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Original Research Paper

Radiology

EVALUATION OF DIFFUSE LUNG DISEASE ON HIGH RESOLUTION COMPUTED TOMOGRAPHY OF CHEST & ITS CORRELATION WITH PFT & DLCO

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ABSTRACT **Aim:** This study assessed the HRCT features of diffuse lung diseases and their correlation with (PFT) and DLCO. **Materials and methods:** The study was conducted in the Department of Radiodiagnosis, Sharda Hospital, SMS&R, Sharda University, Greater Noida, Uttar Pradesh, India. The study included both the outpatients and inpatients in the department of Respiratory Medicine and General Medicine with a sample size of 30 patients. HRCT scans of the chest were done in all the cases taken in the study. The patient was explained and demonstrated the breath-holding procedure during the acquisition of the HRCT scan. **Results:** in Idiopathic Interstitial Pneumonia, FEV1/FVC Ratio < 70% was found among 1 (4.8%) patients, FVC < 80% was found among 21 (100.0%) patients. DLCO was mild among 38.1%, Moderate among 28.6% and severe among 33.3% of patients. In Connective Tissue Disorders, FEV1/FVC Ratio > 70% was found among 100.0% of patients. FVC < 80% among all 100.0% patients. DLCO was found to be mild among 14.3%, Moderate among 57.1% and severe among 28.6% of patients. HRCT findings in Idiopathic Interstitial Pneumonia (Usual Interstitial Pneumonia findings predominant finding of inter and intralobular honeycombing and honeycombing among 100.0% patients, Connective Tissue finding predominant findings of Inter and Intra-lobular septal thickening among 35.0% and Idiopathic Interstitial Pneumonia (RB-ILD) had the predominant findings of Ground glass opacities among 50.0%. **Conclusion:** HRCT is a valuable technique for evaluating the extent of lung involvement in various ILDs even when chest X-rays are normal. It can image the lung with excellent spatial resolution and provides good anatomic detail.

KEYWORDS : HRCT, PFT, DLCO, Idiopathic Interstitial Pneumonia, Connective Tissue Disorders, UIP, NSIP

INTRODUCTION

Diffuse lung diseases describe a heterogeneous group of disorders of the lower respiratory tract characterised by inflammation and derangement of the interstitium and loss of functional alveolar units. The disorders in this heterogeneous group are classified together because of similar clinical, roentgenographic, physiologic, or pathologic manifestations. These disorders often are associated with considerable rates of morbidity and mortality. Diffuse lung diseases comprise over 200 entities of known and unknown causes, with or without associated systemic diseases, acute or chronic onset, indolent or rapidly progressive course and wide variations in treatment response.[1]

In 2013, the American Thoracic Society/European Respiratory Society (ATS/ERS) provided an update based on new publications. Major updates included regrouping major 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 organising pneumonia and interstitial pneumonias with a bronchiolocentric distribution. Based on newer research, NSIP was upgraded from a provisional diagnosis to a distinct clinicopathologic entity. A stronger emphasis was additionally placed on the molecular and genetic features where certain biomarkers such as elevated epithelial or macrophage-related proteins could indicate rapid deterioration and a high risk of progression.[2]

Pulmonary function testing (PFT) cannot diagnose a specific ILD or distinguish between active lung inflammations versus fibrosis.[3]HRCT (High resolution computed tomography) is the most accurate non-invasive, high spatial resolution cross-sectional imaging modality for evaluating lung parenchyma. It assesses the presence of disease in the lung, type of disease, changes of active lung disease, biopsy site localisation, changes in disease activity following treatment, and characterisation of interstitial lung disease (ILD) in an appropriate clinical setting. It is more sensitive than the plain radiograph in identifying ILD (sensitivity greater than 90%), and the image pattern of parenchymal abnormalities on HRCT often suggests a particular set of diagnostic possibilities.[4]

High-resolution computed tomography (HRCT) of the lung is well established in formulating an initial diagnosis in patients with diffuse lung disease (DLD); however, its ability to monitor patients with serial examinations may be equally important. Patients with DLD often undergo multiple HRCT examinations at various stages of their disease.[5]

HRCT, for a variety of reasons, is superior to plain radiography. In many cases where, historically, a biopsy might have been considered mandatory, there has been a paradigm shift because of HRCT. For example, in some patients with idiopathic pulmonary fibrosis (characterised by the histological pattern of usual interstitial pneumonia), the HRCT appearance may be characteristic enough to render biopsy unnecessary.[6-8] In instances where a radiological diagnosis is not possible, HRCT may provide guidance on the best site for surgical biopsy. More recently, HRCT has moved

into the realms of prognostic evaluation and disease staging.[9-11]

HRCT comprises multiple sequences, including reconstructions, all of which should be utilised by the interpreting physician in characterising IIPs. One such approach involves first utilising axial inspiratory scans to evaluate for features of fibrotic disease, specifically looking for four characteristics of UIP fin-honeycombing, including honeycombing with traction bronchiectasis, subpleural reticulation, basilar distribution, and absence of atypical UIP features. Atypical UIP findings include mid and upper lung distribution, GGO and consolidations disproportionate to reticulations, cysts, mosaic attenuation on inspiratory imaging, and air trapping on expiratory imaging.[12,13]

An extensive search of the literature revealed that though many studies have been conducted to evaluate diffuse lung diseases by high resolution computed tomography of chest but studies are restricted in the spectrum and are not conducted widespread in our country. This study will highlight HRCT features of diffuse lung diseases and their correlation with (PFT) and DLCO.

MATERIALS AND METHODS

The study was conducted in the Department of Radiodiagnosis, Sharda Hospital, SMS&R, Sharda University, Greater Noida, Uttar Pradesh, India. The study included both the outpatients and inpatients in the department of Respiratory Medicine and General Medicine with a sample size of 30 patients based on the following criteria:

INCLUSION CRITERIA:

1. Patients of age group 18 and above showing reticular opacities on chest X-ray PA
view.
2. Incidentally diagnosed cases on HRCT chest.

EXCLUSION CRITERIA:

1. Patients were having lung malignancy showing pulmonary features of diffuse lung
diseases.
2. All pregnant females.
3. Post radiotherapy

METHODS:

A thorough clinical history of all the patients presenting with suspected diffuse lung disease was taken. The history mainly comprised dyspnoea, cough, whether productive or non-productive, fever, low weather grade or high grade, chest pains, joint pains and a history of smoking. Duration of symptoms was also recorded. General physical and respiratory system examination of all patients was done. Chest x-rays of the patients were studied for the presence of any abnormality.

HRCT scans of the chest were done in all the cases taken in the study.

PATIENT PREPARATION:

The procedure and objectives of performing the high-resolution CT scan of the chest were explained to the patient, and written consent of the patient was taken. Prior fasting was not advocated as the procedure did not warrant the need for contrast injection. The patient was explained and demonstrated the procedure of breath-holding during the acquisition of the HRCT scan.

MDCT PROTOCOL:

PATIENT POSITION:

The patient was kept supine on the gantry table and was scanned cephalo-caudal in the axial axis. The topogram was first taken, and then the whole lung was scanned from the apex to the base. The scans were performed on GE Optima 660 - 128 Slice CT Scanner at Sharda Hospital, Greater Noida, Uttar Pradesh, following protocol.

Lung Window:

Collimation	40mm
Feed	78mm/sec
Scan time	3-4 seconds
Kvp	120
mA	Z- axis modulation
Matrix Size	512x512
WW/WL	1500/-700
Mediastinal	Window:
Collimation	40mm
Feed	78mm/sec
Scan time	3-4 seconds
Kvp	120
mA	Z- axis modulation
Matrix Size	512x512
WW/WL	350/40

RESULTS

The study included 30 patients with a suspected diagnosis of diffuse lung disease and referred for thoracic high resolution computed tomography.

Table 1: Distribution of study population according to Age groups

		Frequency	Per cent
Age groups	20-40 years	4	13.3%
	40-60 years	9	30.0%
	60-80 years	17	56.7%
	Mean±SD	58.60±14.23 (24-80)	
Gender	Male	14	46.7%
	Female	16	53.3%
Smoking	NA	18	60.0%
	Present	12	40.0%

The mean age of the study population was 58.60±14.23 (24-80) years, with the majority belonging to the 60-80 years (56.7%) age group. The study population consisted of 14 (46.7%) males and 16 (53.3%) females. Smoking was reported among 40.0% of patients.

Table 2: INCIDENCE OF ASSOCIATED CLINICAL SYMPTOMS IN PATIENTS WITH DIFFUSE LUNG DISEASE

Clinical Features	Frequency	Per cent
Coughing	23	76.7%
Dyspnoea (GR1)	4	13.3%
Dyspnoea (GR2)	16	53.3%
Dyspnoea (GR3)	10	33.3%
Malaise	2	6.7%
Raynaud's phenomena	2	6.7%
Weight loss	2	6.7%
Arthralgia	2	6.7%
Sclerodactyly	2	6.7%

Coughing and dyspnea were the most frequently associated symptoms. Coughing was reported among 76.7%, Dyspnoea (GR1) among 13.3%, Dyspnoea (GR2) among 53.3%, and Dyspnoea (GR3) among 33.3%, Malaise, Raynaud's phenomena, Weight loss, Arthralgia and Sclerodactyly among 6.7% each. (Table 2)

Table 3: DURATION OF SYMPTOMS DISTRIBUTION

Duration of symptoms	Frequency	Per cent
0-6 months	8	26.7%
6-12 months	10	33.3%

1-2 years	10	33.3%
> 2 years	2	6.7%
Mean±SD	1.18±0.81 (0.17-3.00)	

The duration of symptoms was 1.18±0.81 (0.17-3.00), with the majority having symptoms for 6-12 months and 1-2 years (33.3% each). (Table 3)

Table 4:

	DLCO (%)	
FVC (%)	Pearson Correlation	0.387
	P-value	0.034*
FEV1 (%)	Pearson Correlation	0.410
	P-value	0.024*
FEV1/FVC	Pearson Correlation	-0.313
	P-value	0.042*

There was a significantly positive correlation between DLCO (%) with FVC (%) and FEV1 (%). There was a significantly negative correlation of DLCO (%) with FEV1/FVC. (Table 4)

Mean FVC (%) was 56.13±7.73 (40-74), mean FEV1 (%) 63.73±8.56 (37-86), FEV1/FVC was 86.07±13.03 (65-113) and DLCO (%) was 50.03±14.86 (21-75). FEV1/FVC Ratio > 70% was found among 29 (96.7%) and < 70% among 1 (3.3%) patients. FVC < 80% was found among 30 (100.0%) patients. DLCO was found to be Normal among 0 (0.0%), Mild among 9 (30.0%), Moderate among 12 (40.0%) and Severe among 9 (30.0%) patients.

Table 5: Distribution of cases based on final diagnosis

Final Diagnosis	Frequency	Per cent
Asbestosis	1	3.3%
IIP (NSIP)	5	16.7%
IIP (RB-ILD)	3	10.0%
IIP (UIP)	13	43.3%
LAM	1	3.3%
Sarcoidosis	3	10.0%
Scleroderma (NSIP)	2	6.7%
Sjogren syndrome (LIP)	1	3.3%
Wegner's Granulomatosis (Sec. alveolar Proteinosis)	1	3.3%
Total	30	100.0%

Idiopathic Interstitial Pneumonia was noted in most patients (~70%). In IIP, the UIP pattern was noted in 43.3% of patients and the NSIP pattern in 16.7% of patients. Diffuse Lung disease was noted in Connective Tissue disorders such as sarcoidosis in 10%, Scleroderma in 6.7%, Sjogren syndrome in 3.3% and Wegners Granulomatosis in 3.3% of patients, H/O smoking-associated diffuse lung disease, RB-ILD was noted in only one patient. Occupationally related lung disease was seen in only one patient with asbestos, respectively.

Table 6: Distribution of study population according to HCRT chest findings in Idiopathic Interstitial Pneumonia (Usual Interstitial Pneumonia), Connective Tissue disorders and Idiopathic Interstitial Pneumonia (RB-ILD)

	HRCT findings	Frequency	Per cent
Idiopathic Interstitial Pneumonia (Usual Interstitial Pneumonia)	Ground glass opacities	0	0.0%
	Inter and Intralobular septal thickening	13	100.0%
	Honeycombing	13	100.0%
	Traction Bronchiectasis	7	54.0%
	Cyst with centrilobular nodules	0	0.0%
Connective Tissue disorders	Ground glass opacities Inter and Intra lobular septal thickening	5 7	25.0% 35.0%
	Honeycombing	1	5.0%
	Traction Bronchiectasis	3	15.0%
	Cyst with centrilobular nodules	4	20.0%
Idiopathic Interstitial Pneumonia (RB-ILD)	Ground glass opacities	3	50.0%
	Inter and Intra lobular septal thickening	1	16.7%
	Honeycombing	1	16.7%
	Traction Bronchiectasis	0	0.0%
	Cyst with centrilobular nodules	1	16.7%

HRCT findings in Idiopathic Interstitial Pneumonia (Usual Interstitial Pneumonia) showed that inter and intralobular sehoneycombinging and honeycombing among 13 (100.0%) patients and tractional bronchiectasis among 7 (54%).

HRCT findings in Connective Tissue disorders showed that Ground glass opacities among 5 (25.0%), Inter and Intra lobular septal thickening honeycombing35.0%), honeycombing among 1 (5.0%), Traction Bronchiectasis among 3 (15.0%) and Cyst with centrilobular nodules 4 (20.0%) patients.

HRCT findings in Idiopathic Interstitial Pneumonia (RB-ILD) showed that Ground glass opacities among 3 (50.0%), Inter and Intra lobular septal thickenihoneycombing16.7%), Honeycombing among 1 (16.7%), and Cyst with centrilobular nodules 1 (16.7%) patients.

Table 7: Pulmonary Function Test findings in patients with Idiopathic Interstitial Pneumonia

		Frequency	Per cent
FEV1/FVC Ratio	> 70%	20	95.2%
	< 70%	1	4.8%
FVC	< 80%	21	100.0%
	> 80%	0	0.0%
DLCO	Normal	0	0.0%
	Mild	8	38.1%
	Moderate	6	28.6%
	Severe	7	33.3%

FEV1/FVC Ratio > 70% was found among 20 (95.2%) and < 70% among 1 (4.8%) patients. FVC < 80% was found among 21 (100.0%) patients. DLCO was found to be mild among 8 (38.1%), Moderate among 6 (28.6%) and Severe among 7 (33.3%) patients.

Table 8: Distribution of study population according to Pulmonary function tests in Connective Tissue Disorders

		Frequency	Per cent
FEV1/FVC Ratio	> 70%	7	100.0%
	< 70%	0	0.0%
FVC	< 80%	7	100.0%
	> 80%	0	0.0%
DLCO	Normal	0	0.0%
	Mild	1	14.3%
	Moderate	4	57.1%
	Severe	2	28.6%

FEV1/FVC Ratio > 70% was found among 7 (100.0%) patients. FVC < 80% was found among all 7 (100.0%) patients. DLCO was found to be mild among 1 (14.3%), Moderate among 4 (57.1%) and Severe among 2 (28.6%) patients.

FIGURE 1: 65-year-old female with complaints of dry cough

and dyspnoea. A) Axial HRCT Chest shows the presence of interlobular sehoneycombinging and honeycombing (marked with a blue arrow) in the subpleural distribution. B) Coronal reconstruction image shows interlobular sehoneycombingng with honeycombing in basal segments of bilateral lung fields (marked with red arrows). Findings are suggestive of Idiopathic Interstitial Pneumonia, likely UIP Patterns.

Figures

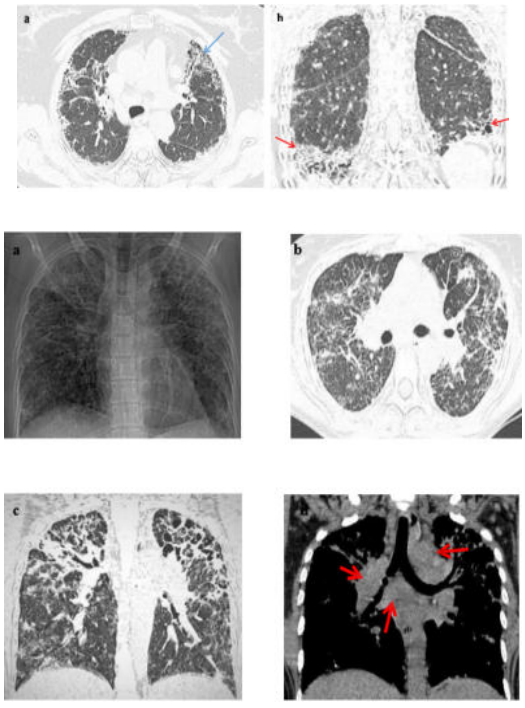

Figure 2: 45-year-old female presented with a complaint of dyspnoea and weight loss for one year. The patient had raised ACE levels and is a biopsy-proven case of sarcoidosis. a) X-ray chest PA view shows extensive reticular and nodular opacities involving the bilateral lung fields diffusely. B and c) Limited axial and coronal sections of HRCT Chest shows the presence of multiple nodules along the fissure and peri-bronchovascular interstitium with the presence of interlobular septal thickening. Multiple subpleural fibrous bands with adjacent tractional bronchiectasis are also seen. These findings diffusely involve the bilateral lung fields (upper lobe > lower lobe). d) Coronal reconstruction image of the mediastinal window shows multiple enlarged para-tracheal, pre carinal, subcarinal and bilateral hilar lymph nodes (marked with red arrows).

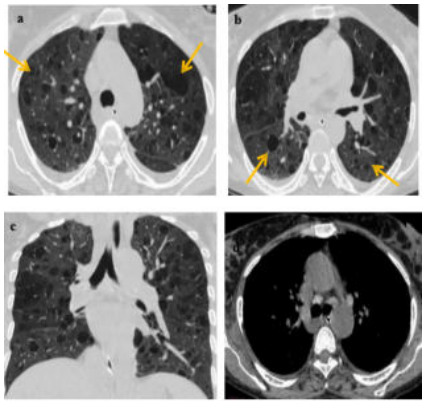

Figure 3: 41-year-old female presented with complaints of dry cough, dyspnoea and arthralgia for six months. The patient is a known case of Sjogren syndrome. A,b, c and d) Limited axial and coronal sections of HRCT Chest show multiple thin-walled cystic areas (marked with yellow arrows) diffusely involving the bilateral lung fields. The axial section of the mediastinal window in (image d) shows multiple enlarged mediastinal lymph nodes (marked with red arrows). Imaging features are highly suggestive of LIP in a known case of Sjogren syndrome.

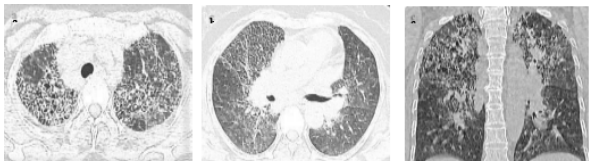

Figure 4: 59-year-old female patient came with a complaint of dyspnoea and dry cough. A, B, and C) Axial and Coronal sections of HRCT Chest show inter and intralobular septal thickening, mainly involving the bilateral upper lobes. There is evidence of tractional bronchiectasis with ground-glass opacities and honeycombing noted in bilateral upper lobes. Imaging features are suggestive of Idiopathic Interstitial Pneumonia, Likely NSIP Patterns.

DISCUSSION

ILD or Diffuse parenchymal lung diseases (DPLD) are terms used to encompass a large group of disorders that primarily affect the lung parenchyma in a diffuse manner. The parenchyma of the lung includes the pulmonary alveolar epithelium, capillary endothelium and the spaces between these structures, together with the tissues within the septa, including the perivascular and peri lymphatic tissues.[1]

Age

In our study, the mean age of the study population was 58.60±14.23 (24-80) years, with the majority belonging to 60-80 years (56.7%) age group. In similarity to our study, *Badarkhe-Patil et al*.[14] found that majority of the patients were between 60-80 years. *Vohra and sidhu*[15] found that the mean age of patients in our study was 44.2 years, ranging from 21 to 72 years. *Senger et al*[16] The age group ranged from 32 years to 66 years, with a median age of 44±7 years.

Earlier Indian studies of Muhammed SK et al. showed the age of presentation almost two decades earlier (40-60 years) than western study of Aziz ZA, et al. (60-80 years).[17,18] *Mathur et al*.[19] reported that the maximum (46.67%) subjects in the age group 51-70 years.

The age group of our patients is in variance with previously published Indian studies and matches that of western study. This might suggest a change in the Indian lifestyles towards more westernisation, a small sample size and a more urban bias of the study population.

Pal et al.[20] reported the mean age of 56.00 ± 16.51 years (Range: 25–79 years). Similar kind of results were seen in S. Annapurna et al.[21] (Age 60-80 years) and Bhat et al.[22] (Age 22-85 years (mean = 53.5 years)). In contrast, Siddhant S. Lolge et al.[23] (age 24-74 years) and Agrawal MK et al.[24] (age 30-74 years) showed male predominance.

Gender

In our study, the study population consisted of 46.7% males and 53.3% females. *Badarkhe-Patil et al.*[14] found that majority of the study subjects were females, with eight males and 17 females. *Vohra and Sidhu*.[15] reported that there was a female preponderance (~70% of the total cases). *Murata et al.* stated that there was a slight female preponderance. *Aziz ZA et al.* found that there was predominance of females.[18]

Mathur et al.[19] reported that 56.67% of patients were females and 43.33% were males. *Pal et al*.[20] reported that the study population was predominantly females (56.7%). Similar kind of results were seen in S. Annapurna et al.[21] (females > males)

and Bhat et al.[22] (56% females). In contrast, Siddhant S. Lolge et al.[23] (60% Male) and Agrawal MK et al.,[24] (65% males) showed male predominance.

Clinical symptoms

In the current study, Coughing was reported among 76.7%; dyspnoea was present among 99.9%, with GR1 among 13.3%, GR2 among 53.3% and GR3 among 33.3%, Malaise, Raynaud's phenomena, Weight loss, Arthralgia and Sclerodactyly among 6.7% each. Matching our study, *Senger et al*.[16] The most common presenting clinical feature was dry cough (55/65), followed by dyspnoea (45/65).

Digital clubbing was noted in 17 patients. Auscultatory crackles were present in all patients. *Mathur et al*.[19] found that the most common presenting complaint was gradual onset dyspnoea (95 %), followed by dry cough (88.3%) and generalised weakness (80%).

Badarkhe-Patil et al. [14] stated that the most common presenting complaint was progressive dyspnea seen in 48 patients (96%), followed by dry cough (74%) and associated joint pain (44%). These findings were in accordance with those reported by *Muhammed SK et al*.[17]

The study Study by Perez RL.[25] Moreover, Weinrib L et al. [26] showed a similar clinical profile, with progressive dyspnea on exertion and dry cough as significant complaints.

Vohra and sidhu.[15] reported that dyspnoea was the main presenting complaint in 60% of the patients in our study group. According to the severity as suggested by *Mawson et al*.,[27] 23% of patients had grade 3 to 4 dyspnoea at the time of presentation.

Smoking

In the present study, smoking was reported among 40.0% of patients. Various authors have tried to establish the relationship between a history of smoking and diffuse lung diseases. Ryu JH et al.[28] described four lung disorders linked to smoking- desquamative interstitial pneumonia, respiratory bronchiolitis-associated lung disease, pulmonary Langerhans cell histiocytosis and idiopathic pulmonary fibrosis.

This was much more than the study by *Badarkhe-Patil et al.* [14] the risk factors recorded were 38% serologically positive for connective tissue disorder, followed by smoking (18%) and allergy (16%). Three patients had a history of exposure which included exposure to chemotherapy, radiotherapy in two patients and coal dust particles in coal mine in one patient. Smoking and exposure history as compared to literature was less common. This might have happened due to more females being included in the study population, limited sample size and referral bias.

Duration of symptoms

In our study, the duration of symptoms was 1.18±0.81 (0.17-3.00) years, with the majority having symptoms for 6-12 months and 1-2 years (33.3% each). *Mathur et al*.[19] reported that the maximum duration of illness was five years, and the minimum duration of illness was two months. The mean duration of illness of the patients was three years with an SD of 1.6. Maximum patients presented between 1-5 years. A similar duration of illness was found in the study by *Gagiya AK et al*.,[29], in which maximum patients presented before five years of onset of illness and the majority presented between 1-3 years.

Spirometry (Forced vital capacity, FEV and DLCO)

Forced vital capacity reports of all patients were evaluated in our study. All the values were expressed as a percentage of the predicted value, as per the standards laid down by the American Thoracic Society. In our study, Mean FVC (%) was 56.13±7.73, mean FEV1 (%) 63.73±8.56, FEV1/FVC was 86.07±13.03 and DLCO (%) was 50.03±14.86. FVC < 80% was found among 100.0% patients. FEV1/FVC Ratio > 70% was found among 96.7% and < 70% among 1 (3.3%) patient. DLCO was found to be Normal among 0.0%, Mild among 30.0%, Moderate among 40.0% and Severe among 30.0% of patients.

In current study, in Idiopathic Interstitial Pneumonia, FVC < 80% was found among all 100.0% patients. FEV1/FVC Ratio > 70% was found among 95.2% and < 70% among 1 (4.8%) patients. DLCO was found to be Mild among 38.1%, Moderate among 28.6% and Severe among 33.3% patients. In Connective Tissue Disorders, FVC < 80% was found among 100.0% patients. FEV1/FVC Ratio > 70% was found among 100.0% patients. DLCO was found to be Mild among 1 (14.3%), Moderate among 57.1% and Severe among 28.6% patients.

Most interstitial disorders have a restrictive defect with reductions in total lung capacity (TLC), functional residual capacity (FRC), and residual volume (RV). Flow rates are decreased (FEV1 and FVC), but the changes are in proportion to the decreased lung volumes; thus, the FEV1/FVC ratio is usually normal or increased. The reductions in lung volumes become more pronounced as lung stiffness worsens with disease progression.[30]

Mathur et al.[19] reported that most (36.67%) of the patients showed severely low FVC, 16.67% had moderately low, and 23.33% had mildly low FVC. Severely low vital capacity was present among 23.33% of patients. FEV1 of a majority of the patients were normal, i.e., 33.33% of ILD showed a normal FEV1, whereas 21.67% had a moderate affection for FEV1, and only 1.67% had very severe affection for the FEV1.

Interstitial lung diseases show a typical restrictive pattern. *Chinet et al*.[31] have described the restrictive lung pattern with FVC≤80%. *Vohra and sidhu*.[15] found that the mean value of FVC was 73.3% of the predicted value. Senger et al.[16] reported that Restrictive pattern on spirometry was noted in 60 out of 65 patients, 03 patients had normal spirometry, and 02 patients had mixed obstructive and restrictive patterns on spirometry.

HRCT Findings

In the present study, HRCT findings in Connective Tissue disorders showed ground-glass opacities among 25.0%, Inter and Intra lobular septal thick honeycombing 35.0%, and honeycombing among 1 (5.0%), Traction Bronchiectasis among 15.0% and Cyst with centrilobular nodules 20.0% patients. HRCT findings in Idiopathic Interstitial Pneumonia (Usual Interstitial Pneumonia) showed ground honeycombing and honeycombing among 100.0% of patients. HRCT findings in Idiopathic Interstitial Pneumonia (RB-ILD) showed that Ground glass opacities among 50.0%, Inter and Intra lobular septal thickenihoneycombing16.7%), Honeycombing among 1 (16.7%), and Cyst with centrilobular nodules 1 (16.7%) patients.

Badarkhe-Patil et al. [14] reported that the various patterns found to be associated with interstitial lung disease on HRCT were reticular opacities (64%) followed by increased opacity (58%) and decreased opacity (58%). Our findings are well correlated with the Indian study done by Muhammed SK et al.[17] which was very similar to our study, except for decreased opacity which was not separately described in that study. Decreased opacity was mainly contributed by traction bronchiectasis, and in most conditions, it was part of reticular opacity.

However, HRCT of lungs, along with clinical data, is essential

for the diagnosis of ILD, as reported by Aziz ZA et al., Potente G et al., and Ghulam Shabbier et al.[18,32,33]

Mathur et al.[19] stated that the most common finding observed on HRCT was septal or subpleural lines. Ground Glass Opacities (GGO's), irregular honeycombingins and honeycombing.

Pal et al.[20] found that the most common findings were reticular opacities (56.6%) detected in HRCT chest. Other common findings frequently detected in HRCT chest were traction bronchiectasis (43.3%), honeycombing (33.3%), septal thickening (46.7%), and ground-glass opacity (GGO) (50.0%), nodules (23.3%). Similar findings were observed by C. K Onyambu et al., where predominant reticular opacities (56.1%), honeycombing (37.8%), GGO (26.8%) pattern on HRCT chest among ILD patients. S. Annapurna et al.[88] revealed septal thickening (64%) followed by bronchiectasis (52%) and GGO (48%) in the HRCT chest.

The ground-glass opacity seen on HRCT in some patients with IPF can be associated with alveolar inflammation but predominantly with patchy fibrotic thickening of alveolar septa, and interalveolargranulation tissue. Ground glass opacity on HRCT often regresses on treatment but may not decrease as readily in patients with UIP. An area of ground-glass opacity may progress to rhoneycombingcity or honeycombing on follow-up examination. Patients with predominant rhoneycombingcity or honeycombing usually progress despite treatment. The extent of lung fibrosis on HRCT is a significant predictor of survival.[16]

Diagnosis

In present study, Asbestosis, IIP (NSIP), IIP (RB-ILD), IIP (UIP), LAM, Sarcoidosis, Scleroderma (NSIP), Sjogren syndrome (LIP) and Wegner's Granulomatosis (Sec. alveolar Proteinosis) was reported among 3.3%, 16.7%, 10.0%, 43.3%, 3.3%, 10.0%, 6.7%, 3.3% and 3.3% respectively.

Pal et al.[16] found that the spectrum of diseases diagnosed was Idiopathic Pulmonary Fibrosis (IPF) (26.7%), Connective tissue disease-related ILD (CTD- ILD) (26.7%), Hypersensitivity Pneumonitis (HP) (13.3%) and Sarcoidosis (13.3%) most commonly. Among CTD-ILD most common were Rheumatoid Arthritis (RA) (4/8) and Scleroderma (3/8). Siddhant S. Lolge et al observed sarcoidosis (23.3%), RA (10%), IPF (23.3%), HP (6.7%). Bhat et al.[22] revealed common presentation in HRCT chest as IPF (32%), RA (26%), followed by scleroderma (20%) cases.

Mathur et al.[19] found that the most common interstitial lung disease found was Usual Interstitial Pneumonia (UIP)/Idiopathic Pulmonary Fibrosis (IPF) (55%), followed by nonspecific interstitial pneumonia (NSIP) (15%), sarcoidosis (8.3%), hypersensitivity pneumonitis (HSP, 8.3%), respiratory bronchiolitis associated RB-ILD (1.67%), Desquamative Interstitial Pneumonia (DIP, 1.67%) and unclassified Idiopathic Interstitial Pneumonia (IIP, 10.0%).

The spectrum of diseases included in Agrawal MK et al.[24] was IPF (25%), HP (17.5%), Sarcoidosis (15%), RA (10%), Silicosis (10%) and others. In Meraj Rentia et al.[34] the spectrum of diseases was IPF (25%), idiopathic NSIP (16.5%), RA (14.5%), lymphangitis carcinomatosis (8.33%), asbestosis (6.25%), HP (6.25%) were common out of which 2 of 48 patients (4.16%) had normal CXR.

CONCLUSION

HRCT is a valuable technique for evaluating the extent of lung involvement in various ILDs even when chest X-rays are normal. It can be used for imaging the lungs with excellent spatial resolution and provides good anatomic detail. Specific diagnosis can be made and is helpful in planning patients management. In conjunction with clinical diagnosis, it can obviate the need for lung biopsy. HRCT is invaluable in characterising the disease process, but it cannot assess physiological lung functions. As the severity and extent scores of HRCT have an inverse relationship with the spirometric indices in ILD, spirometry and DLCO can provide a viable alternative to assess the disease severity.

Conflict of Interest:

None of the Authors have any conflicts of interest.

REFERENCES

1. Gupta A, Mathur R, Shyojiram, Prasanna R, Meena R. Role of High Resolution Computed Tomography in Evaluation of Diffuse Parenchymal Lung Diseases. RUHS Journal of Health Sciences. 2017;2(1):16-23.
2. Travis WD, Costabel U, Hansell DM, King Jr TE, Lynch DA, Nicholson AG, Ryerson CJ, Ryu JH, Selman M, Wells AU. An official American Thoracic Society/European Respiratory Society statement: update the international multidisciplinary classification of the idiopathic interstitial pneumonias. 2013;188:733-48.
3. Raghu G, Brown KK. Interstitial lung disease: clinical evaluation and keys to an accurate diagnosis. Clin Chest Med. 2004;25:409-19.
4. Lynch D. Imaging of diffuse parenchymal lung disease. In: Schwarz MI, King TE, editors. Interstitial lung disease. 4th ed. Hamilton (Ontario): BC Decker, Inc; 2003.
5. Elicker B, Pereira CA, Webb R, Leslie KO. High-resolution computed tomography patterns of diffuse interstitial lung disease with clinical and pathological correlation. J Bras Pneumol. 2008;34(9):715-44.
6. American Thoracic Society. Idiopathic pulmonary fibrosis: diagnosis and treatment. International consensus statement. American Thoracic Society (ATS), and the European Respiratory Society (ERS). Am J Respir Crit Care Med. 2000;161:646–64.
7. Hunninghake GW, Zimmerman MB, Schwartz DA, et al. Utility of a lung biopsy for the diagnosis of idiopathic pulmonary fibrosis. Am J Respir Crit Care Med. 2001;164:193–6.
8. Wells A. Clinical usefulness of high resolution computed tomography in cryptogenic fibrosing alveolitis. Thorax. 1998;53:1080–7.
9. Goh NS, Desai SR, Veeraraghavan S, et al. Interstitial lung disease in systemic sclerosis: a simple staging system. Am J Respir Crit Care Med. 2008;177:1248– 54.
10. Walsh SL, Wells AU, Sverzellati N, et al. An integrated clinicoradiological staging system for pulmonary sarcoidosis: a case-cohort study. Lancet Respir Med. 2014;2:123–30.
11. Wells AU, Antoniou KM. The prognostic value of the GAP model in chronic interstitial lung disease: the quest for a staging system. Chest. 2014;145:672–4.
12. Elicker BM, Webb WR. Fundamentals of high-resolution lung CT: common findings, common patterns, common diseases and differential diagnosis: Lippincott Williams & Wilkins; 2018.
13. Raghu G, Remy-Jardin M, Myers JL, Richeldi L, Ryerson CJ, Lederer DJ, et al. Flaherty KR. Diagnosis of idiopathic pulmonary fibrosis. An official ATS/ERS/JRS/ALAT clinical practice guideline. Am J Respir Crit Care Med. 2018;198(5):e44-68.
14. Pankaj Badarkhe-Patil, Dayanand Kawade, Prashant Titare, Varsha Rote-Kaginalkar. HRCT assessment of interstitial lung diseases. International Journal of Contemporary Medical Research 2016;3(8):2426-30.
15. Vohra P, Sidhu HS. Evaluation of diffuse lung diseases by high resolution computed tomography of chest. Int J Res Med Sci 2017;5:1655-61.
16. Senger KPS, Singh A. Highresolution computed tomography as a non-invasive imaging biomarker for interstitial lung diseases: a tertiary center study. Int J Adv Med 2021;8:207-13.
17. Muhammed SK, Anithkumari K, Fathahudeen A, Jayprakash B, et al. Aetiology And Clinic-Radiological Profile Of Interstitial Lung Disease In A Tertiary Care Centre. J Pulmon. 2011;13:12-5.
18. Aziz ZA, Wells AU, Hansell DM, Bain GA, et al. HRCT Diagnosis Of Diffuse Parenchymal Lung Disease: Interobserver Variation, Thorax. 2004;59:506-11.
19. Mathur M, Gupta S, Bhalla R, Mathur A. High Resolution Computed Tomography Assessment of Interstitial Lung Diseases and its Correlation with Spirometry Indices. Journal of Clinical and Diagnostic Research. 2017;11(11):TC07-12.
20. Pal A, Yadav, MK, Pant C, Shrestha BK. High resolution computed tomography and chest radiography findings among interstitial lung disease patients. Journal of Chitwan Medical College. 2019;9(4):24-7.
21. Annapurna S, Badarke P, Chandra E. Study of Interstitial Lung Disease with reference to radiological profile. Asian Journal of Medical Radiological Research. 2018;6(1):15-21.
22. Bhat IM, Bhat JA, Shamshad M, Malik AA, Mir S. Role of High-resolution Computed Tomography Chest in Interstitial Lung Diseases. Int J Sci Stud. 2016;4(2):20-6.
23. Lolge SS, Kachewar SG, Ghule SS, Lakhkar DL, Tamhane TM, Shinde PP. Comparative study of HRCT thorax with plain chest radiograph in evaluating the patients with interstitial lung diseases. Scholars Journal of Applied Medical Sciences. 2016;4(11C):4028-33.
24. Agrawal MK, Kumar A, Agrawal R, Rana R. To study the significance of HRCT over Chest x-ray in the diagnosis of interstitial lung diseases. J Evolution Med Dent Sci. 2019;8(02):94-8.
25. Perez RL. Interstitial lung disease: causes, treatment, and prevention. Ethn Dis. 2005;15(2 suppl 2):S45-8.
26. Weinrib L, Sharma OP, Quismorio FP Jr. A long-term study of interstitial lung disease in systemic lupus erythematosus. Semin Arthritis Rheum.1990;20(1):48-56.
27. Mawson JB, Muller NL, Mathieson Jr. Sarcoidosis- correlation of extent of

disease at CT with clinical, functional and radiographic findings. Radiology. 1989;171:613-8.
28. Ryu JH, Colby TV, Hartmann TE. Smoking related interstitial lung diseases: A Review. Eur Resp J. 2001;17:122-32.
29. Gagiya AK, Suthar HN, Bhagat GR. Clinical profile of interstitial lung diseases cases. Natl J Med Res. 2012;2(1):2-4.
30. Wells AU, Hirani N. Interstitial lung disease guideline: the British Thoracic Society in collaboration with the Thoracic Society of Australia and New Zealand and the Irish Thoracic Society. Thorax. 2008;63(5):v1-58.
31. Chinet T, Dusser D, Labrune S, Collignon MA, Chretien J, Huchon GJ. Lung Function declines in patients with Pulmonary sarcoidosis and increased respiratory epithelial permeability to 99mTc-DTPA. Am Rev Resp Dis. 1990;141(2):445-9.
32. Potente G, Bellelli A, Nardis P. Specific diagnosis by CT and HRCT in six chronic lung diseases. Comput Med Imaging Graph. 1992;16:277-282.
33. Shabbier G, Amin S, Ullah F, Rehman S, Khan S. Role of high resolution Computed Tomographic Scan in diagnosis of Interstitial Lung Diseases in local population. J Postgrad Med Inst. 2012;26:149-52.
34. Rentia M, Singla H, Malpani D, Vaishnav T, Jhala P. Radiological analysis of interstitial lung diseases. IAIM. 2015;2(6):69-76.