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PATTERN OF INTERSTITIAL LUNG DISEASE USING HRCT IN CLINICALLY SUSPECTED CASES

Radio-Diagnosis

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ABSTRACT

INTRODUCTION: Interstitial lung diseases (ILD) are a heterogeneous group of diffuse parenchymal lung disorders characterised by inflammation, fibrosis, and architectural distortion of the lung interstitium. High-resolution computed tomography is key to detection of interstitial abnormalities, definition of disease distribution and classification of radiological patterns in clinically suspected cases due to overlapping and nonspecific clinical presentation .**OBJECTIVES:** To characterize and classify various Interstitial Lung Disease, particularly idiopathic interstitial pneumonias, according to their HRCT appearance, and to characterize the various HRCT patterns of interstitial lung disease in clinically suspected patients.**METHODS:** This cross-sectional observational study was conducted at the Department of Radio-diagnosis of BRD Medical College and Nehru Hospital, a multidisciplinary tertiary care referral hospital, over a period of 12 months. A total of 50 cases with positive findings of interstitial lung disease among inpatients and outpatients were included. Clinically suspected cases of interstitial lung disease based on symptoms such as chronic cough, dyspnea, or abnormal pulmonary function tests were evaluated using HRCT chest on a GE Healthcare Optima 64-slice CT machine. Data were analysed using SPSS software version 17.**RESULTS:** Among the 50 clinically suspected ILD patients, 28 were male and 22 were female, with a mean age of 36 ± 9 years. Cough was the most frequent presenting complaint, noted in 45 patients (90.0%), followed by dyspnea in 38 patients (76.0%). On HRCT, reticulation was observed in 24 patients (48.0%), while ground-glass opacity and fibrosis were each present in 22 patients (44.0%). The predominant HRCT pattern was UIP in 18 patients (36.0%), followed by NSIP in 12 patients (24.0%) and hypersensitivity pneumonitis in 8 patients (16.0%). Honeycombing showed significant association with fibrotic-predominant diagnosis (OR 4.8; 95% CI: 1.5–15.1; p=0.009) and demonstrated the highest AUC for predicting UIP-predominant fibrotic pattern (AUC 0.84; 95% CI: 0.73–0.94; p<0.001).**CONCLUSION:** HRCT is an important non invasive imaging modality for characterisation and classification of the interstitial lung disease in clinically suspected cases . It allows to identify dominant ILD patterns and lesion distribution and fibrotic markers. UIP was the most common HRCT pattern in this cohort. Significant radiological predictors of fibrotic disease were honeycombing, fibrosis and reticulation.

KEYWORDS

Interstitial Lung Disease, Hrct, Usual Interstitial Pneumonia, Non-specific Interstitial Pneumonia, Hypersensitivity Pneumonitis, Ground-glass Opacity, Honeycombing, Reticulation.

INTRODUCTION

Interstitial lung diseases are a heterogeneous group of diffuse parenchymal lung diseases involving the pulmonary interstitium, alveolar structures, and supporting connective tissue framework. These disorders are characterised by different degrees of inflammation, fibrosis and architectural distortion that may ultimately result in progressive respiratory impairment. Clinically, patients often present with nonspecific symptoms including chronic cough, exertional dyspnoea, and abnormal pulmonary function, making imaging a critical element in diagnosis and classification.[1]

High-resolution computed tomography has become the modality of choice for evaluating suspected ILD because it provides detailed visualisation of secondary pulmonary lobules and subtle interstitial abnormalities. HRCT can identify characteristic features including ground-glass opacity, reticulation, honeycombing, bronchiectatic changes, bronchiolectasis, air trapping and fibrosis. These imaging features help to differentiate fibrotic from non-fibrotic disease patterns and provide a structured basis for radiological categorisation.[2]

The pattern-based approach to HRCT interpretation is especially important in idiopathic interstitial pneumonias and other diffuse parenchymal lung diseases. Usual interstitial pneumonia, non-specific interstitial pneumonia, hypersensitivity pneumonitis, organising pneumonia, other ILD patterns and indeterminate patterns may have overlapping clinical features, but differ in distribution, extent, zonal predominance and associated fibrotic markers.[3] Thus, in radiological assessment both morphology and anatomical distribution have to be considered.

Conventional chest radiography may miss early or subtle interstitial abnormalities, while HRCT has better sensitivity for detection of parenchymal change and disease extent. In clinically suspected cases, HRCT can reduce diagnostic uncertainty, guide further workup, aid multidisciplinary decision-making, and assist in management planning.[4] HRCT is especially useful in tertiary centres where patients are referred with ongoing respiratory symptoms, abnormal pulmonary function tests or unexplained diffuse lung disease.

The present study was done with the aim to characterise and classify interstitial lung disease patterns using HRCT in clinically suspected cases attending or referred to BRD Medical College and Nehru Hospital. The study aimed to evaluate the spectrum of HRCT findings, predominant radiological patterns, distribution of lesions and predictors of fibrotic predominant disease in a hospital based cohort.

MATERIALS & METHODS

Study design: Cross-sectional observational study.

Study area: This study was conducted at the Department of Radio-diagnosis of BRD Medical College and Nehru Hospital. It was a multi-disciplinary tertiary care referral hospital.

Source of data: Data for the study were collected from patients attending/referred to BRD Medical College and Nehru Hospital.

Study population: Clinically suspected cases of Interstitial Lung Disease based on symptoms like chronic cough, dyspnea, or abnormal pulmonary function tests who were attending/referred to BRD Medical College and Nehru Hospital were included.

Period of data collection: 12 months.

Sample size: A total of 50 cases with positive findings of interstitial lung disease among inpatients and outpatients were collected. The sample size was calculated using prevalence of ILDs in India as 3.1%, confidence level 95%, and precision ±5%. The calculated sample size was 47, which was increased to 50 to allow for a predicted dropout from treatment.

Sampling technique: Consecutive sampling technique was used in this study. Every patient suspected to have ILD who underwent HRCT was recruited after obtaining consent. Average monthly patients of suspected ILD were approximately 3–4 patients per month.

Inclusion criteria:
All patients with clinically suspected interstitial lung disease referred for HRCT were included in the study after taking their informed consent.

All age groups and both sexes, including children, adults, and elderly patients, were included in the study.

Exclusion criteria:
Patients with associated lung pathology like consolidation or mass.
Hemodynamically unstable and unconscious patients.
All patients who did not consent to be a part of the study.

Imaging protocol: GE Healthcare Optima 64-slice CT machine was used for this study. Each patient underwent a thorough clinical evaluation including detailed history and physical examination. Duration of complaints was noted in each patient. All patients underwent HRCT scan as the radiological examination after obtaining informed consent. HRCT evaluation included characterization of the pattern and profusion of lesions at representative anatomical levels.

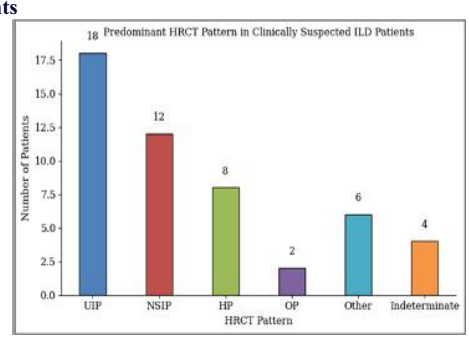
Data analysis: Data analysis was performed using SPSS software version 17. Quantitative variables were presented as means and standard deviation and were compared using paired t-test. Qualitative variables were presented as frequencies and percentages and were compared using chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

The study included 50 clinically suspected ILD patients. Among them, 15 patients (30%) were aged 18–30 years, 22 patients (44%) were aged 31–45 years, and 13 patients (26%) were aged 46–60 years. The mean age was 36 ± 9 years. Males constituted 28 cases (56%) and females 22 cases (44%). Education status included 10 patients (20%) with illiterate/primary education, 25 patients (50%) with secondary education, and 15 patients (30%) with graduate or above education. According to Kuppuswamy socioeconomic status, 4 patients (8%) belonged to upper class, 10 (20%) upper middle, 18 (36%) middle, 12 (24%) lower middle, and 6 (12%) lower class.

Cough was the most frequent presenting complaint, noted in 45 patients (90.0%), followed by dyspnea in 38 patients (76.0%). Dry cough was present in 30 patients (60.0%), whereas cough with fever was reported in 15 patients (30.0%). Relevant clinical history showed chronic cough in 40 patients (80.0%), abnormal pulmonary function test findings in 22 cases (44.0%), smoking history in 12 patients (24.0%), occupational exposure in 10 (20.0%), environmental exposure in 15 (30.0%), and past respiratory disease in 8 patients (16.0%). On physical examination, bibasilar dry crackles were present in 40 patients (80.0%), tachypnea in 35 patients (70.0%), clubbing in 15 patients (30.0%), late inspiratory high-pitched rhonchi in 12 patients (24.0%), and cyanosis in 5 patients (10.0%).

Figure 1: Predominant HRCT Pattern in Clinically Suspected ILD Patients



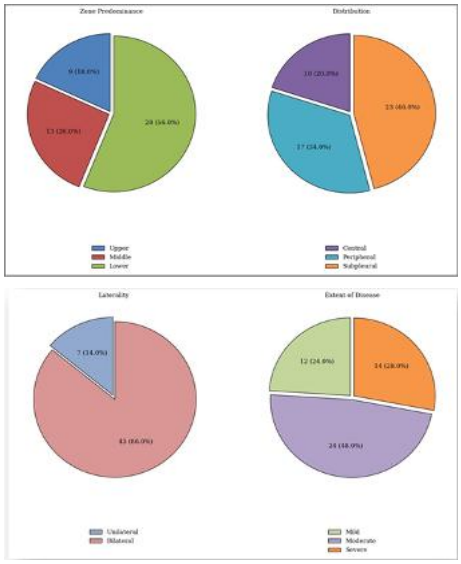
Among the 50 clinically suspected ILD patients, UIP was the commonest HRCT pattern, accounting for 18 cases (36.0%), followed by NSIP in 12 cases (24.0%) and hypersensitivity pneumonitis in 8 cases (16.0%). Other ILD patterns were seen in 6 cases (12.0%), indeterminate pattern in 4 cases (8.0%), and organizing pneumonia in 2 cases (4.0%). The total distribution comprised all 50 cases.

Table 1: HRCT Findings in Clinically Suspected ILD Patients, n = 50

HRCT feature	Present n (%)	Absent n (%)
Honeycombing	14 (28.0)	36 (72.0)
Bronchiectasis	13 (26.0)	37 (74.0)
Bronchiolectasis	9 (18.0)	41 (82.0)
Reticulation	24 (48.0)	26 (52.0)
Ground-glass opacity	22 (44.0)	28 (56.0)
Air trapping	14 (28.0)	36 (72.0)
Consolidation	3 (6.0)	47 (94.0)
Fibrosis	22 (44.0)	28 (56.0)

In Table 1, reticulation was the most frequent HRCT finding, observed in 24 patients (48.0%). Ground-glass opacity and fibrosis were each present in 22 patients (44.0%). Honeycombing and air trapping were each observed in 14 patients (28.0%), bronchiectasis in 13 (26.0%), bronchiolectasis in 9 (18.0%), and consolidation in 3 patients (6.0%).

Figure 2: Zone-wise Distribution of HRCT Lesions in Clinically Suspected ILD Patients, n = 50



Lower zone predominance was the commonest zonal distribution, seen in 28 patients (56.0%), followed by middle zone in 13 patients (26.0%) and upper zone in 9 patients (18.0%). Subpleural distribution was present in 23 patients (46.0%), peripheral distribution in 17 (34.0%), and central distribution in 10 (20.0%). Bilateral involvement was seen in 43 patients (86.0%), whereas unilateral disease was present in 7 patients (14.0%). Moderate profusion was observed in 24 patients (48.0%), severe in 14 (28.0%), and mild in 12 (24.0%).

Table 2: Distribution and Extent of HRCT Lesions in Clinically Suspected ILD Patients, n = 50

Parameter	Category	n (%)
Zone predominance	Upper	9 (18.0)
	Middle	13 (26.0)
	Lower	28 (56.0)
Distribution	Central	10 (20.0)
	Peripheral	17 (34.0)
	Subpleural	23 (46.0)
Laterality	Unilateral	7 (14.0)
	Bilateral	43 (86.0)
Extent/profusion	Mild	12 (24.0)
	Moderate	24 (48.0)
	Severe	14 (28.0)

In Table 2, the most common anatomical pattern was lower-zone, subpleural, bilateral disease with moderate extent/profusion. This

distribution supports the predominance of fibrotic and basal interstitial involvement in the study cohort.

Table 3: Association of HRCT Parameters with Fibrotic-Predominant Diagnosis and UIP-Predominant Fibrotic Pattern

Section	Variable / predictor	Value / result	p-value
HRCT findings association with fibrotic-predominant diagnosis (UIP/NSIP)	Honeycombing	OR 4.8; 95% CI: 1.5–15.1	0.009
	Reticulation	OR 2.9; 95% CI: 1.1–7.4	0.028
	Ground-glass opacity	OR 1.6; 95% CI: 0.6–4.1	0.24
	Fibrosis	OR 3.6; 95% CI: 1.3–9.7	0.014
Predictors of UIP pattern by multivariate logistic regression	Age >40 years	OR 2.4; 95% CI: 1.1–5.2	0.031
	Smoking history	OR 3.4; 95% CI: 1.2–9.2	0.019
	Honeycombing	OR 5.1; 95% CI: 1.6–16.2	0.006
	Fibrosis	OR 3.8; 95% CI: 1.3–10.8	0.012
ROC analysis for UIP-predominant fibrotic pattern	Honeycombing	AUC 0.84; 95% CI: 0.73–0.94	<0.001
	Reticulation	AUC 0.76; 95% CI: 0.64–0.88	0.002
	Fibrosis	AUC 0.81; 95% CI: 0.70–0.92	<0.001
	Age >40 years	AUC 0.69; 95% CI: 0.56–0.82	0.016
	Smoking history	AUC 0.72; 95% CI: 0.60–0.84	0.008

In Table 3, honeycombing, reticulation, and fibrosis were significantly associated with fibrotic-predominant diagnosis. On multivariate logistic regression for UIP pattern, age >40 years, smoking history, honeycombing, and fibrosis were significant predictors. ROC analysis showed that honeycombing had the highest discriminatory performance for UIP-predominant fibrotic pattern, with AUC 0.84 (95% CI: 0.73–0.94; p<0.001), followed by fibrosis with AUC 0.81 (95% CI: 0.70–0.92; p<0.001).

DISCUSSION

The present study evaluated HRCT patterns of interstitial lung disease in clinically suspected cases at the Department of Radio-diagnosis, BRD Medical College and Nehru Hospital. The study was conducted as a cross-sectional observational investigation and included 50 patients with positive HRCT findings of interstitial lung disease. The main purpose was to characterize and classify interstitial lung diseases, particularly idiopathic interstitial pneumonias, according to their HRCT appearance.

The demographic profile showed that the majority of patients belonged to the 31–45 year age group, comprising 22 of 50 cases (44%), followed by 18–30 years in 15 cases (30%) and 46–60 years in 13 cases (26%). The mean age was 36 ± 9 years, with a modest male predominance of 28/50 (56%) compared with 22/50 (44%) females. This distribution indicates that clinically suspected ILD in the present cohort was observed mainly among younger and middle-aged adults. Similar studies have emphasized that HRCT-based ILD cohorts may vary in age and sex distribution depending on referral pattern, underlying disease composition, and exposure profile.[5,9]

Cough and dyspnea were the dominant clinical complaints in the present study. Cough was reported in 45 patients (90.0%), while dyspnea was present in 38 patients (76.0%). Dry cough was present in 30 patients (60.0%) and cough with fever in 15 patients (30.0%). This symptom pattern reflects the nonspecific clinical nature of ILD, where clinical presentation alone is insufficient for accurate subtype classification. Roy et al. described ILD as a heterogeneous disorder commonly associated with dyspnea, diffuse parenchymal lung involvement, restrictive physiology, and impaired gas exchange.[4] Palleiro et al. also emphasized the importance of clinicoradiological correlation because diffuse interstitial lung diseases often require pattern-based imaging interpretation for meaningful classification.[6] Relevant clinical history showed chronic cough in 40 patients (80.0%), dyspnea in 38 patients (76.0%), abnormal pulmonary function test findings in 22 patients (44.0%), smoking history in 12 patients (24.0%), occupational exposure in 10 patients (20.0%), environmental exposure in 15 patients (30.0%), and past respiratory disease in 8 patients (16.0%). These findings demonstrate that clinical suspicion of ILD was based on a combination of persistent respiratory symptoms, exposure history, and functional abnormality. Smoking history was significantly associated with major HRCT patterns, being present in 7 of 18 UIP cases (38.9%), 2 of 12 NSIP cases (16.7%), 2 of 8 hypersensitivity pneumonitis cases (25.0%), and none of the organizing pneumonia cases, with p-value 0.041. This supports the interpretative relevance of exposure history when assessed alongside imaging morphology.

On physical examination, bibasilar dry crackles were the commonest finding, present in 40 patients (80.0%), followed by tachypnea in 35 patients (70.0%), clubbing in 15 patients (30.0%), late inspiratory high-pitched rhonchi in 12 patients (24.0%), and cyanosis in 5 patients (10.0%). Bibasilar dry crackles were present in all UIP cases (100.0%), 11 of 12 NSIP cases (91.7%), 6 of 8 hypersensitivity pneumonitis cases (75.0%), and 1 of 2 organizing pneumonia cases (50.0%), with p-value 0.018. These findings are clinically compatible with interstitial parenchymal involvement and support the role of bedside examination in raising suspicion, although exact pattern classification depends predominantly on HRCT.

The HRCT spectrum in this study was dominated by reticulation, ground-glass opacity, and fibrosis. Reticulation was observed in 24 patients (48.0%), while ground-glass opacity and fibrosis were each seen in 22 patients (44.0%). Honeycombing and air trapping were each observed in 14 patients (28.0%), bronchiectasis in 13 patients (26.0%), bronchiolectasis in 9 patients (18.0%), and consolidation in 3 patients (6.0%). These findings are consistent with the pattern-based HRCT approach described in radiological literature, where reticulation, ground-glass opacity, honeycombing, traction bronchiectasis, and fibrosis are important markers for classifying diffuse interstitial lung disease.[6,7,8]

UIP was the most common HRCT pattern in the present study, accounting for 18 cases (36.0%), followed by NSIP in 12 cases (24.0%) and hypersensitivity pneumonitis in 8 cases (16.0%). Other ILD patterns were seen in 6 cases (12.0%), indeterminate pattern in 4 cases (8.0%), and organizing pneumonia in 2 cases (4.0%). The predominance of UIP is clinically important because fibrotic UIP-pattern disease carries diagnostic and prognostic significance. Previous literature has also emphasized the importance of HRCT in identifying UIP and related fibrotic patterns, especially when imaging findings are sufficiently characteristic to guide multidisciplinary diagnosis.[12,13,15]

The anatomical distribution further supported the predominance of fibrotic lower-zone disease. Lower zone predominance was seen in 28 patients (56.0%), followed by middle zone in 13 patients (26.0%) and upper zone in 9 patients (18.0%). Subpleural distribution was present in 23 patients (46.0%), peripheral distribution in 17 patients (34.0%), and central distribution in 10 patients (20.0%). Bilateral involvement was observed in 43 patients (86.0%). This lower-zone, subpleural, bilateral distribution is radiologically compatible with fibrotic interstitial disease and supports the observed predominance of UIP and NSIP patterns.

Regression analysis demonstrated that honeycombing, reticulation, and fibrosis were significant radiological markers of fibrotic-predominant diagnosis. Honeycombing showed OR 4.8 with 95% CI 1.5–15.1 and p=0.009; reticulation showed OR 2.9 with 95% CI 1.1–7.4 and p=0.028; and fibrosis showed OR 3.6 with 95% CI 1.3–9.7 and p=0.014. Ground-glass opacity did not show significant association, with OR 1.6, 95% CI 0.6–4.1, and p=0.24. These findings suggest that structural fibrotic features carried stronger diagnostic weight than inflammatory-appearing ground-glass opacity in identifying fibrotic-predominant disease.

Multivariate logistic regression for UIP pattern identified age >40

years, smoking history, honeycombing, and fibrosis as significant predictors. Honeycombing showed the strongest association with UIP pattern, with OR 5.1, 95% CI 1.6–16.2, and p=0.006. Fibrosis showed OR 3.8, 95% CI 1.3–10.8, and p=0.012. Smoking history showed OR 3.4, 95% CI 1.2–9.2, and p=0.019, while age >40 years showed OR 2.4, 95% CI 1.1–5.2, and p=0.031. ROC analysis further confirmed that honeycombing had the highest predictive performance for UIP-predominant fibrotic pattern, with AUC 0.84, 95% CI 0.73–0.94, and p<0.001.

Overall, the study demonstrates that HRCT reliably delineates the radiological spectrum of interstitial lung disease in clinically suspected cases. Clinical symptoms and examination findings are important for raising suspicion, but the discriminatory strength for pattern classification lies mainly in HRCT morphology. The findings support the role of HRCT not only as a detection tool but also as a structured modality for pattern-based classification, especially for fibrotic phenotypes.

CONCLUSION

The present study concludes high resolution computed tomography is a clinically useful and analytically robust modality for characterisation and classification of interstitial lung disease in clinically suspected patients. In this cohort of 50 patients, usual interstitial pneumonia was the commonest HRCT pattern followed by non-specific interstitial pneumonia and hypersensitivity pneumonitis. The most common anatomical distribution was lower-zone, subpleural and bilateral involvement.

Reticulation, ground-glass opacity and fibrosis were the most common individual HRCT abnormalities. Honeycombing, fibrosis and reticulation were significantly associated with fibrotic-predominant disease, while honeycombing had the strongest discriminatory performance for UIP-predominant fibrotic pattern on ROC analysis. HRCT thus provides a reliable framework for radiological classification of ILD and supports its central role in the structured diagnostic evaluation of clinically suspected interstitial lung disease.

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