



Original Article

Spectrum of HRCT Findings in Cases of Interstitial Lung Disease with Pulmonary Function Test Correlation

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Article History:

Received on: Aug 16, 2026

Revised on: Sep 15, 2026

Accepted on: Sep 22, 2026

Published on: Oct 04, 2026

Citation: Ankita Chaudhary *et al.*
Spectrum of HRCT Findings in Cases
of Interstitial Lung Disease with
Pulmonary Function Test
Correlation. *Biomedicine and
Chemical Sciences*, 5 (4): 12-16,
2026

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Published in *Biomedicine and
Chemical Sciences*



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ABSTRACT

Background: Interstitial lung disease (ILD) comprises a heterogeneous group of disorders with inflammation and fibrosis of the lung parenchyma. High-resolution computed tomography (HRCT) characterizes morphological patterns, while pulmonary function tests (PFTs) quantify functional impairment.

Objective: To evaluate the spectrum of HRCT findings in patients with ILD and to correlate radiological patterns and severity with PFT parameters at a tertiary care centre.

Methods: A prospective, cross-sectional observational study was conducted over 18 months in the Departments of Radiodiagnosis and Pulmonary Medicine. Fifty adults with clinically suspected or diagnosed ILD underwent HRCT thorax and PFTs (spirometry and DLCO) on the same day or within one week. HRCT findings, distribution, and severity were recorded by two radiologists blinded to PFT results and correlated with FVC, DLCO, and restrictive pattern using chi-square tests and ROC analysis ($p < 0.05$ significant).

Results: Mean age was 47.02 ± 11.12 years; 56% were male and 64% were non-smokers. Dyspnea (92%) and cough (78%) were the commonest symptoms. UIP/IPF was the leading diagnosis (36%), followed by NSIP (24%). Reticular opacity (76%), ground-glass opacity (64%), and lower-lobe predominance (48%) were frequent. Moderate-to-severe HRCT involvement was seen in 72%. Restrictive PFT pattern was present in 84%; mean FVC was $63.10 \pm 15.21\%$ and mean DLCO $57.10 \pm 14.76\%$. Major HRCT findings and HRCT severity were significantly associated with restrictive dysfunction. FVC and DLCO each showed an AUC of 0.915 for predicting restrictive pattern.

Conclusion: HRCT pattern, distribution, and severity closely correlate with restrictive physiology and diffusion impairment in ILD. Combined HRCT and PFT assessment is essential for diagnosis and severity evaluation.

Keywords: Interstitial lung disease; High-resolution computed tomography; Pulmonary function tests; Usual interstitial pneumonia; Forced vital capacity; Diffusing capacity.

INTRODUCTION

Interstitial lung disease (ILD) represents a diverse category of clinico-pathological entities characterized by varying degrees of inflammation and fibrosis within the lung parenchyma¹. Clinical presentation is often non-specific, typically progressive exertional dyspnea and persistent dry cough, which may delay diagnosis². High-resolution computed tomography (HRCT) has become central to multidisciplinary diagnosis and can reliably identify patterns such as usual interstitial pneumonia (UIP), often reducing the need for surgical lung biopsy³⁴.

The physiological hallmark of ILD is a restrictive ventilatory defect with reduced lung volumes and impaired gas exchange⁵. Forced vital capacity (FVC) and diffusing capacity of the lung for carbon monoxide (DLCO) are essential for quantifying functional impairment and for monitoring disease course⁶⁷. HRCT defines morphological pattern and anatomical extent, whereas PFTs assess physiological impact; correlation between radiological burden and functional impairment supports severity assessment and follow-up⁸⁹. The present study evaluated the spectrum of HRCT findings in ILD and correlated radiological severity with contemporaneous PFT parameters in a tertiary care setting.

MATERIALS AND METHODS

This prospective, cross-sectional observational study was conducted in the Departments of Radiodiagnosis and Pulmonary Medicine at Geetanjali Medical College and Hospital, Udaipur, Rajasthan, over 18 months (October 2024 to March 2026), after approval from the institutional ethics committee. Written informed consent was obtained from all participants.

Adults aged 18 years or above of either gender with clinically suspected ILD or previously diagnosed ILD undergoing severity evaluation were included. Patients with acute respiratory infection or pneumonia at evaluation, known primary cardiac failure or significant valvular heart disease, inability to perform PFTs, pregnancy, or contraindications to CT were excluded. Fifty patients who completed both HRCT and PFT evaluation formed the analyzed cohort (N = 50).

HRCT of the thorax was performed on a multidetector CT scanner in the supine position at full inspiration, with prone and expiratory acquisitions as required. Images were independently reviewed by two experienced radiologists blinded to PFT results. Ground-glass opacity, reticular opacity, honeycombing, traction bronchiectasis, interlobular septal thickening, lobar distribution, and semi-quantitative severity (mild, moderate, severe) with an HRCT severity score were recorded. PFTs were performed according to ATS/ERS standards and included FVC, FEV1, FEV1/FVC, and DLCO, on the same day or within one week of HRCT.

Data were analyzed using SPSS. Descriptive statistics summarized demographic and clinical variables. Associations between categorical variables and restrictive versus non-restrictive PFT interpretation were assessed with chi-square tests. Diagnostic performance of FVC% and DLCO% for restrictive pattern was evaluated by ROC analysis. A p-value < 0.05 was considered statistically significant.

RESULTS

The mean age of the study population was 47.02 ± 11.12 years. The largest age groups were 41–50 years (30.0%) and 51–60 years (28.0%). Males comprised 56.0% and females 44.0%. Non-smokers predominated (64.0%). Dyspnea (92.0%) and cough (78.0%) were the leading symptoms, followed by fatigue (50.0%), chest pain (20.0%), and weight loss (16.0%) (Tables 1 and 2).

Table 1. Age distribution of study participants (N = 50)

Age Category (years)	n	%
18–30	5	10.0
31–40	9	18.0
41–50	15	30.0
51–60	14	28.0
61–65	7	14.0
Total	50	100.0

Table 2. Demographic and clinical profile (N = 50)

Variable	Category	n (%)
Gender	Male	28 (56.0)
	Female	22 (44.0)
Smoking	Non-smoker	32 (64.0)
	Smoker	18 (36.0)
Symptoms	Dyspnea	46 (92.0)
	Cough	39 (78.0)
	Fatigue	25 (50.0)
	Chest pain	10 (20.0)
	Weight loss	8 (16.0)

UIP/IPF was the most common clinical and HRCT diagnosis (36.0%), followed by NSIP (24.0%), hypersensitivity pneumonitis (16.0%), CTD-ILD (14.0%), sarcoidosis (6.0%), and others (4.0%). Clinical and HRCT diagnostic distributions were identical (Table 3).

Table 3. Clinical and HRCT diagnosis (N = 50)

Diagnosis	n	%
UIP/IPF	18	36.0
NSIP	12	24.0
Hypersensitivity pneumonitis	8	16.0
CTD-ILD	7	14.0
Sarcoidosis	3	6.0
Others	2	4.0
Total	50	100.0

Reticular opacity was the commonest HRCT finding (76.0%), followed by ground-glass opacity (64.0%), interlobular septal thickening (62.0%), traction bronchiectasis (54.0%), and honeycombing (40.0%). Lower-lobe involvement predominated (48.0%), with diffuse involvement in 36.0% and upper-lobe involvement in 16.0%. HRCT severity was moderate in 42.0%, severe in 30.0%, and mild in 28.0%; thus 72.0% had moderate-to-severe radiological disease (Tables 4 and 5).

Table 4. HRCT findings and distribution (N = 50)

HRCT Finding / Distribution	Present n (%)
Ground-glass opacity	32 (64.0)
Reticular opacity	38 (76.0)
Honeycombing	20 (40.0)
Traction bronchiectasis	27 (54.0)
Interlobular septal thickening	31 (62.0)
Lower-lobe involvement	24 (48.0)
Diffuse involvement	18 (36.0)
Upper-lobe involvement	8 (16.0)

Table 5. HRCT severity (N = 50)

HRCT Severity	n	%
Mild	14	28.0
Moderate	21	42.0

HRCT Severity	n	%
Severe	15	30.0
Total	50	100.0

A restrictive PFT pattern was present in 42 patients (84.0%). Mean FVC was $63.10 \pm 15.21\%$ and mean DLCO $57.10 \pm 14.76\%$. DLCO reduction was moderate in 50.0%, mild in 32.0%, severe in 14.0%, and normal in only 4.0% (Table 6).

Table 6. Pulmonary function findings (N = 50)

Parameter	Value
Restrictive PFT pattern	42 (84.0%)
Non-restrictive pattern	8 (16.0%)
Mean FVC (%)	63.10 ± 15.21
Mean DLCO (%)	57.10 ± 14.76
DLCO mild reduction	16 (32.0%)
DLCO moderate reduction	25 (50.0%)
DLCO severe reduction	7 (14.0%)
DLCO normal	2 (4.0%)

Age category was not associated with PFT interpretation ($\chi^2 = 1.153$, $p = 0.886$). Gender showed a highly significant association: all males had restrictive dysfunction versus 63.6% of females ($\chi^2 = 12.121$, $p < 0.001$). All smokers were restrictive versus 75.0% of non-smokers ($\chi^2 = 5.357$, $p = 0.021$). Dyspnea, cough, and fatigue were significantly associated with restriction ($p < 0.001$, $p < 0.001$, and $p = 0.002$, respectively).

Ground-glass opacity, reticular opacity, honeycombing, traction bronchiectasis, and interlobular septal thickening were each significantly associated with restrictive dysfunction ($p < 0.001$, $p < 0.001$, $p = 0.012$, $p = 0.001$, and $p < 0.001$, respectively). Lung distribution ($p < 0.001$), HRCT severity ($\chi^2 = 22.222$, $p < 0.001$), HRCT severity score ($\chi^2 = 23.214$, $p = 0.003$), and DLCO category ($\chi^2 = 12.245$, $p = 0.007$) were also significantly associated with PFT interpretation.

ROC analysis showed excellent accuracy of FVC% and DLCO% for predicting restrictive pattern (each AUC 0.915; 95% CI 0.837–0.993; $p < 0.001$). Optimal cut-offs were FVC 46.50% and DLCO 42.50%, each with sensitivity 85.7%.

DISCUSSION

In this tertiary-care cohort, ILD predominantly affected middle-aged adults, with mild male predominance and a substantial proportion of non-smokers, underscoring multifactorial etiology beyond smoking alone¹⁰¹¹. Dyspnea and cough dominated the clinical picture, consistent with typical ILD presentation².

UIP/IPF as the leading pattern, followed by NSIP and hypersensitivity pneumonitis, aligns with contemporary multidisciplinary classification and the central role of HRCT in pattern recognition¹⁴. Predominance of reticular opacity, frequent traction bronchiectasis and honeycombing, and lower-zone preference reflect a substantial fibrotic burden, while ground-glass opacity indicates coexisting inflammatory change³.

Restrictive physiology in 84% with reduced mean FVC and DLCO confirms the expected physiological hallmark of ILD⁵. Strong associations between major HRCT features, radiological severity, and restrictive dysfunction support combined imaging–physiology assessment for severity staging and follow-up⁸⁹. High AUC values for FVC and DLCO further highlight their complementary diagnostic utility for functional restriction.

Limitations include single-centre design, modest sample size (N = 50), and cross-sectional assessment without longitudinal progression or treatment-response data. Semi-quantitative HRCT scoring, though pragmatic, is less granular than fully quantitative morphometry. Despite these constraints, contemporaneous HRCT and PFT evaluation strengthens clinico-radiological–functional correlation for routine practice.

CONCLUSION

This study demonstrates that HRCT reveals a broad morphological spectrum in ILD, with UIP/IPF and NSIP predominating and fibrotic features frequently present. Radiological findings and severity correlate significantly with restrictive PFT abnormality and reduced DLCO.

Integrated assessment using HRCT and pulmonary function testing should be considered essential for diagnosis, severity evaluation, and follow-up planning in patients with interstitial lung disease.

Overall, early radiological characterization combined with physiological quantification remains the cornerstone of comprehensive ILD evaluation in tertiary care.

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