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Research Article

RADIOLOGICAL EVALUATION OF INTERSTITIAL LUNG DISEASES ON HIGH-RESOLUTION COMPUTED TOMOGRAPHY IN TERTIARY CARE CENTER OF NORTH INDIA

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ABSTRACT

Objective: This study assessed the various high-resolution computed tomography (HRCT) patterns of interstitial lung diseases (ILDs) and to differentially diagnose ILD based on their clinical findings and distribution patterns.

Methods: The study was conducted in the Department of Radiodiagnosis, Government Medical College and Rajindra Hospital, Patiala, Punjab, India. Forty-three patients with clinical suspicion of ILD were enrolled in the study. HRCT scans of the chest were done in all the cases taken in the study.

Results: The mean age (±he age group of 51–60 years. We found slight female preponderance with females accounting for 53.5% and males accounting for 46.5% of the caseload. The most common presenting complaint was dyspnea on exertion (83.7%) followed by cough in 69.8%. The most frequent HRCT finding was septal thickening (90.7%), followed by tractional bronchiectasis (83.7%), fibrotic changes (72.1%), ground-glass opacities (65.1%), and honeycombing (58.1%). Based on HRCT findings, the most common HRCT pattern was the typical usual interstitial pneumonia pattern (58.1%), followed by the non-specific interstitial pneumonia pattern. The final diagnoses were made based on clinic-radiological findings and by the exclusion of other possibilities. The most common ILD reported was idiopathic pulmonary fibrosis (39.5%), followed by connective tissue disorder-ILD (20.9%), and SR-ILD (13.9%). This is followed by idiopathic non-specific interstitial pneumonia (11.6%), persensitivity pneumonitis (6.9%), and cryptogenic organizing pneumonia (2.3%).

Conclusion: HRCT is a valuable technique for evaluating various ILDs even when chest X-rays are normal. It can differentially diagnose ILDs based on their clinical findings and distribution patterns.

Keywords: High-resolution computed tomography, Interstitial lung diseases, Usual interstitial pneumonia, Non-specific interstitial pneumonia, Idiopathic pulmonary fibrosis.

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INTRODUCTION

Interstitial lung diseases (ILDs) are a heterogeneous group of diffuse lung diseases of known and unknown causes. They share similar clinical, radiological, and histological manifestations [1,2].

In 2013, the American Thoracic Society/European Respiratory Society provided an update based on new publications. Major updates included regrouping major idiopathic interstitial pneumonia (IIPs) into chronic fibrosing, smoking-related, acute/subacute IIPs, and AIP. Cryptogenic fibrosing alveolitis was removed from the classification. Rare entities were added to the classification system, such as acute fibrinous and organizing pneumonia and interstitial pneumonia with a bronchiolocentric distribution. Based on newer research, non-specific interstitial pneumonia (NSIP) was upgraded from a provisional diagnosis to a distinct clinicopathologic entity [3].

High-resolution computed tomography (HRCT) comprises multiple sequences, including reconstructions, all of which should be utilized in characterizing ILD. In cases in which HRCT features are not sufficiently specific for a definitive diagnosis, HRCT can aid in selecting the best site for surgical lung biopsy. CT follow-up is useful for identifying progressive fibrosing ILDs [4].

HRCT imaging has a central role in the diagnosis of ILD and has improved the ability to make a definitive diagnosis without the need for lung biopsy in some disorders [5].

METHODS

The study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Pulmonary Medicine at Govt. Medical College and Rajindra Hospital, Patiala.

Study design

Hospital-based cross-sectional study.

Sample size and study population

The study was conducted on 43 patients with clinical suspicion of ILD.

Patient preparation

Informed written consent from patients was taken before the examination.

Inclusion criteria

Patients presenting with

- Connective tissue disorders (CTD) such as systemic lupus erythematosus, rheumatoid disease, systemic sclerosis
- Patients of systemic vasculitis like Wegener's granulomatosis
- Industrial exposure-related diseases such as asbestosis, silicosis, and coal workers' pneumoconiosis
- Medication, drugs, and radiation exposure-related cases
- Cases of idiopathic interstitial pneumonia and hypersensitivity pneumonia
- Patients giving consent to enroll in the study
- Age >18 years.

Exclusion criteria

- Patients who did not give consent for the study
- Pregnant females
- Age <18 years
- Patients with active tuberculosis.

Study equipment

The study was conducted on the GE Healthcare Care Revolution 128-slice CT machine.

CT protocol

The protocol for the HRCT chest was as follows: 120 kVp, 100–200 mAs, slice thickness 0.625–1.25 mm, interval 5 mm, reconstruction interval 0.625 mm.

Image analysis and interpretation

Patients were evaluated on HRCT and various findings as the presence of pulmonary nodules, septal thickening, ground-glass opacities (GGOs), honeycombing, air trapping, lymphadenopathy, fibrosis (fibrotic bands, subpleural reticulations, architectural distortion associated loss of volume, and mediastinal shift, tractional bronchiectasis and other findings (emphysema, bronchial thickening, consolidation, pleural effusion, etc.) were noted.

Ethical consideration

The approval of the institutional ethics and research committee was taken for the study protocol, Govt. Medical College and Rajindra Hospital, Patiala. Written informed consent from all participants was obtained before gathering any information.

RESULTS

Forty-three patients with a clinical suspicion of ILD were enrolled in the study and HRCT of the chest was done on all the patients.

The mean age of the study population was 54.1±13.1 years, with the majority belonging to the 51–60-year (34.9%) age group. The study population consisted of 20 (46.5%) males and 23 (53.5%) females. Smoking was reported among 14% of patients.

Dyspnea and coughing were the most frequent presenting complaints. Dyspnea was reported among 83.7%, cough among 62.8%, weight loss, and chest pain among 13.9%, arthralgia among 11.6%, and fever among 9.3% (Table 2).

In our study, 58% of the patients had no known risk factor. Among patients with known risk factors, the most common risk factor was CTD present in 20.9% followed by smoking in 14%. Among CTD, rheumatoid arthritis was the most common risk factor followed by systemic sclerosis, seen in 9.3% and 7% of patients, respectively (Table 3).

Table 1: Distribution of the study population according to age group, gender, and smoking

	Frequency	Percentage
Age groups		
21–30 years	4	9.2
31–40 years	3	7.0
41–50 years	6	14.0
51–60 years	15	34.9
61–70 years	12	27.9
71–80 years	3	7.0
Mean±SD	54.1±13.1 years	
Gender		
Male	20	46.5
Female	23	53.5
Smoking		
Yes	6	14.0
No	37	86.0

X-ray findings were evident in 24 (55.8%) of the cases. While in 19 cases (44.1%), no significant abnormality was detected on a plain radiograph. The most common X-ray finding was reticular opacities among 27.9% followed by GGOs among 25.6% of patients. In most of the cases, X-ray findings were non-specific and findings cannot be differentiated into various types of ILDs (Table 4).

The most common HRCT finding was septal thickening at 90.7%, followed by tractional bronchiectasis at 83.7%, fibrotic changes at 72.1%, and at 65.1%. Table 5 and Fig. 1 show honeycombing among

Table 2: Incidence of presenting symptoms in patients with interstitial lung diseases

Symptoms	Frequency	Percentage
Dyspnea on exertion	36	83.7
Cough	27	62.8
Fever	4	9.3
Arthralgia	5	11.6
Weight loss	6	13.9
Chest pain	6	13.9

Table 3: Frequency of risk factors in patients enrolled in our study

Underlying disease/exposure	Number	Percentage
Allergen exposure		
Farm worker	2	4.7
Poultry worker	1	2.3
Connective tissue disorder		
MCTD	1	2.3
RA	4	9.3
SSc	3	7.0
SLE	1	2.3
Smoking	6	14
No exposure/CTD	25	58.1
Total	43	100.0

CTD: Connective tissue disorder

Table 4: Frequency of distribution of X-ray findings in the study population

X-ray findings	Frequency	Percentage
Consolidation	1	2.3
Fibrocystic changes	1	2.3
GGO's	11	25.6
Reticular opacities	12	27.9
Honeycombing	2	4.6
Reticulonodular opacities	9	20.9
NAD	19	44.1

GGO: Ground-glass opacities

Table 5: Frequency of distribution of individual HRCT findings in the study population

HRCT findings	Number	Percentage
GGOs	28	65.1
Septal thickening	39	90.7
Honeycombing	25	58.1
Mosaic attenuation	9	20.9
Fibrotic changes	31	72.1
Pulmonary nodules	10	23.3
Tractional bronchiectasis	36	83.7
Mediastinal LAP	18	41.9

HRCT: High-resolution computed tomography, GGO: Ground-glass opacities, LAP: Lymphadenopathy

58.1% of cases followed by pulmonary nodules among 23.3% and mosaic attenuation in 20.9% of patients.

In our study, in 32 out of 43 patients (74.4%), the findings were predominant in lower (basal) lung fields followed by upper lobe predominance in six cases (14%). In five cases (11.5%), there is diffuse involvement of both upper and lower lung fields (Table 6).

Specific patterns of ILD were reported in 41 cases (95.35%) and in two cases (4.65%), probable usual interstitial pneumonia (UIP) was seen which required further investigation and was categorized under unclassified ILD.

In our study, the most common HRCT pattern was typical UIP, seen in 25 cases (58.1%) followed by the NSIP pattern in 10 cases (23.2%), hypersensitivity pneumonitis (HP) pattern in two, probable UIP in two cases, and pulmonary Langerhans cell histiocytosis (PLCH) pattern in two cases. RB-ILD and organizing pneumonia were seen in one case each.

The final diagnoses were made based on clinic-radiological findings and by the exclusion of other possibilities. The most common ILD reported on HRCT was IPF among 17 (39.5%) cases, that is, UIP pattern with idiopathic cause followed by CTD-ILD seen in nine cases (20.9%) and SR-ILD in six cases (13.9%) (Table 7).

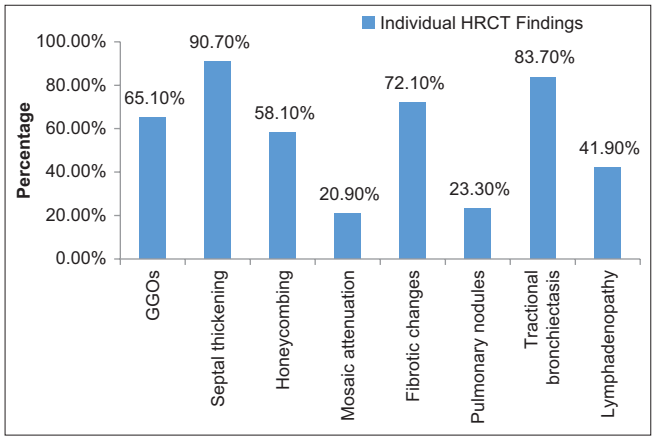


Fig. 1: Frequency of distribution of individual high-resolution computed tomography findings in the study population

Table 6: Lobar distribution of HRCT findings in the study population (n=43)

Distribution	Number	Percentage
Diffuse	5	11.6
Lower lobe	32	74.4
Upper lobe	6	14.0
Total	43	100.0

HRCT: High-resolution computed tomography

In the present study, the two most common HRCT patterns were typical UIP and NSIP patterns. Among typical UIP patterns, the most common HRCT findings were honeycombing and tractional bronchiectasis (100%) followed by septal thickening (88%), whereas among NSIP patterns, the most common HRCT findings were GGOs and septal thickening, seen in 100% of cases. It is followed by tractional bronchiectasis changes seen in 60% of cases (Table 8).

In our study, out of 25 patients with typical UIP, 22 cases (88%) had predominantly lower (basal) distribution and two cases (8%) had diffuse involvement of both the upper and lower lobes while in one case (4%), findings were predominant in the upper lobes.

Whereas out of 10 patients with NSIP pattern, eight cases (80%) had lower (basal) predominance and two cases had diffuse involvement of both upper and lower lobes (Table 9).

The most common ILD reported on HRCT was IPF (ILD with UIP pattern and no known etiology). The most common HRCT finding in patients with IPF was honeycombing and traction bronchiectasis seen in 100% of cases followed by septal thickening (88.2%) (Table 10).

The 2nd most commonly diagnosed ILD in our study was CTD-ILD, seen in nine patients (20.9%). Rheumatoid arthritis was the most common CTD seen in four patients followed by systemic sclerosis (scleroderma) in three patients. One patient was diagnosed case of MCTD and one1 with SLE.

Among four patients with rheumatoid arthritis, two had a typical UIP pattern and two had an NSIP pattern. Whereas among three patients with systemic sclerosis, two had NSIP pattern and one had UIP pattern.

In our study, out of 43 patients, six had a history of cigarette smoking and were diagnosed with SR-ILD, based on HRCT 50% of cases had typical UIP pattern, 33.3% cases had PLCH, 16.6% had respiratory bronchiolitis, and zero cases were dependency inversion principle pattern.

DISCUSSION

Demographic profile

Age distribution

We aimed to evaluate patients above 18 years of age in our study. The maximum and minimum age of patients scanned was 75 years and 22 years, respectively. Maximum patients were between the 51 and 60-year-old age group (34.9%), followed by 12 cases (27.9 %) in 61–70 years. The mean age (±SD) of patients was 54.1±13.1 years. Maximum patients were from the older age group.

This study was in concordance with the study done by Shah *et al*., in which the majority of the patients were between 51 and 60 years of age [6].

However, it is in disconcordance with the results of the study conducted by Bhat *et al*. in which the majority of the patients were in the age group 21–40 years (38%) [7].

Table 7: HRCT pattern and final clinico-radiological diagnosis in the study population

HRCT pattern	Clinico-radiological diagnosis							
	HP	iNSIP	CTD-ILD	COP	SR-ILD	Unclassified	IPF	Total
Typical UIP	1		4		3		17	25
NSIP		5	5					10
Organizing pneumonia				1				1
PLCH					2			2
Probable UIP						2		2
RB-ILD					1			1
HP	2							2
Total	3	5	9	1	6	2	17	43

HRCT: High-resolution computed tomography, iNSIP: Idiopathic non-specific interstitial pneumonia, IPF: Idiopathic pulmonary fibrosis, CTD: Connective tissue disorder, HP: Hypersensitivity pneumonitis, UIP: Usual interstitial pneumonia, PLCH: Pulmonary Langerhans cell histiocytosis

Table 8: Distribution of HRCT findings in two of the most common HRCT patterns, typical UIP pattern (n=25), and NSIP pattern (n=10)

HRCT pattern	HRCT findings	Number	Percentage
Typical UIP pattern (n=25)	GGOs	14	56
	Septal thickening	22	88
	Honeycombing	25	100
	Mosaic attenuation	2	8
	Fibrotic changes	19	76
	Pulmonary nodules	4	16
	Tractional bronchiectasis	25	100
	LAP	14	56
NSIP pattern (n=10)	GGOs	10	100
	Septal thickening	10	100
	Honeycombing	0	0
	Mosaic attenuation	3	30
	Fibrotic changes	5	50
	pulmonary nodules	2	20
	Tractional bronchiectasis	6	60
	LAP	4	40

HRCT: High-resolution computed tomography, GGO: Ground-glass opacities, LAP: Lymphadenopathy, UIP: Usual interstitial pneumonia, NSIP: Non-specific interstitial pneumonia

Table 9: Lobar distribution of HRCT findings in typical UIP pattern (n=25) and NSIP pattern (n=10)

HRCT pattern	Distribution	Number	Percentage
Typical UIP pattern (n=25)	Diffuse	2	8
	Lower lobe	22	88
	Upper lobe	1	4
	Total	25	100.0
NSIP pattern (n=10)	Diffuse	2	20
	Lower lobe	8	80
	Upper lobe	0	0
	Total	10	100.0

HRCT: High-resolution computed tomography, UIP: Usual interstitial pneumonia

Table 10: Frequency of distribution of HRCT findings in Idiopathic pulmonary fibrosis (n=17)

HRCT findings	Number	Percentage
GGOs	12	70.5
Septal thickening	15	88.2
Honeycombing	17	100
Mosaic attenuation	1	5.8
Fibrotic changes	14	82.3
Pulmonary nodules	2	11.7
Tractional bronchiectasis	17	100
LAP	11	64.7

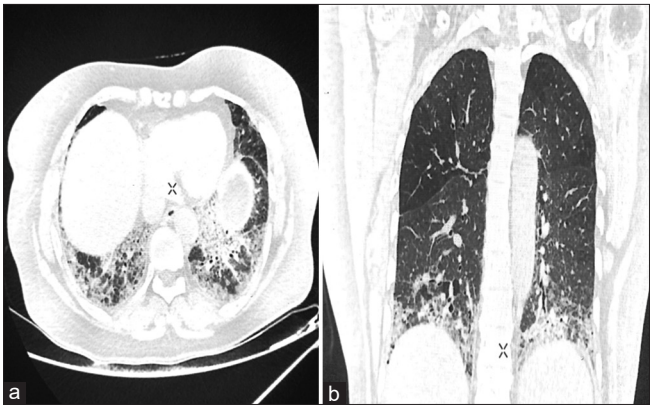
HRCT: High-resolution computed tomography, GGO: Ground-glass opacities, LAP: Lymphadenopathy

Gender distribution

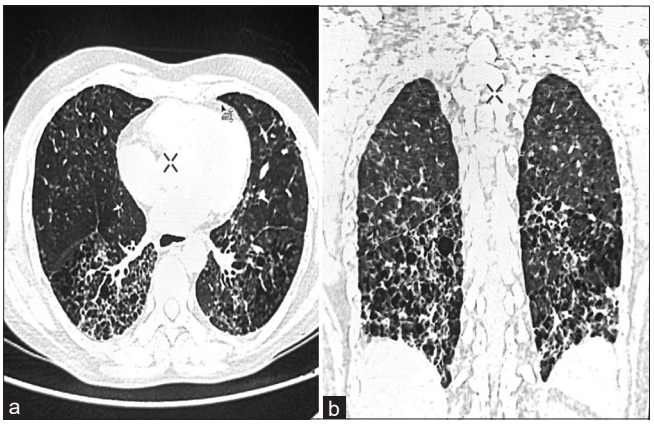
We found slight female preponderance in the present study, with females accounting for 53.5% and males accounting for 46.5% of the caseload. It is in concordance with the study conducted by Bhat *et al*. [7] and Doshi *et al*. [8].

Distribution of cases based on risk factor

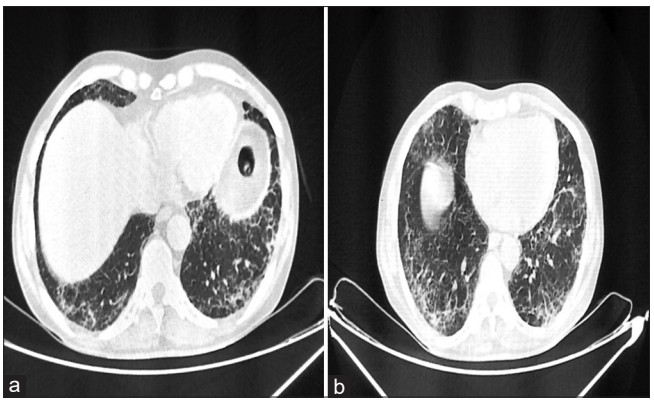
Out of 43 patients in our study, 25 cases (58.1%) had no underlying risk factor. Among patients with an underlying risk factor, the most common was CTD seen in nine cases (20.9%), followed by smoking in six cases (13.9%), and allergen exposure in three cases (6.9%). This is in concordance with the study conducted by Badarkhe-Patil *et al*. [9] and Muhammed *et al*. [10] in which CTD was the most common known risk factor.



Case 1: Axial (a) and reformatted coronal (b) images showing GGOs with inter/intralobular septal thickening and tractional bronchiectasis in bilateral lungs with a basal predominance (non-specific interstitial pneumonia pattern)



Case 2: Axial (a) and reformatted coronal (b) images showing areas of honeycombing in bilateral lungs predominantly in basal and peripheral locations with tractional bronchi ectatic changes (typical usual interstitial pneumonia pattern)



Case 3: Axial (a and b) high-resolution computed tomography images showing GGOs with interspersed inter/intraseptal thickening and basal predominance in bilateral lungs (non-specific interstitial pneumonia pattern)

Presenting complaints of patients

The maximum number of patients presented with dyspnea on exertion (83.7%) followed by cough in 69.8%. This is in concordance with the study done by Bhat *et al.* [7]. It is also in concordance with the study conducted by Muhammed *et al*. [10] and Doshi *et al*. [8].

Table 11: Connective tissue disorder associated with ILD

Type of CTD	Number	Percentage	HRCT pattern	Frequency
Rheumatoid arthritis	4	44.5	Typical UIP pattern	2
			NSIP pattern	2
Systemic sclerosis	3	33.3	Typical UIP pattern	1
			NSIP pattern	2
MCTD	1	11.1	Typical UIP pattern	1
SLE	1	11.1	NSIP pattern	1
Total	9	100		9

HRCT: High-resolution computed tomography, CTD: Connective tissue disorder, UIP: Usual interstitial pneumonia, NSIP: Non-specific interstitial pneumonia

Table 12: Smoking-related interstitial lung diseases

HRCT pattern	Number	Percentage
UIP	3	50
PLCH	2	33.3
DIP	0	0
RB-ILD	1	16.7
Total	6	100

HRCT: High-resolution computed tomography, UIP: Usual interstitial pneumonia, DIP: Dependency inversion principle, PLCH: Pulmonary Langerhans cell histiocytosis

Individual HRCT findings of patients

Inter/intralobular septal thickening was the most common HRCT finding seen in 39 cases (90.7%), followed by tractional bronchiectasis seen in 36 cases (83.7%), fibrotic changes seen in 31 cases (72.1%), and GGOs seen in 28 cases (65.1%). Honeycombing was seen in 58.1% of cases (n=25). A positive correlation was found in a study conducted by Bhat *et al*. [7]. It is also in concordance with the study conducted by Badarkhe-Patil *et al*. [9] and Shah *et al*. [6].

Distribution of various HRCT patterns in patients

Out of the 43 cases in our study, specific patterns of ILD were seen in 41 (95.3%) cases and two cases (4.65%) showed probable UIP patterns which required further investigation and were classified under unclassified ILD.

The most common HRCT pattern was the typical UIP pattern seen in 25 cases (58.1%), followed by the NSIP pattern in 10 cases (23.2%), followed by the HP pattern in two cases, probable UIP in two cases, and PLCH in two cases. RB-ILD and organizing pneumonia were seen in one case each.

Typical UIP pattern

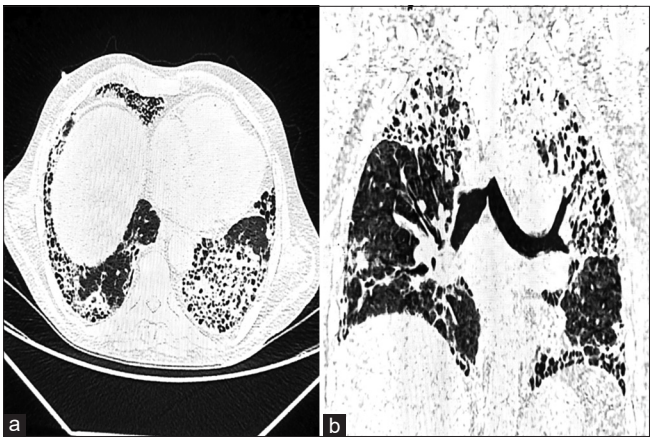
Out of 25 cases showing typical UIP pattern, 17 cases had no definitive underlying etiology and were classified as IPF and four were classified as CTD-ILD (having underlying CTD), three as SR-ILD (with a history of smoking and no other etiology) and one as HP (with a history of allergen exposure and upper lobe distribution). A positive correlation was found in studies conducted by Muhammed *et al*. [10] and Badarkhe-Patil *et al*. [9] in which the most common HRCT pattern was the UIP pattern.

NSIP pattern

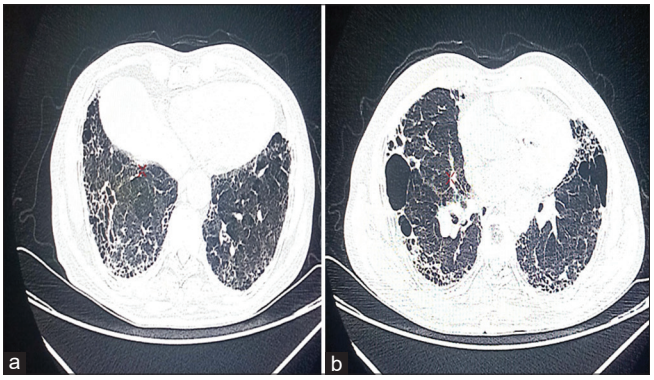
Out of 10 cases showing NSIP pattern, five were classified as CTD-ILD (having underlying CTD) and five as iNSIP with no definitive underlying cause. A positive correlation was found in studies conducted by Badarkhe-Patil *et al*. [9] and Kim *et al*. [11].

HP pattern

In our study, the HP pattern was seen in two cases (4.65%). Both had a history of allergen exposure. The most common HRCT findings in the HP pattern were GGOs, mosaic attenuation, and septal thickening. The findings were predominantly seen in the upper lobes. A positive correlation was found in a study conducted by Badarkhe-Patil *et al*. [9].



Case 4: Axial (a) and reformatted coronal (b) high-resolution computed tomography images showing extensive areas of honeycombing with tractional bronchiectasis in bilateral lungs (typical usual interstitial pneumonia pattern)



Case 5: Axial (a and b) high-resolution computed tomography images showing marked honeycombing with associated bronchiectasis and bronchiectasis changes with basal predominance in bilateral lungs. Paraseptal emphysematous changes and bullae are seen in bilateral lungs with upper lobe predominance (typical usual interstitial pneumonia pattern with emphysematous changes also known as chronic pulmonary fibrosis with emphysema)

Lobar distribution of HRCT findings

In our study, in 32 patients (74.4%) the findings were predominant in lower (basal) lobes followed by upper lobes in six cases (14%). In five cases (11.5%) there is seen diffuse involvement of both upper and lower lobes.

Distribution according to clinical-radiological diagnosis

The final diagnoses were made based on clinic-radiological findings and by the exclusion of other possibilities. The most common ILD reported was IPF seen in 17 cases (39.5%), followed by CTD-ILD seen in nine

cases (20.9%), and SR-ILD seen in six cases (13.9%). This is followed by iNSIP seen in five cases (11.6%), HP in three patients (6.9%), and cryptogenic organizing pneumonia seen in one (2.3%) case. In two cases (4.6%) no definitive diagnosis can be made with confidence based on HRCT and further investigation is required, these were categorized under unclassified ILD. It is in concordance with the study conducted by Shah *et al*. in which the most common ILD reported was IPF [6]. A similar positive correlation was found in studies conducted by Badarkhe-Patil *et al*. [9] and Muhammed *et al*. [10] in which the most common ILD reported was IPF.

However, our study is in disconcordance with the study conducted by Singh *et al*. [12].

Comparison of the present study with previous studies

HRCT diagnosis	Muhammed *et al*.[10] (%)	Sen and Udwadia [13] (%)	Present study (%)
IPF	39	43	39.5
iNSIP	24	18	11.6
CTD-ILD	24	18.6	20.9
COP	4	2	2.3
HP	17	6	6.9

HRCT: High-resolution computed tomography, iNSIP: Idiopathic non-specific interstitial pneumonia, IPF: Idiopathic pulmonary fibrosis, CTD: Connective tissue disorder, HP: Hypersensitivity pneumonitis

CONCLUSION

Ultimately, all patients with clinical suspicion of ILDs should benefit from an HRCT scan of the thorax. HRCT chest scans are essential to the diagnostic work-up since each type of ILD is characterized by a specific pattern of abnormalities and a confident diagnosis can often be arrived at by HRCT alone or in correlation with the clinical symptoms. When HRCT findings are characteristic in appropriate clinical settings, HRCT may even obviate the need for a lung biopsy.

AUTHOR CONTRIBUTION(S)

Mohit Threja: Conceptualization; Formal analysis; Investigation; Methodology; Writing original draft; Writing-review and editing. Jaswinder K Mohi: Data curation; Formal analysis; Writing-original draft; Writing-review and editing. Amanjeet Kaur: Data curation; Formal analysis; Writing-original draft; Writing-review and editing. Surinder P Singh: Conceptualization; Investigation; Methodology; Writing-review and editing.

DECLARATION OF CONFLICT OF INTEREST

No author has any affiliation (financial or otherwise) with a pharmaceutical, medical device, or communications organization."

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