Radiology Section

High Resolution Computed Tomography Assessment of Interstitial Lung Diseases and its Correlation with Spirometry Indices

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ABSTRACT

Introduction: Interstitial lung diseases are characterized by varying degrees of inflammation and fibrosis of the lung interstitium. Lung biopsy, though the sine qua non for diagnosis is not feasible at routine health facilities due to its invasive nature. High Resolution Computed Tomography (HRCT) is now a valuable tool for the evaluation of patients with Interstitial Lung Diseases (ILD). But even HRCT is not widely available in India. Spirometry, a non-invasive modality, can be used in detecting the severity of the ILD. Spirometry carries no harmful effects of radiation, is much more easily available compared to HRCT and is also cheaper.

Aim: The present study aims at an in-depth HRCT based evaluation of interstitial lung diseases with relevant spirometric correlation. Qualitative as well as semi quantitative features of interstitial lung diseases were assessed on the HRCT scan.

Materials and Methods: A total of 60 patients were included in this study conducted at Government Medical College, Patiala. HRCT chest was done on Siemens-Somatom Emotion 6 slice third generation spiral CT scanner using standard protocol in supine position. Lung parenchymal abnormalities were categorized for specific diagnosis. Spirometry was performed using Medisoft Spiro Air dry rolling seal spirometer.

Results: Usual Interstitial Pneumonia (UIP) was the most common ILD (55%) found in our study followed by Nonspecific Interstitial Pneumonia (NSIP) (15%) and sarcoidosis (8.33%). HRCT severity had strong and significant negative correlation with spirometry indices, especially Forced Vital Capacity (FVC), followed by Vital Capacity (VC) and least with forced expiratory volume in first second (FEV1).

Conclusion: HRCT and spirometry are two simple and reliable noninvasive modalities for the diagnosis. Each ILD presents with its typical HRCT features. HRCT, with relevant clinical and laboratory information, gives a reliable diagnosis of various ILDs. Spirometry with its merits of non-invasiveness, easy availability and low cost is a reliable means for assessing the severity of disease.

INTRODUCTION

Interstitial Lung Diseases (ILDs) are a diverse group of pulmonary disorders classified together because of similar clinical, roentgenographic, physiologic, or pathologic features. Pathologically, the interstitial lung diseases are characterized by a varying degree of fibrosis and inflammation of the lung parenchyma or interstitium [1].

HRCT is widely recognized as a sensitive and specific modality for the assessment of diffuse lung processes, most notably the idiopathic interstitial pneumonias, eosinophilic lung diseases, and obstructive lung diseases [2].

HRCT though a sensitive modality, suffers from limitations of radiation exposure, making it unsuitable for use in pregnancy and children. Moreover, it is not available at primary and secondary levels of health care. Spirometry has the advantage of being free from the hazards of radiation exposure. It is a low-cost alternative to HRCT and does not require an experienced radiologist for its interpretation. Its importance also lies in the fact that it provides a fair assessment of pulmonary function, an aspect which cannot be evaluated by HRCT [1,2].

The aim of this study hence, was to establish a correlation between HRCT and spirometry, so as to ascertain if spirometric indices can be used as an economical alternative to establish the severity of disease.

MATERIALS AND METHODS

The study was hospital-based cross-sectional study conducted during November 2014 to August 2016. The Institutional Review Board approval for conducting this study was obtained and informed consent for study was taken from all patients. A total of 60 patients referred to Department of Radio-Diagnosis, Rajindra Hospital, Patiala with clinical diagnosis of ILD were included in this study. Both male and female patients with clinical profile of dyspnea and chronic cough and X-ray findings suspicious of ILD were included in this study. Patients of varied socioeconomic strata and literacy levels were included. Cases of infective aetiology (HIV, Tuberculosis etc.,) or malignant aetiology as well as chronic obstructive pulmonary disease were excluded. Detailed proforma was filled for all those patients who met with the inclusion criteria. The proforma included the patient's name, age, sex, address, registration number, complaints, risk factors, previous medical or surgical history, laboratory investigations and spirometric findings. Complaints were noted in detail and the severity grading of various complaints were done e.g., dyspnoea, measured as per modified Medical Research Council (mMRC) Dyspnoea scale [3], Dry Cough (based on 10-point Visual Analogue-type response scales (VAS) [4], Generalized weakness (based on patient's subjective perception), Weight loss (Unintentional weight loss, of at least 5% of the patient's usual body weight within the preceding 6 to 12 months), Chest pain (VAS, scale 1-10) [5-7] and Joint pain (based on patient's subjective perception) etc., Using the standard protocol, HRCT chest was done on 6 slice Siemens-Somatom CT scanner in supine position and it was read by a single experienced radiologist. Parenchymal abnormalities were categorized into four

main and 12 other associated features with their distribution along the lung zones. HRCT severity score [Table/Fig-1] was calculated based on Semi-quantitative scoring method used by Warrick JH et al., [8].

Severity score		Extent score	
Abnormality	Grading	Bronchopulmonary segments – for each abnormality, score by number of segments involved	Grading
Ground-glass opacities Irregular pleural margin Septal or subpleural lines Honeycombing Subpleural cyst	1 2 3 4 5	1 to 3 segments involved 4 to 9 segments involved >9 segments involved	1 2 3
Maximal severity score	15	Maximal extent score	15

[Table/Fig-1]: Correlation between severity and extent scores.

Spirometry was performed using Medisoft Spiro Air dry rolling seal spirometer. The details of the procedure were explained to all patients and a written consent was obtained from all. Patients exhaled for at least six seconds and stopped when there was no volume change for one second. At least three acceptable spirograms were obtained with a maximum of 8 trials. The largest FVC and FEV1 from acceptable curves were obtained according to American Thoracic society guidelines. Thereafter, these spirometry indices were correlated with HRCT scores.

STATISTICAL ANALYSIS

Microsoft Excel version 2007 was used for Standard statistical analysis. Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Age was compared using Unpaired t-test between male and female. Qualitative variables were correlated using Chi-Square test/Fisher's-exact test. Pearson correlation coefficient was used to correlate scores with FEV1, VC and FVC. A p-value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

Majority of the patients 46.67% (n=28) were between the ages of 51-70 years, and comprised of 13 males and 15 females. The major complaints were gradual onset dyspnea/dyspnea on exertion, followed by dry cough and generalized weakness. Few patients had associated symptoms like fever, joint pain, chest pain and weight loss etc.

The most common interstitial lung disease found in our study was Usual Interstitial Pneumonia (UIP)/Idiopathic Pulmonary Fibrosis (IPF) (n=33; 55%) followed by nonspecific interstitial pneumonia (NSIP) (n=9; 15%), sarcoidosis (n=5; 8.3%), hypersensitivity pneumonitis (HSP, n=5; 8.3%), respiratory bronchiolitis associated RB-ILD (n=1; 1.67%), Desquamative Interstitial Pneumonia (DIP, n=1;1.67%) and unclassified Idiopathic Interstitial Pneumonia (IIP, n=6; 10.0%).

The most common finding observed on HRCT was septal or subpleural lines. Ground Glass Opacities (GGO's), irregular pleural margins and honeycombing were also commonly observed [Table/Fig-2].

Severity score of all the ILD patients was calculated, using a semi-quantitative scoring system based on study by Warrick JH et al., [8], wherein GGO's, Septal/subpleural lines, pleural irregularities, honeycombing and subpleural cysts were taken into consideration. Extent scores were based on number of segments involved. [Table/Fig-3,4].

Spirometry was performed in all the cases. Majority of the patients, 36.67% (n=22) in the study showed severely low FVC. 16.67% (n=8) had moderately low and 23.33% (n=14) had mildly low FVC. 23.33%

HRCT Features in ILD patients (n=60)	No of Patients	Percentage
Septal/subpleural lines	52	86.67%
Ground Glass Opacities (GGO'S)	45	75.00%
Irregular pleural margins	44	73.33%
Honeycombing	33	55.00%
Microcystic honeycombing	6	10.00%
Tractional bronchiectasis	32	53.33%
Nodules	30	50.00%
Tractional bronchioloectasis	14	23.33%
Consolidation	7	11.67%
Subpleural cysts	6	10.00%
Mosaic attenuation	14	23.33%
Bronchovascular thickening	12	20.00%
Emphysematous changes	5	8.33%
Mediastinal lymphadenopathy	9	15.00%
Architectural distortion	17	28.33%
Pleural effusion	2	3.33%
Distribution		
Middle/lingual	41	68.33%
Lower	48	80.00%
Upper	16	26.67%
Subpleural sparing	17	28.33%

[Table/Fig-2]: Common HRCT patterns associated with ILD and their distribution in the present study.

Provisional Diagnosis	HRCT severity score 0-5	6-10	11-15	Total
UIP	4 (22.22%)	22 (66.67%)	7 (77.78%)	33 (55.00%)
NSIP	2 (11.11%)	7 (21.21%)	0 (0.00%)	9 (15.00%)
SARCOIDOSIS	4 (22.22%)	1 (3.03%)	0 (0.00%)	5 (8.33%)
HSP	4 (22.22%)	1 (3.03%)	0 (0.00%)	5 (8.33%)
RB-ILD	0 (0.00%)	0 (0.00%)	1 (11.11%)	1 (1.67%)
DIP	0 (0.00%)	0 (0.00%)	1 (11.11%)	1 (1.67%)
UNCLASSIFIED IIP	4 (22.22%)	2 (6.06%)	0 (0.00%)	6 (10.00%)
Total	18 (100.00%)	33 (100.00%)	9 (100.00%)	60 (100.00%)

[Table/Fig-3]: Severity score in various types of ILD.

| Provisional Diagnosis	HRCT Extent score 0-5	6-10	11-15	Total
UIP	3 (25.00%)	7 (46.67%)	23 (69.70%)	33 (55.00%)
NSIP	2 (16.67%)	0 (0.00%)	7 (21.21%)	9 (15.00%)
SARCOIDOSIS	2 (16.67%)	2 (13.33%)	1 (3.03%)	5 (8.33%)
HSP	1 (8.33%)	4 (26.67%)	0 (0.00%)	5 (8.33%)
RB-ILD	0 (0.00%)	0 (0.00%)	1 (3.03%)	1 (1.67%)
DIP	0 (0.00%)	0 (0.00%)	1 (3.03%)	1 (1.67%)
UNCLASSIFIED IIP	4 (33.33%)	2 (13.33%)	0 (0.00%)	6 (10.00%)
Total	12 (100.00%)	15 (100.00%)	33 (100.00%)	60 (100.00%)

[Table/Fig-4]: Extent score in various types of ILD.

of patients had severe affection of VC (n=14). FEV1 of majority of the patients were normal i.e., 33.33%, (n=20) of ILD, showed a normal FEV1 where as 21.67% had a moderate affection of FEV1 and only 1.67% had very severe affection of the FEV1.

The correlation between the HRCT severity and spirometric severity is established as in [Table/Fig-5]. The HRCT images showing changing indicating IPF, NSIP, HSP, sarcoidosis, DIP and unclassified IIP [Table/Fig-6-11].

| Variables		HRCT Severity Score	HRCT extent Score
Forced Vital capacity (FVC%)	Correlation Coefficient	-0.578	-0.506
	Significance Level P	<0.0001	<0.0001
	N	60	60
Vital Capacity (VC%)	Correlation Coefficient	-0.295	-0.259
	Significance Level P	<0.0001	<0.0001
	N	60	60
Forced Expiratory Volume in 1st second (FEV1%)	Correlation Coefficient	-0.271	-0.163
	Significance Level P	<0.0001	<0.0001
	N	60	60

[Table/Fig-5]: Correlation between HRCT scores.
(severity and extent) and PFT (FVC, VC, FEV1)
(Pearson correlation coefficient and SPSS software was used in this table. Qualitative variables were correlated using Chi-Square test/Fisher's-exact test)
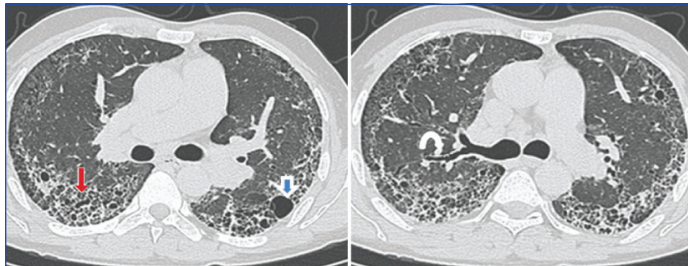

[Table/Fig-6]: a,b) HRCT shows bilateral diffuse extensive fibrosis with septal thickening, honeycombing (straight arrow), subpleural cysts (open blue arrow) and traction bronchiectasis (curved arrow) having mid and basal predominance in subpleural region bilaterally. Findings indicate usual interstitial pneumonia/idiopathic pulmonary fibrosis. (Images from left to right)
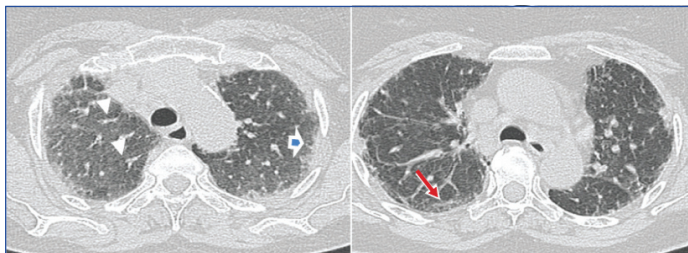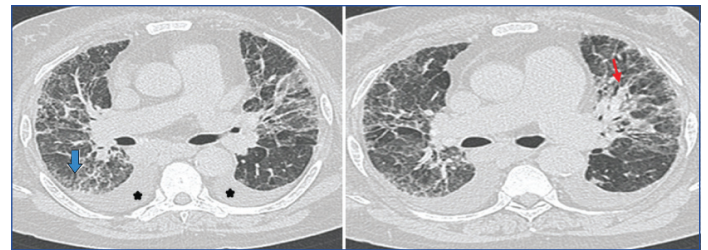

[Table/Fig-7]: a,b) HRCT images show bilateral diffuse interstitial lung disease in the form of interlobular and intralobular septal thickening (arrowhead) and subpleural lines (arrow). Pleural irregularities are also seen (open blue arrow). Findings indicate Nonspecific Interstitial Pneumonia. (Images from left to right)
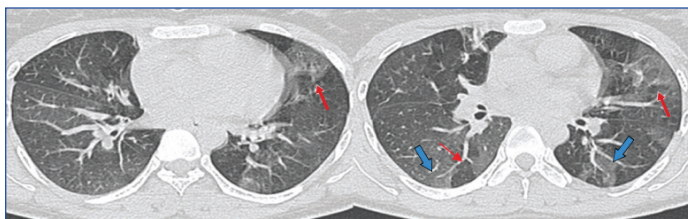

[Table/Fig-8]: a,b) Show bilateral symmetrical ground glass opacities (white arrows) in mid and basal lung zones with round centri-lobular opacities having geographical distribution of increased, decreased (red arrow) and normal lung attenuation giving head cheese sign. Imaging findings are consistent with Hypersensitivity Pneumonitis. (Images from left to right)
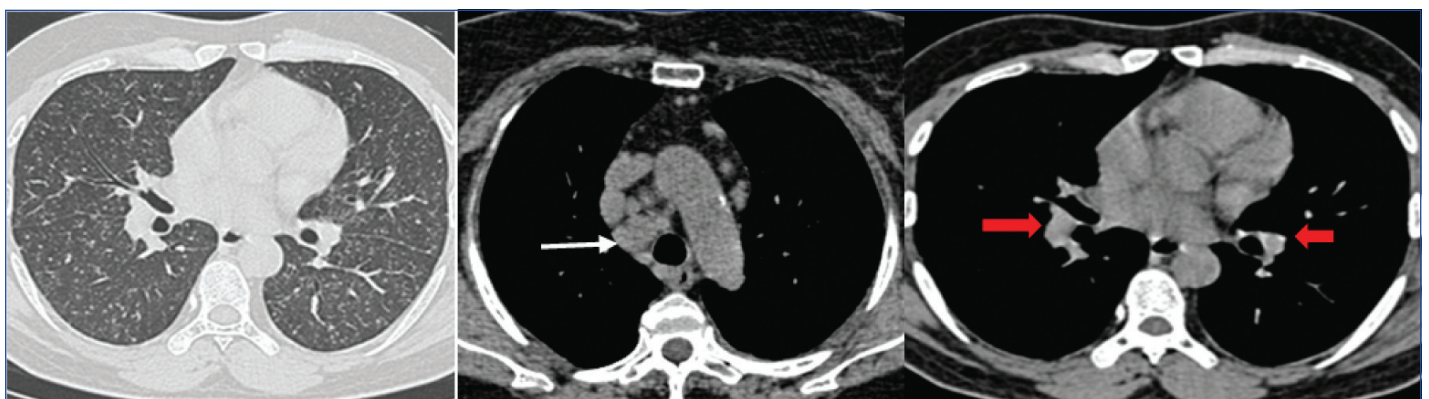
[Table/Fig-9]: a-c) HRCT images show nodular opacities along fissures and lymphatics. Bilateral hilar (thick red arrows) and right paratracheal (thin white arrow) lymphadenopathy seen giving 1-2-3 sign in a case of Sarcoidosis. (Images from left to right)

[Table/Fig-10]: a,b) HRCT images show bilateral symmetrical ground glass opacities with reticular changes more in peripheral region. Bronchioloectatic changes with broncho-vascular interstitial thickening (straight red arrow) and minimal honeycombing (open blue arrow) are seen. Enlarged pulmonary artery and bilateral pleural effusion (star) are also seen. Imaging features are consistent with Desquamative Interstitial Pneumonia. (Images from left to right)
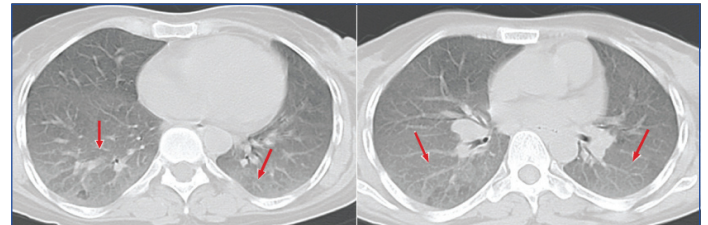
[Table/Fig-11]: a,b) HRCT image shows areas of ground glass opacities (arrows) and centrilobular nodules superimposed on ground glass opacities. Imaging features and history of smoking are in favour of respiratory bronchiolitis associated interstitial lung disease. (Images from left to right)

DISCUSSION

Out of sixty cases in our study 54 (90%) cases showed specific patterns of ILD and six cases (10%) showed nonspecific patterns and were classified under unclassified IIP. Analysis of age distribution of patients in our study showed a wide range with maximum percentage of patients 46.67% in the age group 51-70. Study by Jindal SK et al., showed almost similar age of presentation with maximum patients in age group 40-70 years of age [9]. Coultas DB et al., found the age of presentation almost a decade later (61-70 years) [10].

In our study, 56.67% patients were females and 43.33% were males. It closely correlated with the study by Jindal SK et al., in which female and male incidence was found to be 57.4% and 42.4% respectively [9]. Similar results were seen in other studies done by Devi MS and Haorongbam S, and Patil PB et al., [11,12].

In our study, the maximum duration of illness was found to be 5 years and the minimum duration of illness was found to be 2 months. Mean duration of illness of the patients was 3 years with SD of 1.6. Maximum patients presented between 1-5 years. Similar duration of illness was found in Indian study done by Gagiya AK et al., in which, maximum patients presented before 5 years of onset of illness and majority presented between 1-3 years [13].

In our study, the most common presenting complaint was gradual onset dyspnoea (n=57; 95 %), followed by dry cough (n=53; 88.3%) and generalized weakness (n=48; 80%). Some patients also had varying symptoms like fever, joint pain, chest pain and weight loss etc. This was in accordance with study by Patil PB et al., with most

common presenting complaint being progressive dyspnea (seen in 96% patients), dry cough (in 74%) and associated joint pain (in 44%) [12]. Study by Perez RL and Weinrib L et al., showed similar clinical profile, with progressive dyspnea on exertion and a dry cough as major complaints [14,15]. According to the study by Bhadke BB et al., predominant symptom of ILD was dyspnea on exertion and the degree of dyspnea was closely related to the disease severity and prognosis [16]. Cough was the second most frequent symptom found in the study.

HRCT in disease spectrum of interstitial lung diseases:

In our study the most common interstitial lung disease reported on HRCT was usual interstitial pneumonia (UIP)/Idiopathic Pulmonary

Study	UIP/IPF	NSIP	Sarcoi-dosis	HP	RB-ILD	DIP	Un-clas-sified IIP
Sen T et al., [17]	43%	18%	22%	6%	-	-	-
Patil PB et al., [12]	36%	14%	2%	2%	-	-	-
Muhammed SK et al., [18]	39%	24%	13%	17%	-	-	-
Bjoraker JA et al., [19]	62%	14%	-	1%	2%	8%	-
Flaherty KR et al., [20]	63%	19.6%	-	2.9%	RB-ILD/DIP 13%	RB-ILD/DIP 13%	-
Present study	55%	15%	8.3%	8.3%	1.67%	1.67%	10%

[Table/Fig-12]: Comparison of previous done studies with present study in ILDs.
UIP/IPF: Usual Interstitial Pneumonia/Idiopathic Pulmonary Fibrosis, NSIP: Non Specific Interstitial Pneumonia, HP: Hypersensitivity Pneumonitis, IIP: Idiopathic Interstitial Pneumonia, RB-ILD: Respiratory Bronchiolitis Interstitial Lung disease, DIP: Desquamative interstitial Pneumonia

Fibrosis (IPF), followed by Nonspecific Interstitial Pneumonia (NSIP), sarcoidosis and hypersensitivity pneumonitis [Table/Fig-12,13]. Six cases, did not fit into any particular HRCT imaging pattern of ILD and as the Lung biopsy was not done in all cases, diagnosis could not be reached in these cases. So, these cases are included in unclassified IIP category. [Table/Fig-12,13] shows comparison of previous done studies with present study.

HRCT features of different types of ILDs and various comparison studies are summarized in [Table/Fig-14-19].

Correlation of HRCT severity score and extent score with spirometry:
In our study, special efforts were made to establish correlation between HRCT scores and Pulmonary function tests. Correlation between Semi-quantitative HRCT severity score and extent score with the FVC, VC and FEV1 was studied [Table/Fig-3,4,5].

Correlation coefficient between HRCT score and FVC:
Present study showed significant inverse correlation of HRCT severity score with the FVC (r= -0.578, p-value <0.0001). These findings correlated well with the similar study done by Xaubet A et al., in 39 untreated patients with idiopathic pulmonary fibrosis [31], in which the HRCT score showed a moderate but significant correlation with FVC (r = -0.46, p = 0. 003). Xaubet A et al., also did the correlational study of HRCT extent with the FVC and observed an inverse relationship (r = -0. 51, p = 0.01) [31]. In our study, also a similar negative correlation between HRCT extent score and Pulmonary function test was found {FVC (r= -0.506) with P-value of <0.0001}. Study done by Isaac BTJ et al., in 2015, in 94 patients of IIP, in South India also showed an inverse correlation between the HRCT scores and FVC (r= –0.48) [32]. Mura M et al., and Best AC

Study	Study population	Main Findings
Patil PB et al., [12]	50 patients with clinical suspicion of ILDs	Most commonly found pattern in ILD:Reticular opacity (n=37; 64%), Increased opacity (n=29; 58%), Decreased opacity (n=29; 58%) Most specific HRCT findings: Septal thickening (n=37; 64%), Bronchiectasis (n=26; 52%), Ground glass opacity (n=24; 48%)
Leslie KO [21]		Four basic radiological patterns in ILD (1) increased attenuation/GGO/consolidation, (2) reticulation with parenchymal distortion (fibrosis),(3) nodules (large or small, singular or multiple),(4) mosaic patterns and cysts.
Elicker B et al., [22]		Four general patterns of HRCT in ILD: 1) reticular opacities, 2) nodules, 3) increased lung opacity, 4) decreased lung opacity. Within each of these patterns, other features of the images can help narrow the differential diagnosis.
Present study	60 patients with clinical suspicion of ILD	HRCT patterns seen in present study (n=60): Septal/Subpleural lines: 86.67% (n=52), GGO'S: 75% (n=45), Irregular pleural margins: 73.33% (n=44) Honeycombing: 55% (n=33) patients. Tractional bronchiectasis: 53.33% (n=32), Nodules: 50% (n=30) Tractional bronchioloectasis: 23.33% (n=14), Mosaic attenuation 23.33% (n=14). Bronchovascular thickening: 20% (n=12). Subpleural cysts: 10% (n=6).

[Table/Fig-13]: HRCT patterns associated with ILDs.

Study teams	Study population	Main Findings
Palmucci S et al., [23]		Reticular pattern, with/without traction Bronchiectasis Honeycombing appearance, Basal and Subpleural predominance.
Bourke SJ [24]		Honeycombing, Reticular shadowing, Traction bronchiectasis.
Wuyts WA et al., [25]		Peripheral and basal distribution of honeycomb changes with traction bronchiectasis, Irregular interlobular septal thickening, Minimal ground-glass opacity. With presence of all these features, the diagnostic accuracy of CT approaches 90-100%. Honeycombing being the strongest predictor of a diagnosis of UIP.
Present study	60 patients with clinical suspicion of ILD	Predominant HRCT findings in UIP (n=33): Septal/sub pleural lines: 93.94% (n= 31), Tractional Bronchiectasis: 81.82% (n=27), Irregular pleural margins: 78.79% (n=26), Honeycombing: 75.76% (n=25), GGO: 60.61% (n=20) Distribution: Predominantly Lower: 93.94% (n=31)

[Table/Fig-14]: Abnormal HRCT features and its distribution in UIP.

Study teams	Study population	Main Findings
Palmucci S et al., [23]		Bilateral ground glass areas, Reticular opacities.
Elicker B et al., [22]		Bibasilar, peripheral, traction bronchiectasis accompanied by ground-glass attenuation: considered diagnostic of NSIP. Reticular abnormalities, with/without traction bronchiectasis, are common. Subpleural sparing and tracking of opacities along lower-zone bronchovascular bundles are findings that correlate with NSIP. Honeycombing is rare in NSIP.
Present Study	60 patients with clinical suspicion of ILD	Predominant findings in NSIP (n=9):Septal/Sub pleural lines: 100% (n=9), Nodules: 100% (n=9), GGO's: 88.89% (n=8), Irregular pleural margins: 77.78% (n=7), Tractional Bronchioloectasis : 77.78% (n=7), Tractional Bronchiectasis : 44.44% (n=4), Bronchovascular thickening: 77.78% (n=7), Microcystic honeycombing: 55.67% (n=5) Distribution: Predominantly Lower: 88.89% (n=8), Subpleural sparing in 77.78% (n=7).

[Table/Fig-15]: Abnormal HRCT features and its distribution in NSIP.

Study teams	Study population	Main Findings
Ors F et al., [26]	45 patients with sarcoidosis.	Most common HRCT findings: Nodule, Micronodule, Ground Glass Opacity (GGO), Consolidation.
Elicker B et al., [22]		Nodules as Hallmark, concentrated around bronchovascularstructures, pleura, and interlobular septa. Hilar adenopathy, an expected finding. Confluence of nodules within larger parenchymal opacities. In late stages: Fibrosis (irregular reticulation, traction bronchiectasis, and confluent masses of fibrotic tissue).
Present Study	60 patients with clinical suspicion of ILD	Predominant findings in Sarcoidosis (n=5): Nodularopacities: 100% (n=5), Septal/subpleural lines : 100% (n=5), Mediastinal LAP: 100% (n=5), GGO's : 80.00% (n=4) Distribution: Predominantly Upper and Mid: 100% (Both) (n=5).

[Table/Fig-16]: Abnormal HRCT features and its distribution in Sarcoidosis.

Study teams	Study population	Main Findings
Tateishi T et al., [27]	112 patients with bird-related HP	Predominant findings in acute and recurrent HP: GGO and centrilobular nodules (decreased with disease progression), Chronic HP and insidious HP: Increased Honeycombing.
Hansell DM et al., [28]	22 patients of Hypersensitivity pneumonitis.	Most common CT pattern: Decreased attenuation and mosaic perfusion (n=19), GGO (n=18), Small nodules (n=12), Reticular pattern (n=8), Areas of decreased attenuation correlated with severity of air trapping.
Present Study	60 patients with clinical suspicion of ILD	Predominant HRCT finding in HSP (n=5): GGO's: 100.00% (n=5), Nodules: 100.00% (n=5), Mosaic attenuation: 100.00% (n=5), Septal/Subpleural lines: 80.00% (n=4). Distribution: Predominantly Mid and lower: 100% (n=5) (Both), Subpleural sparing in 80.00% (n=4).

[Table/Fig-17]: Abnormal HRCT features and its distribution in HSP.

Study teams	Study population	Main Findings
Park JS et al., [29]	21 patients of pathologically proven RB-ILD.	Major radiographic findings were Bronchial wall thickening: 76%, Ground-glass opacity: 57%. The predominant initial CT findings: Central bronchial wall thickening: 90%, Peripheral bronchial wall thickening: 86%, Centrilobular nodules: 71%, Ground-glass opacity: 67%. None of these CT findings had a significant zonal predominance.
Palmucci S et al., [23]		Poorly defined centriobular nodule, Centrilobular emphysema, Bronchial wall thickening.
Present Study	60 patients with clinical suspicion of ILD	Predominant HRCT finding in RB-ILD (n=1): GGO's, Irregular pleural margins, Septal/Subpleurallines Bronchovascular thickening, Honeycombing, Nodules, Tractional Bronchioloectasis, Emphysematous changes, Architectural distortion, Subpleural Sparing seen.

[Table/Fig-18]: Abnormal HRCT features and its distribution in RB-ILD.

Study teams	Study population	Main Findings
Palmucci S et al., [23]		Diffuse ground glass opacities, Irregular linear opacities, Microcysts
Attili et al., [30]		Bilateral patchy ground glass opacity, Reticular opacities, Subpleural and basal predominance, Rare Honeycombing associated centrilobular emphysema
Present Study	60 patients with clinical suspicion of ILD	Predominant HRCT finding in DIP (n=1), GGO'S, Irregular pleural margins, Septal/subpleural lines, Honeycombing Nodules, Tractional bronchioloectasis, Mosaic attenuation, Bronchovascular thickening, Pleural effusion Distribution: In mid and lower, nosubpleural sparing seen.

[Table/Fig-19]: Abnormal HRCT features and its distribution in DIP.

et al., had also observed a good negative correlation of FVC with HRCT scores [33,34].

Correlation coefficient between HRCT score and VC:

Our present study also showed inverse correlation of HRCT severity score with the VC (r= -0.295, p-value <0.0001). This observation was similar as that seen by Battista G et al., who used HRCT visual score [35]. A decrease in the VC and diffusing capacity of lung for carbon monoxide (DLCO) was observed in serial follow up study of the patients with HRCT progression of the disease. O'Donnell D [36] had opined that in restrictive lung diseases, both the VC and FVC are reduced, but the FVC is usually decreased to a relatively lesser extent, as opposed to our study, in which a greater decrease in FVC was seen as compared to VC.

Correlation coefficient between HRCT score and FEV1:

In the present study, negative correlation was also seen between the HRCT severity score and FEV1, with correlation coefficient of (-0.271). This correlation seemed less significant in comparison to the relationship between the HRCT severity with FVC and VC. This was in consistence with the study done by Ooi GC et al., in patients with systemic sclerosis [37], where an inverse correlation between HRCT scores and FEV1 was seen (r=–0.37, p=0.03). Same study found stronger inverse correlation of HRCT score with FVC (r=–0.43, p=0.008).

Biederer J et al., in his study of correlation between HRCT findings and pulmonary function tests, in 53 patients of ILD, observed that lesions in HRCT correlated weakly with FEV1 (r=–0.31; p<0.01) [38]. Same study found a much stronger correlation between the HRCT severity with the diffusion capacity (r=–0.54; p<0.001). As there is a definite correlation between the HRCT severity and spirometric findings, spirometric indices can be used in the follow up of patients with ILD.

LIMITATION

This was not a prospective study and critically ill patients could not perform spirometric manoeuvers.

CONCLUSION

Spirometry is a simple, noninvasive modality to measure severity of ILD and help in its objective assessment. It is bereft of all radiation hazards and can be conveniently performed in pregnant patients and young children. Being cheaper it is more readily available than HRCT and it is a powerful tool that can be used to detect and manage patients with restrictive lung disorders. HRCT is invaluable in characterizing the disease process, but it cannot assess the physiological lung functions. As the severity and extent scores of HRCT have an inverse relationship with the spirometric indices in ILD, spirometry can provide a viable alternative to assess the disease severity.

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