

Original Research Article

RADIOGRAPHIC AND HRCT PATTERNS IN CLINICALLY SUSPECTED INTERSTITIAL LUNG DISEASE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Interstitial lung disease comprises a heterogeneous group of disorders characterized by varying degrees of inflammation and fibrosis of the pulmonary interstitium. Chest radiography is commonly used as the initial imaging investigation but may fail to demonstrate early or subtle disease. High-resolution computed tomography provides superior anatomical detail and facilitates the detection and characterization of interstitial abnormalities. The aim is to evaluate and compare radiographic and HRCT patterns in patients with clinically suspected interstitial lung disease.

Materials and Methods: This hospital-based analytical cross-sectional study included 40 adult patients with clinically suspected interstitial lung disease who attended the Department of Radiodiagnosis, Great Eastern Medical School and Hospital, Ragolu, Andhra Pradesh, from April 2023 to September 2024. Demographic characteristics, clinical manifestations, smoking history, occupational exposures and respiratory signs were recorded. All participants underwent posteroanterior chest radiography and HRCT of the chest. Pulmonary abnormalities detected using the two modalities were compared using the exact McNemar test. Proportions were reported with 95% confidence intervals, and a p value below 0.05 was considered statistically significant.

Results: The mean age was 55.4±9.6 years, and 24 (60.0%) participants were male. Dyspnoea was the most common symptom (52.5%), while fine inspiratory crackles were the most frequent clinical sign (92.5%). Smoking and occupational exposure were reported by 37.5% and 32.5% of patients, respectively. Reticular opacity was the predominant HRCT finding, occurring in 90.0%, followed by nodular opacity in 67.5%, septal thickening in 60.0%, lymphadenopathy in 52.5%, and traction bronchiectasis and ground-glass opacity in 47.5% each. HRCT detected significantly more reticular opacities (90.0% versus 72.5%; p=0.016), nodular opacities (67.5% versus 47.5%; p=0.008), septal thickening (60.0% versus 27.5%; p<0.001), traction bronchiectasis (47.5% versus 30.0%; p=0.016), ground-glass opacity (47.5% versus 30.0%; p=0.016) and lymphadenopathy (52.5% versus 30.0%; p=0.004) than chest radiography. Septal thickening showed the greatest absolute additional HRCT yield of 32.5% (95% CI: 20.1–48.0). Consolidation was detected equally by both modalities (40.0%; p=1.000).

Conclusion: HRCT was superior to conventional chest radiography for detecting and characterizing most pulmonary abnormalities in clinically suspected ILD, particularly septal thickening, lymphadenopathy, nodular opacity, reticulation, ground-glass opacity and traction bronchiectasis. Chest radiography remains a useful initial investigation, but HRCT is essential when ILD is clinically suspected or radiographic findings are inconclusive.

Keywords: Interstitial lung disease; High-resolution computed tomography; Chest radiography.

INTRODUCTION

Interstitial lung disease (ILD), also termed diffuse parenchymal lung disease, comprises a heterogeneous group of disorders characterized by inflammation, fibrosis or a combination of both involving the pulmonary interstitium. ILD may occur without an identifiable cause, as in idiopathic interstitial pneumonias, or secondary to connective-tissue diseases, occupational exposures, environmental antigens, infections and drugs. Patients commonly present with progressive exertional dyspnoea, persistent dry cough, fatigue, weight loss and fine bibasal inspiratory crackles. Because these manifestations are often nonspecific, diagnosis may be delayed until substantial and potentially irreversible pulmonary fibrosis has developed. The prevalence and distribution of individual ILD subtypes vary considerably across geographical regions; hypersensitivity pneumonitis and connective-tissue disease-associated ILD represent important causes in India and other Asian countries.^[1]

Chest radiography is generally the initial imaging investigation performed in patients with suspected ILD because it is inexpensive, readily accessible and associated with a relatively low radiation dose. It may demonstrate reticular, reticulonodular, nodular, ground-glass or honeycomb patterns, along with reduced lung volumes. Nevertheless, conventional radiography has limited sensitivity and may appear normal in patients with early or mild disease. The superimposition of thoracic structures and limited contrast resolution may also restrict the characterization and anatomical distribution of parenchymal abnormalities.^[2]

High-resolution computed tomography (HRCT) provides detailed evaluation of the secondary pulmonary lobule and is substantially more sensitive than chest radiography for detecting interstitial abnormalities. It can demonstrate ground-glass opacity, interlobular septal thickening, reticulation, traction bronchiectasis, honeycombing, mosaic attenuation, air trapping and associated pleural or mediastinal abnormalities. The distribution of these findings—such as basal or upper-lobe predominance, peripheral or peribronchovascular involvement and subpleural sparing—provides important diagnostic information. In an appropriate clinical setting, a characteristic HRCT pattern may permit a confident diagnosis of usual interstitial pneumonia and may reduce the need for surgical lung biopsy.^[3,4]

Modern diagnosis of ILD requires the integration of clinical, radiological, serological and, when necessary, histopathological information through multidisciplinary discussion. Although HRCT has a central diagnostic role, chest radiography continues to be widely used for the initial assessment, particularly in resource-limited settings. Comparing the patterns detected by conventional radiography and HRCT can therefore identify the limitations of

radiography and demonstrate the additional diagnostic information offered by HRCT.^[4,5] The present study was undertaken to describe and compare radiographic and HRCT patterns among patients with clinically suspected ILD.

Aim

To evaluate and compare the radiographic and HRCT patterns in patients with clinically suspected interstitial lung disease.

Objectives

1. To describe the demographic, clinical and exposure profiles of patients with clinically suspected interstitial lung disease.
2. To determine the patterns and distribution of pulmonary abnormalities detected on conventional chest radiography and HRCT.
3. To compare chest radiographic findings with HRCT findings and assess the additional diagnostic yield of HRCT.

MATERIALS AND METHODS

Source of Data: The study population consisted of adult patients with clinically suspected ILD who were referred to the Department of Radiodiagnosis for chest radiography and HRCT evaluation. Patients were recruited from the outpatient and inpatient departments of Great Eastern Medical School and Hospital, Ragolu, Srikakulam, Andhra Pradesh. Eligibility was assessed according to predefined inclusion and exclusion criteria. Written informed consent was obtained from every participant before enrolment.

Study Design: A hospital-based, analytical, observational cross-sectional study was conducted.

Study Location: The study was conducted in the Department of Radiodiagnosis, Great Eastern Medical School and Hospital, Ragolu, Srikakulam, Andhra Pradesh, India.

Study Duration: The study was conducted over 18 months, from April 2023 to September 2024.

Sample Size: A total of 40 patients with clinically suspected ILD were included. Since this was a hospital-based study and reliable local estimates for calculating the required sample size were unavailable, the sample size was determined pragmatically. A previous comparable study included 30 participants; therefore, the present study included 40 eligible patients to improve the precision and reliability of the observations.

Convenience sampling was used. Patients presenting during the study period who satisfied the eligibility criteria and provided informed consent were enrolled consecutively until the required sample size was reached. Two otherwise eligible patients who did not provide consent were excluded, and the final analysis included 40 participants.

Inclusion Criteria

- Patients aged 18 years or older.
- Patients of either sex.
- Patients clinically suspected of having ILD.

- Patients with suspected idiopathic interstitial pneumonia or hypersensitivity pneumonitis.
- Patients with suspected connective-tissue disease-associated ILD, including rheumatoid arthritis-associated lung disease.
- Patients with granulomatous or infectious conditions potentially producing diffuse interstitial abnormalities, including granulomatosis with polyangiitis and tuberculosis.
- Patients with suspected occupational lung diseases, including silicosis, asbestosis and coal workers' pneumoconiosis.
- Patients with suspected invasive aspergillosis, allergic bronchopulmonary aspergillosis or lymphatic malignancy with diffuse pulmonary involvement.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients younger than 18 years.
- Pregnant women.
- Patients who did not provide informed consent.
- Patients who were clinically unstable and could not safely undergo HRCT.
- Patients whose radiographs or HRCT images were technically inadequate for interpretation.
- Patients with incomplete clinical or imaging information required for analysis.

Procedure and Methodology: After obtaining approval from the Institutional Ethics Committee, patients referred with clinical suspicion of ILD were screened for eligibility. The purpose, imaging procedures and potential benefits and risks of participation were explained in a language understood by the patient. Written informed consent or a thumb impression was obtained before data collection.

A detailed clinical history was recorded using a structured proforma. Information included age, sex, occupation, duration of symptoms, smoking history, allergy history, occupational or environmental exposure and relevant underlying diseases. Presenting complaints such as dyspnoea, cough with or without expectoration, wheezing, chest pain, haemoptysis, fever, fatigue, anorexia and weight loss were documented.

A general and systemic physical examination was performed. Pallor, cyanosis, digital clubbing, pedal oedema, tachypnoea, bibasal inspiratory crackles, rhonchi and clinical evidence of cardiac failure were recorded. Relevant biochemical, serological and sputum investigations performed as part of routine clinical care were also documented.

All 40 participants underwent posteroanterior chest radiography in the erect position using an Allengers 500-mA X-ray unit. Images were obtained using approximately 60 kVp and 5–8 mAs, with exposure parameters modified when necessary according to patient habitus. Radiographs were evaluated for reticular opacity, nodular opacity, reticulonodular opacity, ground-glass opacity, consolidation, Kerley

lines, honeycombing, reduced lung volume, pleural abnormalities, hilar enlargement and other associated findings.

HRCT of the chest was subsequently performed with the patient in the supine position using a GE 16-slice multidetector CT scanner. Images were acquired during suspended full inspiration using 1-mm-thick sections at 10-mm intervals. The principal acquisition parameters included 130 kVp, 60–70 mAs, a pitch of 1:1 and a matrix of 512 × 512. Lung images were assessed using a window width of approximately 1200–1500 Hounsfield units and a window level of approximately –600 to –700 Hounsfield units. Additional expiratory or prone images were obtained whenever clinically required to assess air trapping or differentiate dependent opacity from genuine parenchymal disease.

The HRCT images were examined for ground-glass opacity, reticulation, interlobular septal thickening, nodules and their distribution, consolidation, honeycombing, traction bronchiectasis, air trapping, emphysema, fissural or pleural thickening, architectural distortion, peribronchial cuffing, and hilar or mediastinal lymphadenopathy. The zonal, axial and craniocaudal distribution of abnormalities was documented wherever applicable.

The overall imaging appearances were categorized as normal, predominantly reticular, predominantly ground-glass, mixed or other patterns. Chest radiographic findings were compared with the corresponding HRCT findings for every participant. The number and type of additional abnormalities detected by HRCT were documented. Images were reviewed by the investigator under faculty supervision, and a consensus interpretation was accepted as the final imaging diagnosis.

Sample Processing: The investigation was imaging-based; therefore, no biological sample was collected or processed specifically for the study. Routine blood, serological or sputum investigations requested by the treating physician were recorded when available.

The acquired HRCT data were reconstructed into high-resolution thin-section images using a high-spatial-frequency reconstruction algorithm. Images were reviewed in lung and mediastinal windows. Chest radiographs and HRCT images were anonymized using study identification numbers and arranged for systematic interpretation. Imaging observations were entered into the predefined data collection form before statistical analysis.

Data Collection: Data were collected using a predesigned and structured case-record form. The following variables were recorded:

- Demographic characteristics: age and sex.
- Clinical details: symptoms, duration, comorbidities, smoking and allergy history.
- Occupational and environmental exposures.
- General and respiratory examination findings.
- Relevant laboratory, serological and sputum examination results.
- Individual chest radiographic findings.

- Individual HRCT findings and their anatomical distribution.
- Predominant radiographic and HRCT patterns.
- Concordant findings and additional abnormalities detected on HRCT.

Each participant was assigned a unique study number. Data were checked for completeness and consistency before being entered into a computerized database. Participant identity and clinical information were maintained confidentially.

Statistical Methods: Data were entered into a spreadsheet and analysed using an appropriate statistical software package. Continuous variables were summarized using mean and standard deviation when normally distributed and median with interquartile range when the distribution was skewed. Categorical variables were expressed as frequencies and percentages.

The independent-samples Student's t-test was used for comparisons of normally distributed continuous variables between two groups, where applicable. The chi-square test or Fisher's exact test was used to assess associations between categorical variables. Because chest radiography and HRCT findings were obtained from the same patients, McNemar's test was used to compare paired proportions for individual imaging findings. Agreement between the predominant chest radiographic and HRCT patterns was assessed using Cohen's kappa coefficient, where applicable.

The additional diagnostic yield of HRCT was calculated as the proportion of patients in whom HRCT detected clinically relevant abnormalities that were absent or inadequately demonstrated on conventional radiography. All statistical tests were two-tailed. A p value of less than 0.05 was considered statistically significant, and effect estimates were

reported with 95% confidence intervals wherever appropriate.

Ethical Considerations: Approval was obtained from the Institutional Ethics Committee of Great Eastern Medical School and Hospital before commencement of the study. Written informed consent was obtained from all participants. No additional invasive procedure was performed solely for research purposes. Patient information was kept confidential and was used only for academic and research purposes.

RESULTS

[Table 1] compares the pulmonary abnormalities detected using conventional chest radiography and HRCT in 40 patients with clinically suspected interstitial lung disease. HRCT detected reticular opacities in 36 (90.0%; 95% CI: 76.9–96.0) patients compared with 29 (72.5%; 95% CI: 57.2–83.9) on chest radiography, representing a statistically significant difference ($p=0.016$). Nodular opacities were detected in 27 (67.5%) patients on HRCT compared with 19 (47.5%) on radiography ($p=0.008$). Septal thickening showed the greatest difference, being identified in 24 (60.0%) patients on HRCT and only 11 (27.5%) on radiography ($p<0.001$). HRCT also detected significantly more cases of traction bronchiectasis (47.5% vs 30.0%; $p=0.016$), ground-glass opacity (47.5% vs 30.0%; $p=0.016$) and lymphadenopathy (52.5% vs 30.0%; $p=0.004$). Although HRCT detected more cases of honeycombing (30.0% vs 17.5%) and air trapping (22.5% vs 10.0%), these differences were not statistically significant ($p=0.063$ for each). Consolidation was detected equally by both modalities in 16 (40.0%) patients ($p=1.000$).

Table 1: Comparison of radiographic and HRCT findings among patients with clinically suspected interstitial lung disease (N=40)

Imaging finding	Chest radiograph, n (%) [95% CI]	HRCT, n (%) [95% CI]	McNemar test statistic*	p value
Reticular opacities	29 (72.5) [57.2–83.9]	36 (90.0) [76.9–96.0]	Exact discordant pairs: 7:0	0.016
Nodular opacities	19 (47.5) [32.9–62.5]	27 (67.5) [52.0–79.9]	Exact discordant pairs: 8:0	0.008
Septal thickening	11 (27.5) [16.1–42.8]	24 (60.0) [44.6–73.7]	Exact discordant pairs: 13:0	<0.001
Honeycombing	7 (17.5) [8.7–32.0]	12 (30.0) [18.1–45.4]	Exact discordant pairs: 5:0	0.063
Traction bronchiectasis	12 (30.0) [18.1–45.4]	19 (47.5) [32.9–62.5]	Exact discordant pairs: 7:0	0.016
Ground-glass opacity	12 (30.0) [18.1–45.4]	19 (47.5) [32.9–62.5]	Exact discordant pairs: 7:0	0.016
Lymphadenopathy	12 (30.0) [18.1–45.4]	21 (52.5) [37.5–67.1]	Exact discordant pairs: 9:0	0.004
Air trapping	4 (10.0) [4.0–23.1]	9 (22.5) [12.3–37.5]	Exact discordant pairs: 5:0	0.063
Consolidation	16 (40.0) [26.3–55.4]	16 (40.0) [26.3–55.4]	No discordant pairs	1.000

*The test statistic represents the number of discordant pairs detected by HRCT alone versus CXR alone.

Table 2: Demographic, clinical and exposure profiles of patients with clinically suspected interstitial lung disease (N=40)

Characteristic	n (%) or mean (SD)	95% CI	Test of significance	p value
Age, years	55.4 (9.6)	52.3–58.5	—	—
Age group			$\chi^2=12.60$, df=3†	0.006
31–40 years	4 (10.0)	4.0–23.1		
41–50 years	7 (17.5)	8.7–32.0		
51–60 years	10 (25.0)	14.2–40.2		
61–70 years	19 (47.5)	32.9–62.5		
Sex			$\chi^2=1.60$, df=1†	0.206
Male	24 (60.0)	44.6–73.7		
Female	16 (40.0)	26.3–55.4		
Duration of symptoms			$\chi^2=1.20$, df=3†	0.753

1.0–2.0 years	11 (27.5)	16.1–42.8		
2.1–3.0 years	11 (27.5)	16.1–42.8		
3.1–4.0 years	7 (17.5)	8.7–32.0		
More than 4 years	11 (27.5)	16.1–42.8		
Presenting symptoms†				
Dyspnoea	21 (52.5)	37.5–67.1	$\chi^2=0.10$	0.752
Cough	14 (35.0)	22.1–50.5	$\chi^2=3.60$	0.058
Chest pain	5 (12.5)	5.5–26.1	$\chi^2=22.50$	<0.001
Exposure profile‡				
Current or former smoking	15 (37.5)	24.2–53.0	$\chi^2=2.50$	0.114
Occupational exposure	13 (32.5)	20.1–48.0	$\chi^2=4.90$	0.027
Respiratory signs‡				
Fine inspiratory crackles	37 (92.5)	80.1–97.4	$\chi^2=28.90$	<0.001
Tachypnoea	22 (55.0)	39.8–69.3	$\chi^2=0.40$	0.527
Rhonchi	14 (35.0)	22.1–50.5	$\chi^2=3.60$	0.058
Digital clubbing	14 (35.0)	22.1–50.5	$\chi^2=3.60$	0.058
Cyanosis	3 (7.5)	2.6–19.9	$\chi^2=28.90$	<0.001

†Goodness-of-fit chi-square test assessed whether participants were equally distributed across the listed categories.

‡For binary clinical variables, the chi-square goodness-of-fit test compared the presence and absence of the characteristic.

[Table 2] presents the demographic, clinical and exposure profiles of the study participants. The mean age was 55.4±9.6 years (95% CI: 52.3–58.5), and the largest proportion of patients belonged to the 61–70-year age group (47.5%). The age-group distribution was statistically significant ($\chi^2=12.60$, df=3; p=0.006). Males constituted 60.0% of the participants and females 40.0%, without a significant difference in sex distribution ($\chi^2=1.60$; p=0.206). Symptom duration exceeded four years in 27.5% of patients, while another 27.5% each had durations of 1–2 and 2.1–3 years; the distribution was not

significant (p=0.753). Dyspnoea was the most common presenting symptom, affecting 52.5% of patients, followed by cough in 35.0% and chest pain in 12.5%. A smoking history was reported by 37.5%, while 32.5% had occupational exposure. Fine inspiratory crackles were the predominant respiratory sign, occurring in 92.5% (95% CI: 80.1–97.4) and showing a statistically significant predominance ($\chi^2=28.90$; p<0.001). Tachypnoea was recorded in 55.0%, whereas rhonchi and digital clubbing were each present in 35.0%. Cyanosis was relatively uncommon, occurring in only 7.5% of patients.

Table 3: Patterns and distribution of pulmonary abnormalities detected on CXR and HRCT (N=40)

Pulmonary pattern	CXR, n (%)	HRCT, n (%) [95% CI]	HRCT absent, n (%)	χ^2 statistic†	p value
Reticular pattern	29 (72.5)	36 (90.0) [76.9–96.0]	4 (10.0)	25.60	<0.001
Nodular pattern	19 (47.5)	27 (67.5) [52.0–79.9]	13 (32.5)	4.90	0.027
Septal thickening	11 (27.5)	24 (60.0) [44.6–73.7]	16 (40.0)	1.60	0.206
Lymphadenopathy	12 (30.0)	21 (52.5) [37.5–67.1]	19 (47.5)	0.10	0.752
Traction bronchiectasis	12 (30.0)	19 (47.5) [32.9–62.5]	21 (52.5)	0.10	0.752
Ground-glass pattern	12 (30.0)	19 (47.5) [32.9–62.5]	21 (52.5)	0.10	0.752
Consolidation	16 (40.0)	16 (40.0) [26.3–55.4]	24 (60.0)	1.60	0.206
Honeycomb pattern	7 (17.5)	12 (30.0) [18.1–45.4]	28 (70.0)	6.40	0.011
Air trapping	4 (10.0)	9 (22.5) [12.3–37.5]	31 (77.5)	12.10	0.001

†One-sample chi-square test compared the presence and absence of each finding on HRCT. This test describes the distribution of HRCT abnormalities and does not compare HRCT with CXR.

[Table 3] describes the distribution of pulmonary abnormalities detected on chest radiography and HRCT. The reticular pattern was the most frequent HRCT abnormality and was demonstrated in 36 (90.0%; 95% CI: 76.9–96.0) patients compared with 29 (72.5%) on chest radiography. Its predominance on HRCT was statistically significant ($\chi^2=25.60$; p<0.001). Nodular opacities were the second most common HRCT pattern, occurring in 27 (67.5%; 95% CI: 52.0–79.9) patients ($\chi^2=4.90$; p=0.027), followed by septal thickening in 24 (60.0%).

Lymphadenopathy was identified on HRCT in 52.5% of patients, while traction bronchiectasis and ground-glass opacity were each detected in 47.5%. Consolidation occurred in 40.0%, and honeycombing was found in 30.0% of patients. The relatively lower prevalence of honeycombing was statistically significant when its presence was compared with its absence ($\chi^2=6.40$; p=0.011). Air trapping was the least frequent HRCT finding, affecting 22.5% of patients ($\chi^2=12.10$; p=0.001).

Table 4: Additional diagnostic yield of HRCT over chest radiography (N=40)

Imaging finding	Detected on CXR, n (%)	Detected on HRCT, n (%)	Additional cases detected by HRCT, n	Absolute additional yield, % (95% CI)	Exact McNemar p value
Reticular opacities	29 (72.5)	36 (90.0)	7	17.5 (8.7–32.0)	0.016
Nodular opacities	19 (47.5)	27 (67.5)	8	20.0 (10.5–34.8)	0.008
Septal thickening	11 (27.5)	24 (60.0)	13	32.5 (20.1–48.0)	<0.001
Honeycombing	7 (17.5)	12 (30.0)	5	12.5 (5.5–26.1)	0.063
Traction bronchiectasis	12 (30.0)	19 (47.5)	7	17.5 (8.7–32.0)	0.016
Ground-glass opacity	12 (30.0)	19 (47.5)	7	17.5 (8.7–32.0)	0.016
Lymphadenopathy	12 (30.0)	21 (52.5)	9	22.5 (12.3–37.5)	0.004
Air trapping	4 (10.0)	9 (22.5)	5	12.5 (5.5–26.1)	0.063
Consolidation	16 (40.0)	16 (40.0)	0	0.0 (0.0–8.8)	1.000

[Table 4] demonstrates the additional diagnostic yield of HRCT over conventional chest radiography. The greatest incremental yield was observed for septal thickening: HRCT detected 13 additional cases, corresponding to an absolute additional yield of 32.5% (95% CI: 20.1–48.0; $p < 0.001$). HRCT detected nine additional cases of lymphadenopathy, resulting in a significant yield of 22.5% (95% CI: 12.3–37.5; $p = 0.004$). Eight additional cases of nodular opacity were detected, producing a yield of 20.0% (95% CI: 10.5–34.8; $p = 0.008$). The additional yields for reticular opacity, traction bronchiectasis and ground-glass opacity were each 17.5%, and all were statistically significant ($p = 0.016$). HRCT identified five additional cases each of honeycombing and air trapping, corresponding to an additional yield of 12.5%; however, these improvements did not reach statistical significance ($p = 0.063$). No additional case of consolidation was identified using HRCT, giving an incremental yield of 0.0% ($p = 1.000$).

DISCUSSION

The present cross-sectional study compared conventional chest radiography with HRCT in 40 patients with clinically suspected interstitial lung disease (ILD). The principal finding was that HRCT detected substantially more interstitial and associated thoracic abnormalities than chest radiography, particularly septal thickening, lymphadenopathy, nodular opacity, reticular opacity, traction bronchiectasis and ground-glass opacity. These findings support the central role of HRCT in characterizing suspected ILD, while conventional radiography remains useful as an accessible initial investigation.

Comparison of radiographic and HRCT findings:

Reticular opacity was the most frequent abnormality in the present study, being detected in 90.0% of patients on HRCT compared with 72.5% on chest radiography ($p = 0.016$). This difference reflects the higher spatial and contrast resolution of HRCT for demonstrating fine intralobular lines, interlobular septal thickening and early fibrotic alterations. Pal et al. (2019).^[1] similarly reported that reticular opacity was the most common imaging pattern among

patients with ILD and was identified more frequently on HRCT than on chest radiography. However, their prevalence of reticular opacity on HRCT was 56.6%, lower than the 90.0% observed in the present study. The difference may be related to variations in referral patterns, disease duration and the proportions of fibrotic and nonfibrotic ILD subtypes.

Lolge et al. (2016).^[2] found reticular opacities in approximately 86% of patients on HRCT, which was close to the present prevalence. Bhat et al. (2016).^[3] also demonstrated that HRCT was superior to radiography in identifying and characterizing reticular abnormalities. Madhu and Santhosh (2020).^[4] reported reticular opacity in 90% of patients, which was identical to the present result. Collectively, these studies indicate that a reticular pattern is one of the most consistent HRCT manifestations in clinically established or suspected ILD.

Nodular opacities were detected in 67.5% of patients on HRCT compared with 47.5% on chest radiography, giving a significant additional detection rate ($p = 0.008$). Madhu and Santhosh (2020).^[4] reported nodular opacities in approximately 63% of patients, closely corresponding to the present prevalence. Agrawal et al. (2019).^[5] also observed significantly greater detection of nodular opacities with HRCT than with chest radiography. HRCT permits better visualization of small nodules and their centrilobular, perilymphatic or random distribution, which may help narrow the differential diagnosis between hypersensitivity pneumonitis, sarcoidosis, pneumoconiosis, infection and lymphatic tumour spread.

Septal thickening demonstrated the greatest difference between the two modalities. It was detected in 60.0% of patients on HRCT but only 27.5% on radiography ($p < 0.001$). The 60.0% prevalence in the present study was slightly higher than the 50% reported by Madhu and Santhosh (2020).^[4] Agrawal et al. (2019).^[5] similarly found that HRCT identified significantly more cases of septal thickening. Thin-section HRCT can directly delineate interlobular septa, whereas mild septal thickening may be obscured on radiographs by overlapping bronchovascular and skeletal structures. Traction bronchiectasis and ground-glass opacity were each detected in 47.5% of patients on HRCT

compared with 30.0% on radiography ($p=0.016$ for both). Madhu and Santhosh (2020).^[4] observed traction bronchiectasis in 36% and ground-glass opacity in 43% of their patients. Thus, the occurrence of ground-glass opacity was comparable, whereas traction bronchiectasis was more common in the present study. Traction bronchiectasis represents irreversible bronchial or bronchiolar dilatation caused by surrounding fibrosis and is an important indicator of fibrotic remodelling. Ground-glass opacity is less specific and may reflect potentially reversible inflammation, partial air-space filling, fine fibrosis or a combination of these processes. Consequently, its interpretation should consider associated HRCT findings, clinical chronology and disease distribution.

Lymphadenopathy was found in 52.5% on HRCT and 30.0% on radiography, producing a statistically significant difference ($p=0.004$). This prevalence was comparable to the 53% reported by Madhu and Santhosh (2020)^[4] and slightly higher than the 43% reported by Pal et al. (2019).^[1] The relatively high frequency may be explained by the heterogeneous study population, which included patients with sarcoidosis, tuberculosis, connective-tissue disease and lymphatic malignancy. Enlarged hilar and mediastinal lymph nodes are not characteristic of all ILDs; therefore, the finding should not be interpreted as a general marker of ILD without considering the underlying aetiological composition.

Honeycombing was observed in 30.0% of patients on HRCT compared with 17.5% on radiography. Although HRCT detected five additional cases, the difference did not reach statistical significance ($p=0.063$). Madhu and Santhosh (2020).^[4] reported honeycombing in 33%, whereas Bani et al. (2021).^[6] found honeycombing in 23.3% of patients. Honeycombing is an important feature of established pulmonary fibrosis and, when associated with basal and subpleural predominance, may support a usual interstitial pneumonia pattern. Lynch et al. (2018).^[7] and Raghu et al. (2018).^[8] emphasized that confident recognition of honeycombing is crucial for classifying the usual interstitial pneumonia pattern. Nevertheless, observer variation may occur when distinguishing true honeycombing from traction bronchiolectasis, emphysema or clustered cysts.

Air trapping was found in 22.5% on HRCT and 10.0% on radiography. The additional yield of 12.5% did not attain significance ($p=0.063$), probably because only nine patients had air trapping. Air trapping is generally evaluated more reliably on expiratory HRCT and is particularly important in hypersensitivity pneumonitis and small-airway disease. Raghu et al. (2020).^[9] identified mosaic attenuation, air trapping and the three-density pattern as important CT features in the diagnostic evaluation of hypersensitivity pneumonitis.

Consolidation was detected in 40.0% of patients by both modalities ($p=1.000$). This suggests that larger areas of air-space opacity were sufficiently conspicuous on radiography and did not require

HRCT for their initial detection. Nevertheless, HRCT remains valuable for assessing the precise anatomical distribution, internal characteristics and associated interstitial abnormalities of consolidation.

Demographic, clinical and exposure profile: The mean age of the participants was 55.4 ± 9.6 years, with 47.5% belonging to the 61–70-year age group. Pal et al. (2019).^[1] reported a similar mean age of 56.0 ± 16.5 years, while Lolge et al. (2016)^[2] reported a mean age of approximately 52 years. Vizioli et al. (2017).^[10] studied an older population with a mean age of approximately 65 years. Choi et al. (2018).^[11] in a nationwide population-based investigation, demonstrated that the occurrence of ILD increased with advancing age. The predominance of older adults in the present study may reflect the cumulative influence of environmental and occupational exposures, smoking, autoimmune diseases and age-associated susceptibility to pulmonary fibrosis.

Males constituted 60.0% of the sample, although the difference between males and females was not statistically significant ($p=0.206$). Male predominance was also reported by Lolge et al. (2016).^[2] Agrawal et al. (2019).^[5] and Choi et al. (2018).^[11] Conversely, Pal et al. (2019).^[1] reported a female predominance. Such differences are expected because the sex distribution depends on the underlying ILD spectrum. Idiopathic pulmonary fibrosis, smoking-related ILD and occupational pneumoconiosis are often more common among men, whereas connective-tissue disease-associated ILD may show female predominance.

More than one-quarter of patients had symptoms lasting over four years, indicating the chronic nature of ILD and the possibility of delayed specialist referral. Dyspnoea was the most common presenting symptom, affecting 52.5%, followed by cough in 35.0%. Pal et al. (2019).^[1] similarly identified dyspnoea as the most common complaint, followed by cough. Agrawal et al. (2019).^[5] reported exertional dyspnoea in 65% and cough in 56% of patients. Vizioli et al. (2017).^[10] found dyspnoea in approximately 85% and cough in 34%. The lower prevalence of dyspnoea in the present study might indicate the inclusion of patients with earlier disease or ILD discovered during evaluation of underlying systemic disease.

Fine inspiratory crackles were present in 92.5% of patients and were the most frequent clinical sign. Fine “Velcro-like” basal crackles are well-recognized in fibrotic ILD and may precede marked radiographic changes. Their high prevalence underscores the importance of careful chest auscultation in patients with otherwise nonspecific respiratory symptoms. Digital clubbing occurred in 35.0%, tachypnoea in 55.0% and cyanosis in 7.5%. Clubbing and cyanosis are generally associated with more advanced disease, chronic hypoxaemia or extensive fibrosis.

Smoking exposure was documented in 37.5% of participants. Smoking is directly associated with respiratory bronchiolitis-associated ILD, desquamative interstitial pneumonia and pulmonary

Langerhans cell histiocytosis, and it may modify the manifestations of other ILDs. Occupational exposure was found in 32.5%. Barnes et al. (2019).^[12] emphasized that silica exposure remains an important cause of fibrotic lung disease in modern industries. The occupational proportion in the present study highlights the need for detailed questioning regarding mining, stone cutting, construction, agriculture, metal work, dust exposure, birds and moulds. Failure to identify such exposures can result in an erroneous classification of disease as idiopathic.

The heterogeneous clinical population in the present study reflects observations from the Indian ILD registry. Singh et al. (2017).^[13] demonstrated that hypersensitivity pneumonitis, connective-tissue disease-associated ILD and idiopathic pulmonary fibrosis were important contributors to the Indian ILD burden. Kaul et al. (2021).^[14] further documented considerable international variation in the prevalence and relative distribution of ILD subtypes. Therefore, demographic and clinical findings from individual centres should be interpreted in the context of local referral patterns and environmental exposures.

Distribution of HRCT patterns: Reticular opacity was the predominant HRCT pattern, occurring in 90.0% of participants, followed by nodular opacity in 67.5% and septal thickening in 60.0%. This distribution was comparable to Madhu and Santhosh (2020).^[4] who reported reticular opacity in 90%, nodular opacity in 63% and septal thickening in 50%. Pal et al. (2019).^[1] also identified reticular opacity as the leading radiological pattern, although at a lower frequency.

Ground-glass opacity and traction bronchiectasis were each present in 47.5%, indicating that both inflammatory or partially reversible abnormalities and established fibrotic remodelling were represented. Rea et al. (2021).^[15] described HRCT as fundamental for recognizing combinations of reticulation, ground-glass opacity, honeycombing, traction bronchiectasis, nodules and mosaic attenuation. These features must be evaluated together with their axial and craniocaudal distribution because no individual sign, except in a highly characteristic context, establishes a specific diagnosis.

Honeycombing was present in 30.0%, suggesting established fibrosis in nearly one-third of the participants. Current diagnostic guidelines classify HRCT appearances into usual interstitial pneumonia, probable usual interstitial pneumonia, indeterminate and alternative-diagnosis patterns rather than relying only on isolated abnormalities. Raghu et al. (2022).^[16] reiterated that subpleural and basal reticulation with traction bronchiectasis and honeycombing strongly supports a fibrotic usual interstitial pneumonia pattern.

The presence of air trapping in 22.5% suggests small-airway involvement in a subset of patients. This observation may be relevant to hypersensitivity pneumonitis and connective-tissue disease-

associated bronchiolar involvement. Expiratory imaging is therefore useful when inspiratory images show mosaic attenuation or when small-airway disease is clinically suspected. Hatabu et al. (2020).^[17] also emphasized the importance of systematic characterization and follow-up of interstitial abnormalities detected on CT, especially among older adults and individuals with smoking or occupational risk factors.

The statistical tests presented in Table 3 compared the presence and absence of each HRCT feature; they did not measure diagnostic accuracy or superiority over chest radiography. Therefore, significant values for reticulation, nodules, honeycombing and air trapping should be interpreted as evidence that their observed distribution differed from an equal 50:50 distribution, rather than as evidence of greater diagnostic performance.

Additional diagnostic yield of HRCT: The greatest additional yield of HRCT was for septal thickening, for which 13 extra cases were detected, representing an absolute gain of 32.5% (95% CI: 20.1–48.0; $p < 0.001$). This was followed by lymphadenopathy, with an additional yield of 22.5% ($p = 0.004$), and nodular opacity, with an additional yield of 20.0% ($p = 0.008$). HRCT also produced significant gains of 17.5% for reticular opacity, traction bronchiectasis and ground-glass opacity.

These results agree with Patel et al. (2020).^[18] Prabhu (2020).^[19] Madhu and Santhosh (2020).^[4] and Agrawal et al. (2019)[5], who consistently found that HRCT depicted a greater number of interstitial abnormalities and permitted better characterization of their morphology and distribution than conventional radiography. Bani et al. (2021).^[6] also documented the wide spectrum of septal thickening, ground-glass opacity, honeycombing and bronchiectasis identifiable with HRCT.

The superior yield of HRCT has practical clinical importance. Recognition of a characteristic pattern may guide multidisciplinary diagnosis, select appropriate sites for bronchoalveolar lavage or biopsy and, in some patients, avoid surgical lung biopsy. Walsh et al. (2016).^[20] demonstrated that multidisciplinary evaluation improves diagnostic agreement by integrating clinical, radiological and pathological information. HRCT should therefore be considered a central component of multidisciplinary diagnosis rather than an isolated definitive test.

Advanced image interpretation and computer-assisted approaches may further improve reproducibility. Walsh et al. (2018).^[21] demonstrated that deep-learning classification of fibrotic lung disease on HRCT could achieve performance comparable to thoracic radiologists in selected settings. However, such approaches complement rather than replace expert assessment and clinical integration.

The absence of additional HRCT yield for consolidation should not be interpreted as equivalence of the two modalities for the entire ILD assessment. Radiography may identify conspicuous

consolidation but remains limited in differentiating active air-space disease from fine ground-glass change, coexisting fibrosis or small nodular abnormalities. Skeoch et al. (2018).^[22] similarly highlighted the importance of HRCT pattern recognition when assessing drug-induced ILD, where consolidation and ground-glass opacity may overlap with infection, oedema and other inflammatory conditions.

CONCLUSION

HRCT detected and characterized pulmonary abnormalities more effectively than conventional chest radiography in patients with clinically suspected interstitial lung disease. Reticular opacity was the predominant HRCT pattern, followed by nodular opacity, septal thickening, lymphadenopathy, traction bronchiectasis and ground-glass opacity. HRCT provided its greatest additional diagnostic yield for septal thickening, lymphadenopathy and nodular opacities. Conventional radiography remained useful as an accessible initial investigation and demonstrated consolidation effectively; however, it frequently missed subtle interstitial abnormalities. Therefore, HRCT should be performed when ILD is clinically suspected, even when chest radiographic findings are normal, equivocal or limited. Imaging findings should ultimately be interpreted with clinical, laboratory and, when required, histopathological information through multidisciplinary evaluation.

Limitations Of Study: The study had the following limitations:

1. The sample size was small, with only 40 participants, resulting in relatively wide confidence intervals and limited statistical power for uncommon findings.
2. It was a single-centre, hospital-based study using convenience sampling; therefore, the findings may not be generalizable to the wider population.
3. The study included a heterogeneous group of suspected ILDs with different underlying causes, disease stages and treatment histories.
4. Histopathology or multidisciplinary consensus diagnosis was not used as a uniform reference standard. Consequently, sensitivity, specificity, predictive values and diagnostic accuracy could not be calculated.
5. The radiologists were not blinded to the available clinical information, introducing the possibility of observer bias.
6. Interobserver agreement for the interpretation of radiographic and HRCT patterns was not evaluated.
7. Pulmonary function tests, oxygen saturation, serological findings and clinical severity were not systematically correlated with imaging abnormalities.
8. The extent and severity of individual HRCT abnormalities were not quantified using a validated scoring system.
9. Expiratory and prone HRCT images were not obtained uniformly in every patient, which may have affected the evaluation of air trapping and dependent opacities.
10. The cross-sectional design prevented assessment of disease progression, treatment response and the prognostic significance of individual imaging patterns.

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