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Review Article

Imaging Patterns in Post-COVID Lung Fibrosis: A Mini Review

[1]Pervez Alam*

[1]Department of Radiology and Imaging Technology, Santosh University, Ghaziabad (UP), India

ABSTRACT

Background: Pulmonary complications following COVID-19, particularly lung fibrosis, have become an important clinical concern due to persistent symptoms and long-term respiratory impairment. Imaging plays a key role in identifying and monitoring these changes.

Objective: To review imaging patterns in post-COVID lung fibrosis based on literature published between 2020 and 2026.

Methods: A structured narrative review of 25 peer-reviewed studies was conducted using databases such as PubMed, Scopus, and Google Scholar. Studies focusing on high-resolution computed tomography (HRCT) findings in post-COVID patients were included.

Results: Ground-glass opacities were the most common early finding, often with bilateral peripheral distribution. Progressive changes included reticulation, traction bronchiectasis, and architectural distortion, suggesting fibrosis. Imaging patterns were categorized as organizing pneumonia-like, nonspecific interstitial pneumonia-like, and usual interstitial pneumonia-like. Reversible patterns were seen in mild cases, while severe cases showed persistent fibrotic changes. A strong association was observed between disease severity and extent of fibrosis.

Conclusion: Post-COVID lung fibrosis demonstrates varied imaging patterns ranging from reversible inflammation to irreversible fibrosis. HRCT remains essential for diagnosis and follow-up, and long-term monitoring is necessary for effective management.

Keywords: COVID-19, Post-COVID fibrosis, HRCT

***Corresponding Author**: Pervez Alam, Department of Radiology and Imaging Technology, Santosh University, India

Email: mdpervez988@gmail.com

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Introduction

The global outbreak of COVID-19 has imposed a substantial burden on healthcare systems and has resulted in a wide range of acute as well as chronic pulmonary complications. The disease is caused by SARS-CoV-2 and primarily targets the respiratory system, producing clinical manifestations that vary from mild respiratory symptoms to severe pneumonia and acute respiratory distress syndrome (ARDS). [1] In addition to the acute phase, increasing attention has been directed toward the long-term consequences of the infection, particularly among patients who required hospitalization or intensive care management. [2] One of the most concerning long-term outcomes is the development of post-COVID lung fibrosis, which can significantly affect pulmonary function and overall quality of life. [3] Post-COVID lung fibrosis is characterized by persistent and often irreversible fibrotic alterations within the lung parenchyma following recovery from the initial infection. [4] The underlying mechanisms are multifactorial and involve an exaggerated inflammatory response, cytokine-mediated injury, and impaired tissue repair processes leading to abnormal deposition of fibrous tissue. [5] These pathological processes share similarities with other interstitial lung diseases but are specifically triggered

by viral-induced lung injury associated with COVID-19. [6] The likelihood of developing fibrotic changes is higher in patients with severe disease, prolonged mechanical ventilation, and associated comorbid conditions such as diabetes mellitus and cardiovascular disorders. [7]

Imaging plays a critical role in the identification and evaluation of post-COVID pulmonary fibrosis. High-resolution computed tomography (HRCT) is regarded as the most sensitive modality for detecting subtle parenchymal abnormalities and assessing disease progression [8] During the acute phase of infection, imaging commonly demonstrates bilateral ground-glass opacities and consolidations, typically with a peripheral and basal predominance. [9] As the disease evolves, these findings may transition into features suggestive of fibrosis, including reticular opacities, traction bronchiectasis, and distortion of normal lung architecture [10] Accurate recognition of imaging patterns is essential to differentiate between reversible inflammatory changes and irreversible fibrotic damage. [11] Certain patterns, such as organizing pneumonia or nonspecific interstitial pneumonia (NSIP), may show partial or complete resolution with appropriate treatment [12] In contrast, the presence of honeycombing and persistent reticulation is indicative of established fibrosis and is often associated with a poorer prognosis. [13] Follow-up imaging studies have demonstrated that some patients continue to exhibit progressive fibrotic changes for several months after recovery from the acute illness [14] A comprehensive understanding of the imaging spectrum associated with post-COVID lung fibrosis is crucial for early diagnosis, risk stratification, and clinical management. [15] Imaging findings, when correlated with clinical presentation and pulmonary function tests, provide valuable insights into disease severity and progression. [16] With the growing number of COVID-19 survivors worldwide, the long-term burden of pulmonary complications is expected to rise [17] Therefore, imaging remains a cornerstone in the evaluation and follow-up of these patients. [18] Continued research is essential to better define the natural history of post-COVID lung fibrosis and to establish effective therapeutic strategies [19] This will ultimately contribute to improved patient outcomes and long-term respiratory health [20]

METHODS AND MATERIALS

Study Design: This study was conducted as a structured narrative review aimed at analyzing imaging patterns in post-COVID lung fibrosis following COVID-19. The review focused on synthesizing available evidence from published literature to provide a comprehensive understanding of radiological findings associated with long-term pulmonary sequelae.

Literature Search Strategy: A systematic literature search was performed to identify relevant studies published between 2020 and 2026. Electronic databases including PubMed, Scopus, Web of Science, and Google Scholar were searched using predefined keywords such as “post-COVID fibrosis,” “lung fibrosis after COVID-19,” “HRCT findings in COVID-19,” and “interstitial lung disease post COVID.” Boolean operators (AND, OR) were used to refine the search. Only articles published in English were considered.

Study Selection Criteria: A total of 25 articles were included in the final review based on predefined inclusion and exclusion criteria. Inclusion criteria comprised original research articles, review articles, and observational studies that specifically evaluated imaging findings in post-COVID lung fibrosis using high-resolution computed tomography (HRCT). Studies involving adult populations and reporting follow-up imaging findings were prioritized. Exclusion criteria included studies with inadequate imaging data, case reports with limited generalizability, duplicate publications, and studies focusing solely on acute COVID-19 without follow-up assessment. Articles related to pre-existing interstitial lung diseases unrelated to COVID-19 were also excluded to maintain specificity.

Data Extraction: Relevant data were extracted from the selected studies using a standardized approach. Extracted variables included author details, year of publication, study design, sample size, patient demographics, severity of initial infection, imaging modality used, and key radiological findings. Special emphasis was placed on HRCT features such as ground-glass opacities, reticulation, traction bronchiectasis, honeycombing, and architectural distortion.

Data Synthesis and Analysis: The selected studies were analyzed qualitatively to identify common imaging patterns and trends in post-COVID lung fibrosis. Findings were grouped into categories based on radiological patterns, including organizing pneumonia-like changes, nonspecific interstitial pneumonia (NSIP)-like patterns, and fibrotic changes resembling usual interstitial pneumonia (UIP). A comparative analysis was performed to evaluate the relationship between disease severity and the extent of fibrotic changes. Temporal progression of imaging findings, as reported across studies, was also reviewed to differentiate reversible inflammatory

changes from permanent fibrosis.

Quality Assessment: The methodological quality of the included studies was assessed based on study design, sample size, clarity of imaging findings, and consistency of reported outcomes. Studies with higher methodological rigor and clear imaging descriptions were given greater emphasis in the synthesis.

Outcome Measures: The primary outcome of this review was to identify and summarize the predominant imaging patterns observed in post-COVID lung fibrosis. Secondary outcomes included assessment of disease progression, correlation with clinical severity, and identification of factors associated with persistent fibrotic changes.

RESULTS

A total of 25 studies published between 2020 and 2026 were included in this review, all focusing on imaging findings in patients with post-infectious pulmonary sequelae following COVID-19. The majority of studies were retrospective observational in design, with a smaller proportion comprising prospective cohorts and systematic analyses. Sample sizes varied across studies, ranging from small cohorts to large multicenter populations. Most studies included adult patients who had recovered from moderate to severe COVID-19 infection and underwent follow-up imaging using high-resolution computed tomography (HRCT). The duration of follow-up ranged from 1 month to over 12 months post-recovery. Across the included studies, ground-glass opacities (GGOs) were the most frequently reported imaging finding during early follow-up. These were often bilateral, peripheral, and predominantly involved the lower lobes. In many cases, GGOs were associated with reticular interstitial thickening, indicating evolving interstitial involvement. As the disease progressed, these findings frequently transitioned into more definitive fibrotic changes. Reticulation and interlobular septal thickening were consistently reported in a significant proportion of patients, suggesting early fibrotic remodeling. Additionally, traction bronchiectasis was observed in moderate to severe cases, reflecting distortion of bronchial architecture due to surrounding fibrosis. Architectural distortion and subpleural bands were also commonly described, particularly in patients with prolonged illness or intensive care unit (ICU) admission.

Fibrotic Patterns and Classification: The imaging patterns identified across studies were broadly categorized into three major types. The first was an organizing pneumonia (OP)-like pattern, characterized by patchy consolidations and peripheral GGOs, which demonstrated partial or complete resolution in several cases. The second pattern resembled nonspecific interstitial pneumonia (NSIP), showing diffuse GGOs with fine reticulation and relatively preserved lung architecture. This pattern was associated with a more favorable prognosis. The third and less common pattern resembled usual interstitial pneumonia (UIP), characterized by honeycombing, basal predominance, and significant architectural distortion. This pattern was indicative of advanced and often irreversible fibrosis. However, true UIP-like changes were reported in a smaller subset of patients compared to OP and NSIP patterns.

Temporal Evolution of Imaging Findings: Longitudinal imaging data from the included studies demonstrated a dynamic evolution of lung abnormalities. In the early post-recovery phase (within 1–3 months), inflammatory changes such as GGOs and consolidations were predominant. Between 3 and 6 months, there was either gradual resolution or progression to fibrotic features such as reticulation and traction bronchiectasis. Beyond 6 months, persistent abnormalities particularly fibrotic bands and bronchiectatic changes were considered indicative of irreversible lung damage. Several studies reported partial resolution of imaging findings over time, especially in patients with milder disease. However, a subset of patients, particularly those with severe initial infection or prolonged mechanical ventilation, exhibited progressive fibrotic changes even at long-term follow-up. The majority of studies consistently reported a peripheral and posterior distribution of lung abnormalities, with a predilection for the lower lobes. Diffuse involvement was more commonly associated with severe disease. Subpleural regions were particularly affected, correlating with the development of fibrotic bands and architectural distortion. A strong correlation was observed between the severity of the initial infection and the extent of fibrotic changes on imaging. Patients who required intensive care support, mechanical ventilation, or had prolonged hospital stays were more likely to develop significant fibrosis. In contrast, patients with mild disease generally demonstrated near-complete radiological resolution.

DISCUSSION

The present review highlights the diverse spectrum of imaging manifestations associated with post-infectious pulmonary sequelae following COVID-19. Analysis of 25 studies published between 2020 and

2026 demonstrates that post-COVID lung fibrosis is not a uniform entity but rather a continuum ranging from reversible inflammatory changes to irreversible fibrotic remodeling. High-resolution computed tomography (HRCT) has consistently emerged as the most sensitive modality for detecting and characterizing these changes, making it indispensable in follow-up evaluation. One of the key observations across the included studies is the predominance of ground-glass opacities (GGOs) in the early recovery phase, often accompanied by interstitial thickening. These findings likely represent residual inflammation or incomplete resolution of acute lung injury. Over time, a subset of patients shows progression to fibrotic features such as reticulation, traction bronchiectasis, and architectural distortion. This progression reflects abnormal wound healing and fibroproliferative response triggered by viral-induced lung damage. [21-23]

The classification of imaging patterns into organizing pneumonia (OP)-like, nonspecific interstitial pneumonia (NSIP)-like, and usual interstitial pneumonia (UIP)-like patterns provides valuable clinical insight. OP-like patterns are frequently associated with partial or complete reversibility, suggesting that early intervention may improve outcomes. NSIP-like patterns also tend to have a relatively favorable prognosis with less architectural distortion. In contrast, UIP-like features, including honeycombing and basal predominance, indicate advanced fibrosis and are associated with poor functional recovery. However, true UIP patterns appear to be relatively uncommon in post-COVID patients compared to other interstitial lung diseases. Another important finding is the strong correlation between disease severity and the likelihood of developing fibrosis. Patients with severe COVID-19, prolonged intensive care unit stays, and mechanical ventilation are at significantly higher risk. This association underscores the role of factors such as ventilator-induced lung injury, cytokine storm, and prolonged hypoxia in promoting fibrotic changes. Additionally, comorbid conditions such as diabetes and cardiovascular disease may further exacerbate the risk. Temporal evaluation across studies indicates that while many patients show gradual radiological improvement within 3–6 months, a subset continues to demonstrate persistent abnormalities beyond 6–12 months. This raises concerns regarding long-term pulmonary disability and highlights the need for structured follow-up protocols. Importantly, differentiation between reversible and irreversible changes remains a critical challenge and requires careful interpretation of serial imaging. Despite these insights, the review has certain limitations. The heterogeneity in study design, sample size, imaging protocols, and follow-up duration across the included studies may affect the generalizability of findings. Additionally, most studies are observational in nature, limiting the ability to establish causality. Variability in reporting imaging findings also poses challenges in standardizing interpretation. [24, 25]

CONCLUSION

Post-COVID lung fibrosis represents a significant long-term complication of COVID-19, with imaging playing a central role in its detection and management. The findings of this review demonstrate that HRCT reveals a wide spectrum of patterns, ranging from ground-glass opacities and organizing pneumonia-like changes to established fibrosis characterized by traction bronchiectasis and honeycombing. The progression and severity of fibrotic changes are closely associated with the initial severity of infection, emphasizing the importance of early identification and monitoring of high-risk patients. While many imaging abnormalities may resolve over time, persistent fibrotic changes in a subset of patients can lead to long-term respiratory impairment. Therefore, regular imaging follow-up, combined with clinical and functional assessment, is essential for optimal patient management. Future large-scale, longitudinal studies are needed to better understand the natural history, risk factors, and therapeutic strategies for post-COVID lung fibrosis. Such efforts will be crucial in reducing the long-term burden of pulmonary complications and improving patient outcomes.

DECLARATION

Ethics Approval and Consent: This study is based on a review of previously published literature related to COVID-19; therefore, approval from the Institutional Ethics Committee was not required, and informed consent was not applicable.

Availability of Data and Materials: All data analyzed during this study were obtained from publicly available, peer-reviewed publications. Additional information can be made available by the corresponding author upon reasonable request.

Conflict of Interests: The authors declare that there are no competing interests associated with this study.

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Authors' Contributions: All authors contributed significantly to the study conception, design, literature review, data analysis, and manuscript

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