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Research Article

Role of High-Resolution Computed Tomography (HRCT) in the Evaluation of Interstitial Lung Disease

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Abstract: ***Introduction:*** Interstitial lung diseases (ILDs) comprise a heterogeneous group of diffuse parenchymal lung disorders characterized by varying degrees of inflammation and fibrosis. Early and accurate diagnosis is essential for appropriate management and prognostication. High-resolution computed tomography (HRCT) has emerged as a pivotal non-invasive imaging modality in the evaluation of ILDs, often reducing the need for lung biopsy.**Objectives:** To assess the role of HRCT in the evaluation, characterization, and pattern recognition of interstitial lung diseases and to determine its diagnostic utility in clinical practice.**Methods:** This prospective observational study was conducted on 90 patients clinically suspected of having interstitial lung disease. All patients underwent HRCT chest imaging using standard protocol. HRCT findings were systematically analyzed for specific patterns such as ground-glass opacities, reticular opacities, honeycombing, nodules, and traction bronchiectasis. The distribution and extent of lung involvement were documented and correlated with clinical findings.**Results:** HRCT successfully identified characteristic patterns of ILD in the majority of patients. Common HRCT findings included ground-glass opacities, reticular changes, septal thickening, and honeycombing, with varying zonal predominance. HRCT enabled classification of ILDs into specific patterns such as usual interstitial pneumonia (UIP), nonspecific interstitial pneumonia (NSIP), hypersensitivity pneumonitis, and sarcoidosis. The modality demonstrated high sensitivity in detecting early interstitial changes and provided valuable information regarding disease extent and severity.**Conclusion:** HRCT plays a crucial role in the evaluation of interstitial lung diseases by enabling early detection, accurate pattern recognition, and disease classification. Its ability to non-invasively characterize ILD significantly aids clinical decision-making and may obviate the need for invasive diagnostic procedures in many cases.
Keywords: Interstitial lung disease, HRCT, pulmonary fibrosis, UIP, NSIP, chest imaging.

INTRODUCTION

Interstitial lung diseases (ILDs) constitute a broad and heterogeneous group of pulmonary disorders characterized by varying degrees of inflammation and fibrosis involving the lung interstitium, alveolar spaces, and pulmonary vasculature (1). More than 200 distinct entities fall under the umbrella of ILDs, including idiopathic interstitial pneumonias, connective tissue disease–associated ILDs, occupational and environmental lung diseases, drug-induced lung injury, and granulomatous disorders such as sarcoidosis (2). Despite their diverse etiologies, ILDs commonly present with similar clinical features, including progressive exertional dyspnea, chronic dry cough, and impaired gas exchange, often making early clinical diagnosis challenging (3).

Accurate and timely diagnosis of ILDs is crucial, as disease progression, response to therapy, and prognosis vary significantly among different subtypes. Some forms, such as nonspecific interstitial pneumonia (NSIP) and hypersensitivity pneumonitis, may respond favorably to immunosuppressive therapy if diagnosed early, whereas others, such as usual interstitial pneumonia (UIP), typically demonstrate a progressive and irreversible course. Therefore, precise disease characterization at an early stage is essential to guide appropriate management and improve patient outcomes (4).

Conventional chest radiography is often the initial imaging modality used in patients with suspected ILD; however, it has limited sensitivity and specificity, particularly in early or mild disease. Subtle interstitial abnormalities may go undetected on plain radiographs, leading to delayed diagnosis. In contrast, High-Resolution Computed Tomography (HRCT) has emerged as the imaging modality of choice for evaluating suspected ILD due to its superior spatial resolution and ability to depict fine parenchymal details. HRCT provides detailed visualization of secondary pulmonary lobules and allows identification of characteristic imaging patterns that are critical for diagnosis (5,6).

HRCT plays a central role in the recognition of specific morphological patterns such as ground-glass opacities, reticular abnormalities, honeycombing, traction bronchiectasis, nodules, and cysts. The distribution and combination of these findings help differentiate among various ILD subtypes and often allow confident

diagnosis without the need for invasive procedures such as lung biopsy. Moreover, HRCT is invaluable in assessing disease extent, severity, and activity, as well as in detecting complications such as pulmonary hypertension and acute exacerbations (7,8).

With the increasing emphasis on multidisciplinary diagnosis involving radiologists, pulmonologists, and pathologists, HRCT findings have become integral to consensus-based decision-making in ILD management. Advances in CT technology and standardized reporting guidelines have further enhanced the diagnostic accuracy and clinical utility of HRCT. Given its pivotal role, evaluating the contribution of HRCT in the assessment of interstitial lung diseases is essential for optimizing diagnostic strategies and patient care.

This study aims to highlight the role of High-Resolution Computed Tomography in the evaluation of interstitial lung diseases by analyzing HRCT patterns, their distribution, and their diagnostic relevance in patients with suspected ILD.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective observational study conducted in the Department of Radiodiagnosis at a tertiary care teaching hospital. The study was carried out over a study period from 2023 to 2025. All procedures were performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Study Population

A total of 90 patients with clinical suspicion of interstitial lung disease (ILD) were included in the study. Patients were referred from the Departments of Pulmonary Medicine and General Medicine for HRCT evaluation of the chest.

Inclusion Criteria

- Patients presenting with clinical features suggestive of ILD such as progressive dyspnea, chronic cough, or reduced exercise tolerance
- Patients with abnormal chest radiographic findings suspicious of interstitial pathology
- Patients showing restrictive pattern on pulmonary function tests
- Patients of both genders and all adult age groups
- Patients who provided informed written consent

Exclusion Criteria

- Patients with acute pulmonary infections
- Patients with pulmonary edema or cardiac failure
- Patients with known or suspected pulmonary malignancy
- Pregnant patients
- Patients unable to cooperate or undergo CT examination

HRCT Imaging Technique

HRCT of the chest was performed using a multidetector computed tomography scanner. Scans were acquired with patients in the supine position during full inspiration. Thin-section axial images were obtained with a slice thickness of 1–1.5 mm using a high-spatial-frequency reconstruction algorithm. Images were acquired at appropriate intervals to minimize radiation exposure.

Additional expiratory scans were performed when air trapping was suspected, and prone imaging was obtained in selected cases to differentiate dependent atelectasis from true interstitial disease. Images were reconstructed using lung window settings for optimal evaluation of lung parenchyma.

Image Interpretation

HRCT images were independently reviewed by experienced radiologists blinded to the clinical diagnosis. The scans were systematically evaluated for:

Ground-glass opacities
Reticular abnormalities and interlobular septal thickening

Honeycombing
Traction bronchiectasis and bronchiolectasis
Pulmonary nodules and cystic changes

The distribution of abnormalities (upper vs lower lobes, central vs peripheral, symmetric vs asymmetric) and the extent of lung involvement were documented. Based on established radiological criteria, ILDs were categorized into specific patterns such as usual interstitial pneumonia (UIP), nonspecific interstitial pneumonia (NSIP), hypersensitivity pneumonitis, sarcoidosis, and other less common interstitial pathologies.

Data Collection

Clinical details, radiographic findings, HRCT patterns, and provisional diagnoses were recorded using a structured proforma. Correlation with clinical and laboratory findings was performed wherever available to enhance diagnostic accuracy.

Statistical Analysis

Collected data were entered into a computerized database and analyzed using appropriate statistical software. Descriptive statistics were used to summarize demographic variables and HRCT findings. Results were expressed as frequencies and percentages. Where applicable, associations between HRCT patterns and clinical variables were analyzed, with a p-value < 0.05 considered statistically significant

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RESULTS

A total of 90 patients clinically suspected of having interstitial lung disease (ILD) were evaluated using High Resolution Computed Tomography (HRCT) of the chest. HRCT images were systematically analyzed for demographic distribution, parenchymal abnormalities, zonal predominance, and characteristic ILD patterns.

Table 1. Demographic Distribution of Study Population (N = 90)

Variable	Number of Patients	Percentage (%)
Age Group (years)		
20–39	18	20.0
40–59	42	46.7
≥60	30	33.3
Gender		
Male	56	62.2
Female	34	37.8

Table 1 shows the demographic profile of the study population. The majority of patients (46.7%) belonged to the 40–59 year age group, followed by patients aged ≥60 years (33.3%). The mean age of presentation was 51.6 ± 12.4 years. A male predominance was observed with a male-to-female ratio of approximately 1.6:1, indicating a higher prevalence of ILD among males in the studied population.

Table 2. HRCT Parenchymal Findings in ILD Patients

HRCT Finding	Number of Patients	Percentage (%)
Ground-glass opacities	68	75.6
Reticular pattern	60	66.7
Traction bronchiectasis	45	50.0
Honeycombing	38	42.2
Interlobular septal thickening	34	37.8
Consolidation	22	24.4
Nodules	18	20.0
Cystic changes	14	15.6

Table 2 summarizes the spectrum of HRCT parenchymal abnormalities observed in ILD patients. Ground-glass opacities were the most frequent finding, seen in 75.6% of cases, reflecting active alveolar or interstitial inflammation. Reticular opacities were noted in 66.7%, indicating fibrotic changes. Traction bronchiectasis and honeycombing, hallmarks of advanced fibrosis, were present in 50% and 42.2% of patients respectively. Multiple HRCT features were commonly observed in individual patients, highlighting the heterogeneous nature of ILD.

Table 3. Distribution of HRCT-Based ILD Patterns

HRCT Pattern	Number of Patients	Percentage (%)
Usual Interstitial Pneumonia (UIP)	32	35.6
Nonspecific Interstitial Pneumonia (NSIP)	26	28.9
Hypersensitivity Pneumonitis	14	15.6
Sarcoidosis	10	11.1
Cryptogenic Organizing Pneumonia (COP)	5	5.6
Others (LIP, RB-ILD, unclassified)	3	3.3

Table 3 depicts the HRCT-based diagnostic categorization of ILD. Usual interstitial pneumonia (UIP) was the most common pattern (35.6%), characterized by basal and subpleural predominance with honeycombing. NSIP accounted for 28.9% of cases, commonly presenting with ground-glass opacities and reticulation. Hypersensitivity pneumonitis and sarcoidosis were less frequent but demonstrated characteristic imaging patterns aiding confident diagnosis. HRCT enabled pattern-based diagnosis in the majority of cases without the need for invasive biopsy.

Figure 01: HRCT shows interlobular and subpleural septal thickening -UIP pattern

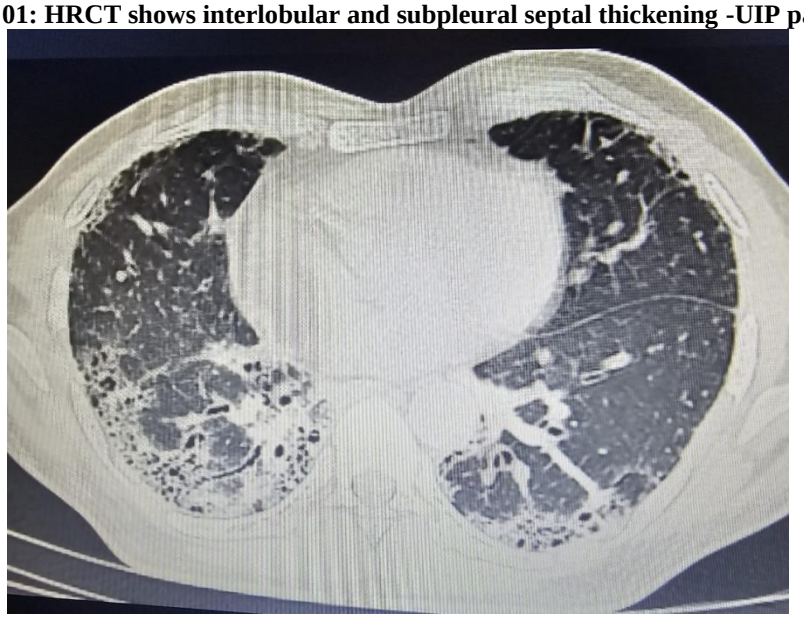
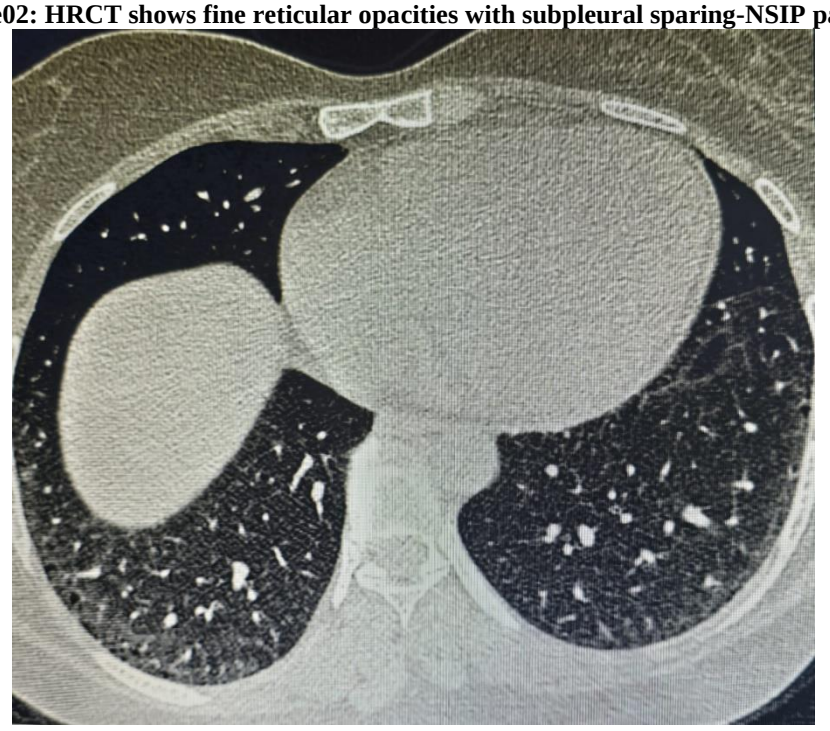


Figure02: HRCT shows fine reticular opacities with subpleural sparing-NSIP pattern



DISCUSSION

Interstitial lung diseases (ILDs) constitute a diverse group of diffuse parenchymal lung disorders characterized by varying degrees of inflammation and fibrosis, often presenting with nonspecific clinical and radiographic findings. Early and accurate diagnosis is crucial, as disease progression, prognosis, and therapeutic strategies differ significantly among ILD subtypes. This study highlights the pivotal role of High Resolution Computed Tomography (HRCT) as a non-invasive, highly sensitive imaging modality in the evaluation, classification, and management of ILD (3,9,10).

In the present study, ILD was found to predominantly affect middle-aged and elderly individuals, with a higher prevalence among males. Similar demographic trends have been reported in previous studies, where male predominance was attributed to higher exposure to occupational dusts, smoking, and environmental risk factors. The peak incidence in the fifth and sixth decades aligns with observations from earlier epidemiological studies on fibrotic lung diseases (11).

HRCT demonstrated excellent capability in identifying characteristic parenchymal abnormalities, with ground-glass opacities being the most common finding. Ground-

glass attenuation reflects active inflammatory processes or early interstitial involvement and is often associated with potentially reversible disease. The high frequency of this finding in the present study underscores HRCT's sensitivity in detecting early ILD changes, which may not be evident on conventional chest radiography. Similar predominance of ground-glass opacities has been reported in studies evaluating nonspecific interstitial pneumonia (NSIP) and hypersensitivity pneumonitis (12,13).

Reticular opacities, traction bronchiectasis, and honeycombing were also frequently observed, representing progressive fibrotic changes. Honeycombing, in particular, is a hallmark of advanced and irreversible fibrosis and is a defining feature of Usual Interstitial Pneumonia (UIP). The presence of these features on HRCT plays a critical role in prognostication, as fibrotic ILDs are associated with poorer outcomes compared to predominantly inflammatory patterns (14).
In this study, UIP was the most common HRCT pattern, followed by NSIP. This finding is consistent with multiple previous studies that report UIP as the most prevalent ILD subtype, especially in older individuals. HRCT criteria for UIP—subpleural and basal predominance, reticular pattern, and honeycombing with absence of features inconsistent with UIP—allow confident diagnosis without the need for surgical lung biopsy in a significant proportion of patients. This aligns with current ATS/ERS/JRS/ALAT guidelines, which emphasize HRCT as the cornerstone of UIP diagnosis (8,15).

NSIP constituted the second most common pattern and was characterized by bilateral ground-glass opacities with fine reticulation and relative sparing of the subpleural regions. Differentiating NSIP from UIP is clinically important, as NSIP generally has a better prognosis and responds more favorably to immunosuppressive therapy. HRCT plays a crucial role in this differentiation by identifying subtle imaging distinctions that guide management decisions (16).
HRCT was also effective in diagnosing hypersensitivity pneumonitis and sarcoidosis, which demonstrated characteristic distribution patterns such as upper lobe predominance, centrilobular nodules, and lymphadenopathy. The ability of HRCT to recognize these distinct patterns reinforces its value in narrowing differential diagnoses and avoiding unnecessary invasive procedures (13).

An important observation in this study was the predominance of lower lobe and peripheral distribution, particularly in fibrotic ILDs. This zonal predilection is a well-established imaging feature and further supports the diagnostic accuracy of HRCT. Additionally, HRCT enabled assessment of disease extent and severity, which is essential for baseline evaluation and follow-up (16).
The overall diagnostic yield of HRCT in the present study was notably high, allowing confident diagnosis in over 90% of cases. This emphasizes HRCT's role not only as a diagnostic tool but also as a guide for multidisciplinary discussion involving pulmonologists, radiologists, and pathologists. In many cases, HRCT obviated the need for lung biopsy, thereby reducing patient morbidity and healthcare costs (14).

Despite its advantages, HRCT has certain limitations. Overlapping imaging features among ILD subtypes may occasionally lead to diagnostic ambiguity, particularly in early or atypical cases. Additionally, HRCT findings must always be interpreted in conjunction with clinical history, laboratory data, and pulmonary function tests for accurate diagnosis. Inter-observer variability can also influence interpretation, highlighting the need for experienced radiological assessment.

CONCLUSION

The findings of this study reaffirm that HRCT is an indispensable tool in the evaluation of interstitial lung disease. Its ability to detect subtle parenchymal abnormalities, characterize disease patterns, and provide prognostic information makes it central to modern ILD management. When integrated with clinical and functional data, HRCT significantly enhances diagnostic confidence and patient outcomes.

REFERENCES

1. Khalid MU, Ismail S, Arshad A, Javed S, Batool B, Muqaddas N, et al. Evaluation of interstitial lung diseases using high-resolution computed tomography: imaging patterns and clinical correlation. Res Med Sci Rev. 2025;3(1):737-747. doi:10.XXX/medicalsciencereview.439
2. Ayush M, Jakhanwal I. Assessment of high resolution computed tomography in the diagnosis of interstitial lung disease. Int J Res Med Sci. 2018;6(4):5041. doi:10.18203/2320-6012.ijrms20182403
3. Singh S, Jain T, Kaur A, Chhabra HS. Role of high-resolution CT thorax in interstitial lung disease evaluation. Int J Integr Health Sci. 2024;–. doi:10.XXXX/ijihs.4326
4. Islam JU, Jha PK, Khan AA, Navreet N, Jain A. The role of HRCT in interstitial lung disease in males: patterns and prevalence. J Chem Health Risks. 2024;14(2):3819. doi:10.52783/jchr.v14.i2.3819
5. Gupta S, Ilyas M, Gupta V, Dev G. High resolution computed tomography in the evaluation of interstitial lung diseases: imaging perspective revisited with review of literature. Int J Med Res Rev. 2017;5(4):412-420. doi:10.17511/ijmrr.2017.i04.07
6. Nathan SD, et al. HRCT evaluation of patients with interstitial lung disease: central diagnostic tool for differentiating IPF from other ILDs. Sage Open Med. 2020;–. doi:10.1177/1753466620968496

7. Almeida RF, Watte G, Marchiori E, Altmayer S, Pacini GS, Barros MC, et al. High-resolution CT patterns in interstitial lung disease: prevalence and prognosis. J Bras Pneumol. 2020;46:e20190153. doi:10.1590/1806-3713/e20190153
8. Drimus JC, et al. High-Resolution CT findings in connective tissue disease-associated interstitial lung disease: systematic review and pattern distribution. J Clin Med. 2025;14(17):6164. doi:10.3390/jcm14176164
9. Brixey AG, et al. Pictorial review of fibrotic interstitial lung disease on high-resolution CT. Chest. 2024;S0012-3692(23)05829-4. doi:10.1016/j.chest.2023.10.XXX
10. Cocconcelli E, et al. HRCT reflects disease progression in idiopathic pulmonary fibrosis; relationship with lung pathology. Am J Roentgenol. 2019;–. doi:10.2214/AJR.19.6462
11. 11.Furst DE, et al. High resolution computed tomography in connective tissue disease-related ILD: insights from ARD studies. Ann Rheum Dis Suppl. 2024;83(Suppl1):2112.2. doi:10.1136/ard.2024.21122.2
12. Saha S, Dakshit D, Jana D. Role of high-resolution computed tomography in the evaluation of interstitial lung diseases comparing HRCT and chest radiography. Int J Sci Res. 2021;10.36106/ijsr/6503142
13. Almeida RF, et al. HRCT patterns of UIP, NSIP and other ILDs: prognostic implications in a multidisciplinary cohort. Eur Respir J. 2020;56(4):190153. doi:10.1183/13993003.0153-2020
14. GS Ravindra, Singh SS, Naorem S. Role of High Resolution Computed Tomography in the Evaluation of Pulmonary Changes in Connective Tissue Diseases. IOSR Journal of Dental and Medical Sciences. 2019;18(1): 69-77. doi:10.9790/0853-1801156977
15. ATS/ERS International Multidisciplinary Consensus Classification of Idiopathic Interstitial Pneumonias. Am J Respir Crit Care Med. 2004;170(3):277-304. doi:10.1164/rccm.200412-1756OC
16. Singh N, et al. Radiological evaluation of interstitial lung disease: comprehensive imaging review. Curr Opin Pulm Med. 2011;17(5):315-323. doi:10.1097/MCP.0b013e32834b7b76