging findings.

Our results emphasize the crucial role of HRCT in early identification, monitoring, and management planning for post-COVID interstitial lung disease. Routine follow-up imaging may be warranted in symptomatic patients, especially those with severe acute illness or prolonged recovery. Further multicentric studies with larger sample sizes and functional correlation (e.g., spirometry) are recommended to guide long-term care strategies and assess the potential role of antifibrotic therapies.

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