

CT EVALUATION OF DIFFUSE LUNG DISEASE WITH RADIOGRAPHIC CORRELATION

Rajeev Ranjan¹, Mihir Kumar Jha²

Received : 01/03/2026
 Received in revised form : 22/03/2025
 Accepted : 06/04/2025

Keywords:
 CT Evaluation, Diffuse Lung Disease.

Corresponding Author:
Dr. Mihir Kumar Jha,
 Email: dr_mihir_online@yahoo.co.in

DOI: 10.47009/jamp.2026.8.5.71

Source of Support: Nil,
 Conflict of Interest: None declared

Int J Acad Med Pharm
 2026; 8 (5); 460-464



¹Assistant Professor, Department of Radiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospitals, Durgapur, West Bengal, India.

²Professor, Department of Radiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospitals, Durgapur, West Bengal, India.

ABSTRACT

Background: High Resolution CT is currently the most accurate non invasive modality for evaluating the lung parenchyma. HRCT uses various technical factors which can increase the spatial resolution and they include narrow collimation, reconstruction using a high spatial frequency algorithm and targeting the image to a small field of view.

Materials and Methods: This Cross-sectional Observational study was conducted in the Department of Radiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospitals, Durgapur, West Bengal from January 2024 to December 2024. Approval from hospital and Institutional Ethical Committee was obtained prior to initiation of the study. Adult patients of either sex of age group 18 and above showing reticular opacities on chest X-ray and those patients who were incidentally diagnosed as cases of diffuse lung diseases on HRCT chest were included in our study. HRCT Chest was performed on Philips Brilliance 40 slice CT. A written informed consent was taken from all the patients. **Result:** The mean age of patients in our study was 44.2 years with the range of 21 to 72 years. There was a female preponderance in our study (~70% of the total cases). Only two patients had dyspnoea as an isolated symptom. In the rest, dry cough was the predominant associated symptom. On HRCT scans, the predominant features observed were intra and interlobular septal thickening (92% cases) in a reticular pattern throughout the lung fields. Thickening of the interstitial network of the lung by fluid, fibrous tissue or cells primarily results in this appearance. **Conclusion:** HRCT has been proposed as a technique for determining the activity of IPF. The CT finding of ground glass opacity refers to the presence of a diffuse homogenous increase in density of the lung.

INTRODUCTION

Diffuse lung diseases describe a heterogeneous group of disorders of the lower respiratory tract characterized by inflammation and derangement of the interstitium and loss of functional alveolar units. The disease is not restricted to the interstitium only, as it involves epithelial, endothelial and mesenchymal cells with the disease process extending into the alveoli, acini and bronchioles. Thus, the entire pulmonary parenchyma is involved.^[1]

The disorders in this heterogeneous group are classified together because of similar clinical, roentgenographic, physiologic, or pathologic manifestations. These disorders often are associated with considerable rates of morbidity and mortality. Diffuse lung diseases comprise over 200 entities of known and unknown causes, with or without associated systemic diseases, of acute or chronic

onset, of indolent or rapidly progressive course and wide variations in treatment response.^[2]

Classification

American Thoracic Society/European Respiratory Society classified these disorders into 4 broad categories: 1

- Diffuse lung diseases of known causes
- Idiopathic interstitial pneumonia
- Granulomatous diseases
- Rare forms of diffuse lung disease

Diffuse lung diseases of known causes

Drugs

- Chemotherapeutic- Bleomycin, Methotrexate
- Cardiovascular- Amiodarone
- Antibiotics- Nitrofurantoin, Sulphasalazine
- Anti-inflammatory- Gold, Penicillamine
- Illicit drugs- Heroin, Methadone
- Miscellaneous- Oxygen, Radiation

Systemic diseases

- a. Connective tissue disorders
 - Systemic Sclerosis
 - Sjogren's syndrome
 - Systemic Lupus Erythematosus
 - Ankylosing Spondylitis
 - Rheumatoid Arthritis
- b. Vasculitis
 - Wegener's granulomatosis
 - Good pasture's syndrome
 - Microscopic polyangitis
- c. Inherited disorders
 - Tuberous Sclerosis
 - Neurofibromatosis
 - Lipid storage disorders
 - Hermansky-Pudlak syndrome

Occupational/ environmental exposure

- a. Inorganic dusts
 - Fibrogenic- Asbestosis, Silicosis
 - Non-fibrogenic- Siderosis (Iron), Stannosis (Tan)
 - Granulomatous-Berylliosis
- b. Organic dusts
 - Bacteria- Farmer's lung (thermoactinomyces in mouldy hay)
 - Bagassosis- (thermoactinomyces in mouldy sugarcane)
 - Fungi- Suberosis (in cork workers), Cheese workers' lung (mouldy cheese)
 - Animal protein- Bird fanciers' lung (avian protein on feathers)

Idiopathic interstitial pneumonia

- Usual interstitial pneumonia
- Non-specific interstitial pneumonia
- Desquamative interstitial pneumonia
- Acute interstitial pneumonia
- Respiratory bronchiolitis- interstitial lung disease
- Cryptogenic organizing pneumonia
- Lymphocytic interstitial pneumonia

Granulomatous diseases

- Sarcoidosis
- Wegener's granulomatosis
- Churg Strauss syndrome
- Extrinsic allergic alveolitis Rare forms of diffuse lung diseases
- Lymphangiomyomatosis
- Langerhans cell histiocytosis
- Alveolar proteinosis
- Eosinophilic pneumonia

Though the etiology may vary vastly, yet the clinical signs and symptoms may differ little from one condition to another. The majority of patients present typically with progressive or unremitting dyspnoea and dry unproductive cough. Chest pain, wheezing and haemoptysis are unusual symptoms. Symptoms in diffuse lung diseases are usually chronic, ranging from few months to years. The physical examination

may reveal bilateral basal or widespread inspiratory crept on auscultation. Resting tachypnea and tachycardia may be present. Digital clubbing and cyanosis usually indicates far advanced fibrotic disease.^[3]

The assessment of pulmonary function is an essential component of the evaluation of patients suspected of having diffuse lung disease. They typically show a reduction in the static lung volumes, decreased pulmonary compliance and a reduction in diffusing capacity.^[4]

Plain radiography remains the first and foremost imaging modality in patient with suspected diffuse lung diseases. In most cases this is abnormal. The radiographic appearances may be sufficiently characteristic to enable a specific diagnosis. However, in a small proportion (10-20%) of patients with open lung biopsy confirmation of diffuse lung disease, the chest radiograph may be normal.^[5]

Introduction of computed tomography (CT) revolutionized the radiologic diagnosis of chest diseases. The disadvantage of conventional CT was inability to resolve small structures in lung parenchyma. The use of CT, especially high-resolution computed tomography for the precise anatomic definition of diffuse lung diseases became possible with technical advancement in CT technology.^[6]

High Resolution CT is currently the most accurate non-invasive modality for evaluating the lung parenchyma. HRCT uses various technical factors which can increase the spatial resolution and they include narrow collimation, reconstruction using a high spatial frequency algorithm and targeting the image to a small field of view.^[7]

MATERIALS AND METHODS

This Cross-sectional Observational study was conducted in the Department of Radiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospitals, Durgapur, West Bengal from January 2024 to December 2024. Approval from hospital and Institutional Ethical Committee was obtained prior to initiation of the study.

Adult patients of either sex of age group 18 and above showing reticular opacities on chest X-ray and those patients who were incidentally diagnosed as cases of diffuse lung diseases on HRCT chest were included in our study. Patients who were referred to the Department of Radiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospitals, Durgapur, West Bengal and in whom chest X-ray findings matched the selection criteria were subjected to the HRCT chest. HRCT Chest was performed on Philips Brilliance 40 slice CT. A written informed consent was taken from all the patients.

RESULTS

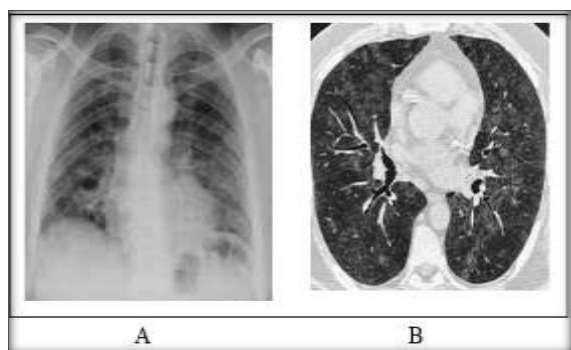


Figure 1: Idiopathic interstitial pneumonia

22-year-old female with dry cough. a) Chest x-ray reveals no abnormality. b) Axial HRCT image shows interstitial thickening and honeycombing predominantly in the sub pleural region suggestive of idiopathic interstitial pneumonia likely usual interstitial pneumonia.



Figure 2: Usual interstitial pneumonia

65-year-old male with dyspnoea and dry cough. a) Chest x-ray shows diffuse reticular opacities in b/l lung fields. b) Axial HRCT image shows diffuse interlobular septal thickening, honeycombing and traction bronchiectasis suggestive of idiopathic interstitial pneumonia likely usual interstitial pneumonia.

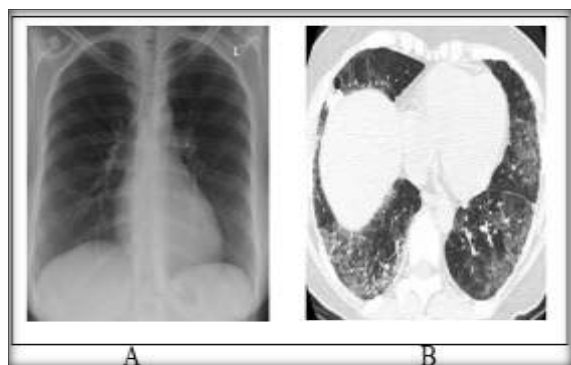


Figure 3: Idiopathic interstitial pneumonia NSIP pattern

34-year-old female with dyspnoea. a) Chest x-ray shows reticular opacities in b/l lower lung zones. b)

Axial HRCT image shows ground glass opacities in the basal segments of b/l lower lobes with areas of interstitial thickening suggestive of idiopathic interstitial pneumonia likely NSIP pattern.

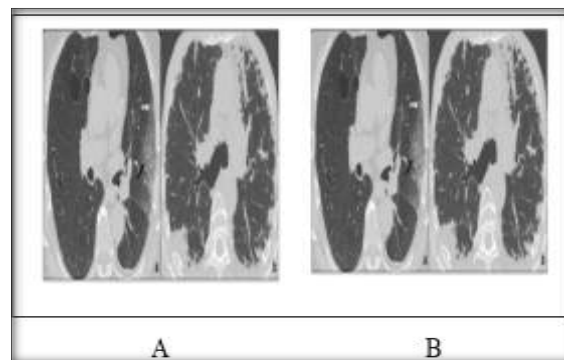


Figure 4: Idiopathic interstitial pneumonia

Axial HRCT image of a 65-year-old female shows interlobular septal thickening, ground glass opacities in bilateral lung parenchyma with peripheral sub pleural predominance and traction bronchiectasis suggestive of idiopathic interstitial pneumonia likely NSIP pattern.

DISCUSSION

Clinical spectrum

Age and sex distribution

The mean age of patients in our study was 44.2 years with the range of 21 to 72 years. There was a female preponderance in our study (~70% of the total cases). The previous reported series by Fulmer et al in 1979 also had a similar age distribution with the mean age of 47 ± 15 years.^[3] However; their series had no male to female preponderance.

In the series reported by Murata et al, the mean age of their patients was around 53 years with slight female preponderance. Severity and duration of dyspnoea was the main presenting complaint in 60% of the patients in our study group. We graded the dyspnoea, according to the severity as suggested by Mawson et al.⁴ 23% of the patients had grade 3 to 4 dyspnoea at the time of presentation.

The dyspnoea was gradually progressive in the patients. Only two patients had dyspnoea as an isolated symptom. In the rest, dry cough was the predominant associated symptom. The symptoms like fever, chest pain and joint pain were common in patients with connective tissue disorders (rheumatoid arthritis and scleroderma).^[4]

Various authors have tried to establish the relationship between a history of smoking and diffuse lung diseases. Ryu JH et al described four lung disorders linked to smoking- desquamative interstitial pneumonia, respiratory bronchiolitis-associated lung disease, pulmonary Langerhans cell histiocytosis and idiopathic pulmonary fibrosis.^[5] 12 patients in our study gave a history of smoking and

they all had diffuse lung disease as described by Ryu JH et al.

Physical examination findings

Inspiratory crackles on auscultation was the most frequent finding (53%) in our patients. Inspiratory crackles were heard in all patients of IIP (UIP) and connective tissue disorders. They were present mostly in the basal lung fields. Epler et al reported that bilateral fine crackles were common in patients with idiopathic pulmonary fibrosis and connective tissue disorders, occurring in 60% of the patients, but generally reported in 90% of the patients with IPF.^[6] Digital clubbing (16%) and cyanosis (13%) were seen in patients with grade 3 or 4 dyspnoea, showing predominantly reticular opacities on chest radiography and on HRCT, most of these were IIP (UIP). Crystal et al found digital clubbing in 58% of cases of idiopathic pulmonary fibrosis.^[7]

Forced vital capacity

Forced vital capacity reports of all patients were evaluated in our study. All the values were expressed as percentage of predicted value, as per the standards laid down by American Thoracic Society.

Interstitial lung diseases show a typical restrictive pattern. Chinnet et al have described the restrictive lung pattern with $FVC \leq 80\%$.⁸

In present series, mean value of FVC was 73.3% of the predicted value.

Radiological spectrum

Idiopathic interstitial pneumonias

a. Usual Interstitial pneumonia

Present study included 28 patients with Idiopathic Interstitial pneumonia of UIP pattern, comprising 46% of total cases. The age of patients ranged from 24 to 72 years with most of the cases between 45-65 years. There was a preponderance of females in patients with UIP pattern.

On chest radiograph, a reticular pattern spread throughout the lung fields was the most commonly observed finding. The lower zones were involved more often (36%) as compared to upper and mid zones; and in cases of diffuse disease, the findings were more profuse in the lower zones. Staples et al reported similar findings in their study.

On HRCT scans, the predominant features observed were intra and interlobular septal thickening (92% cases) in a reticular pattern throughout the lung fields. Thickening of the interstitial network of the lung by fluid, fibrous tissue or cells primarily results in this appearance. Nishimura et al reported the incidence of septal thickening in 94% of cases.^[9] though a diffuse pattern of disease was observed in 55% of cases, the lower zones and the peripheral lung fields were more commonly involved. Muller et al reported the similar findings.^[10]

c. Nonspecific interstitial pneumonia

Present study included 18 patients with Idiopathic NSIP comprising 30% of cases. Majority of the cases were in the range of 35-50 years. Plain radiography shows reticulonodular opacities in 55% cases and no abnormality was detected in the rest of the cases.^[11] On HRCT, the predominant feature observed was

ground glass opacities in 88% cases. Patchy ground glass opacities were noted in three cases. Intra and interlobular septal thickening was present in 66% cases. Similar findings were reported by Cottin et al.^[12]

HRCT chest showed ground glass opacities in 81% cases, patchy areas of consolidation in 54% cases and thickening of interlobular septa in 45% cases

c. Respiratory bronchiolitis- interstitial lung disease

One case of respiratory bronchiolitis- interstitial lung disease was diagnosed in our study. Patient had a history of smoking of 15 pack years. On plain radiography reticulonodular opacities were noted in basal lung zones. On HRCT, ground glassing with interstitial thickening and bronchiolectasis were present. Similar findings were reported in patients with current or previous history of smoking by Ryu et al with ground glass opacities as the predominant finding in 100% of cases with RB-ILD.^[13]

CONCLUSION

HRCT has been proposed as a technique for determining the activity of IPF.^[17] The CT finding of ground glass opacity refers to the presence of a diffuse homogenous increase in density of the lung. When this finding occurs in association with reticular lines and dilated bronchi or bronchioles (traction bronchiectasis or bronchiolectasis), it always indicates lung fibrosis. In conditions other than IPF, isolated ground glass density is usually associated with inflammatory cells in the alveolar septum or alveolar lumen (i.e. alveolitis).^[18]

The ground glass opacity seen on HRCT in some patients with IPF can be associated with alveolar inflammation, but is predominantly associated with patchy fibrotic thickening of alveolar septa, and intraalveolar granulation tissue.^[19,20] Ground glass opacity on HRCT often regresses on treatment but may not decrease as readily in patients with UIP. An area of ground glass opacity may progress to reticular opacity or honeycombing on follow-up examination. Patients with predominant reticular opacity or honeycombing usually progress despite treatment. The extent of lung fibrosis on HRCT is an important predictor of survival.^[21] HRCT is increasingly used for quantification of disease extent. Subjective, semi quantitative assessment of disease extent by HRCT shows moderate interobserver variability. This semi quantitative assessment correlates with evidence of physiologic impairment.^[22] One study showed that the extent of overall lung involvement and the extent of ground glass pattern in the HRCT scans show a moderate correlation only with FVC and arterial PO₂ at peak exercise. For detection of early or mild infiltrative lung disease, HRCT is clearly more sensitive than the chest radiograph. However, in the early stages of any lung disease, including IPF, the degree of parenchymal infiltration may be too slight to cause any CT abnormality.

Funding: No funding sources

Conflict of interest: None declared

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