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Radiological study of characterization of interstitial lung disease using HRCT in clinically suspected cases

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Abstract

Background: Interstitial lung diseases are heterogeneous group of disorders of the lower respiratory tract that are characterized by both acute and chronic inflammation and a generally irreversible and relentless process of fibrosis in the interstitium and the alveolar walls. High-resolution computed tomography of the chest has become an invaluable tool in the diagnostic process of interstitial lung diseases. Present study was aimed to study characteristics of interstitial lung disease using HRCT in clinically suspected cases.
Material and Methods: Present study was single-center, cohort descriptive and observational study conducted in patients of any age, gender, with clinically suspected interstitial lung disease referred for HRCT.
Results: Majority of patients were found in the age group of 60-69 years (45%), were male (65%) & had history of smoking (42.5%). Major chief complaints were cough (55%), breathlessness (25%), dry cough (15%) and cough with fever (5%). Out of total of 40 patients, 22(55%) patients showed HRCT pattern reflecting Usual Interstitial Pneumonia (UIP) and Idiopathic Pulmonary Fibrosis (IPF), 10(25%) patients showed Nonspecific Interstitial Pneumonia (NSIP), 5(12.5%) patients had Hypersensitivity Pneumonitis (HSP) as well as 2(5%) patients had cryptogenic organizing pneumonia (COP) while only 1 patient (2.5%) showed changes of respiratory bronchiolitis-associated interstitial lung disease (RB-ILD). Maximum no of patients had bronchiectasis (57.50%), reticulation (42.50%), honeycombing (35.00%), ground glass opacities (32.50%) & consolidation (5.00%). Out of total of 40 patients, only 2 (9.09%) patient shows regression in UIP in follow-up scan, while others show progression 20(90.91%). 3 each shows progression in HSP (60%) and NSIP (30%), however in COP(100%) all patients show regression.
Conclusion: Based on the HRCT features a histospecific diagnosis can be reached in most cases of Idiopathic Interstitial Pneumonias obviating the need for biopsy.

Keywords: High resolution computed tomography (HRCT), idiopathic interstitial Pneumonias, disease activity. Interstitial lung disease

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Introduction

Interstitial lung diseases are heterogeneous group of disorders of the lower respiratory tract that are characterized by both acute and chronic inflammation and a generally irreversible and relentless process of fibrosis in the interstitium and the alveolar walls [1]. The term "interstitial" can be misleading as most of these conditions also affect the airway spaces and even the blood vessels, but it is the predominant and primary involvement of the interstitium that characterizes those [2].

Interstitial lung diseases are characterized by anatomical distortion of peripheral airways and interstitium, determined by a first stage of alveolitis followed by a stage of fibrosis. Idiopathic pulmonary fibrosis is the most common interstitial lung disease in adults and generally has a poor prognosis [3]. Although there are several interstitial lung diseases, only a few handful of about 10-12 account for more than 90% of them. Among the well over 100 distinct entities of ILDs, a limited number of disorders, including idiopathic pulmonary fibrosis, sarcoidosis, and connective tissue disease-related ILDs, account for most ILDs encountered clinically [4]. Hence, proper knowledge and understanding of these common entities is pertinent in diagnosing them and also in including them in the differential diagnosis.

In the diagnosis of interstitial lung diseases, clinical, radiological and histological correlation is needed on most occasions. The chest radiogram remains the basic radiological tool in the investigation of these patients [5]. However, chest radiography is relatively insensitive and is normal in 10-20% of patients with histologically proven interstitial lung disease [5]. High-resolution computed tomography of the chest has become an invaluable tool in the diagnostic process of interstitial lung diseases. Present study was aimed to study characteristics of interstitial lung disease using HRCT in clinically suspected cases.

Material and Methods

Present study was single-center, cohort descriptive and observational study conducted in Department of Radiology, Seth G.S. Medical College & KEM Hospital, India. Study duration was of 2 years (July 2018 to June 2019). Study was approved by institutional ethical committee.

Inclusion criteria

- All the patients of any age, gender, with clinically suspected interstitial lung disease referred for HRCT.

Exclusion criteria

- Patients with associated lung pathology like consolidation, mass or any other significant lung pathology.
- Hemodynamically unstable and unconscious patients.
- All patients who will not consent to be a part of the study.

This hospital is a tertiary care center equipped with 64 Slice MDCT scanner (Brilliance 64 Philips, Netherlands). Each patient underwent a thorough clinical evaluation including a detailed history and physical examination. The duration of the complaints were noted in each patient. All the patients were made to undergo HRCT scan as the radiological examination after taking an informed consent for the same.

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The scan parameters were

- Detector collimation: 32 × 0.6 mm.
- Slice acquisition: 64 × 0.6 mm.
- Gantry rotation time: 500 milliseconds (temporal resolution, 83 milliseconds);
- Pitch: Automatically calculated by the machine, it is usually 1.0.
- Tube current: 390 mAs per rotation;
- Tube potential: 120 kV.

Scan range: For routine HRCT sequence, 1 cm above the manubrium till the level of adrenal.
Slice thickness and collimation: Images are acquired with a collimation of 0.65 mm with position increment of 0.7 mm and then latter reconstructed.
Scanning time was approximately 6-9 seconds in a single breath hold in the craniocaudal direction.
Scan direction: The scan direction is cranio-caudal for routine HRCT.

HRCT Examination technique

Scans were obtained with the patient in supine position with full inspiration with a collimation of 0.65 mm and 6-9 seconds acquisition time. Images were reconstructed with a high spatial frequency algorithm and photographed at window settings appropriate for viewing the lung parenchyma (Window center, -600HU; Window width, -1200HU).
The Statistical Analysis was done using SPSS Software Ver. 17. The quantitative variables were presented as means and standard deviation and compared using paired t-test. The qualitative variables were presented as frequencies and percentages and compared using chi-square test. The p-value of < 0.05 was considered as significant.

Results

HRCT of chest was performed on 40 patients, which were clinically suspected interstitial lung diseases. Majority of patients were found in the age group of 60-69 years (45%) followed by 70-79 years (25%) and in 50-59 year age groups (12.50%). 26 (65%) patients were Male and 14 (35%) patients were female. The study included 17 (42.5%) patients who gave a history of smoking. Major Chief Complaints were cough (55%), breathlessness (25%), dry cough (15%) and cough with fever (5%).

Table 1: General characteristics

Characteristics	No.	Percentage
Age (years)		
30 - 39	2	5.00%
40 - 49	3	7.50%
50 - 59	5	12.50%
60 - 69	18	45.00%
70 - 79	10	25.00%
80 - 89	2	5.00%
Gender		
Female	14	35.00%
Male	26	65.00%
History of Smoking	17	42.50%
Chief Complaints		
Cough	22	55.00%
Breathlessness	10	25.00%

Dry Cough	6	15.00%
Cough + Fever	2	5.00%

Out of total of 40 patients, 22(55%) patients showed HRCT pattern reflecting Usual Interstitial Pneumonia (UIP) and Idiopathic Pulmonary Fibrosis (IPF), 10(25%) patients showed Nonspecific Interstitial Pneumonia (NSIP), 5(12.5%) patients had Hypersensitivity Pneumonitis (HSP) as well as 2(5%) patients had cryptogenic organizing pneumonia (COP) while only 1 patient (2.5%) showed changes of respiratory bronchiolitis-associated interstitial lung disease (RB-ILD).

Table 2: Distribution of Idiopathic Interstitial Pneumonias (IIPs)

HRCT Diagnosis	No.	Percentage
Usual Interstitial Pneumonia (UIP)	22	55.00%
Nonspecific Interstitial Pneumonia (NSIP)	10	25.00%
Hypersensitivity Pneumonitis (HSP)	5	12.50%
Cryptogenic Organizing Pneumonia (COP)	2	5.00%
Respiratory Bronchiolitis-Associated Interstitial Lung Disease (RB-ILD)	1	2.50%

Out of total of 40patients, maximum no of patients had bronchiectasis (57.50%), reticulation (42.50%), honeycombing (35.00%), ground glass opacities (32.50%) & consolidation (5.00%).

Table 3: HRCT features

HRCT Features	No.	Percentage (N=80)
Bronchiectasis	23	57.50%
Reticulation	17	42.50%
Honeycombing	14	35.00%
Ground Glass Opacities	13	32.50%
Consolidation	2	5.00%

Out of total of 40 patients, only 2 (9.09%) patient shows regression in UIP in follow-up scan, while others show progression 20(90.91%). 3 each shows progression in HSP (60%) and NSIP (30%), however in COP(100%) all patients show regression.

Table 4: showing treatment response among the study population

HRCT Diagnosis	Treatment Response		Total
	Progression	Regression	
Usual Interstitial Pneumonia (UIP)	20 (90.91%)	2 (9.09%)	22
Nonspecific Interstitial Pneumonia (NSIP)	3 (30.00%)	7 (70.00%)	10
Hypersensitivity Pneumonitis (HSP)	3 (60.00%)	2 (40.00%)	5
Cryptogenic Organizing Pneumonia (COP)	0	2 (100.00%)	2

Discussion

Around 15% of patients with interstitial lung disease have an underlying connective tissue disorder [6]. Although interstitial lung diseases are more common in adults, certain forms such as hypersensitivity pneumonitis and idiopathic interstitial pneumonias are seen in children as well.[7] In children, common diseases associated with interstitial lung diseases include viral respiratory tract infections (RSV, parainfluenza, etc.), gastroesophageal reflux, idiopathic pulmonary fibrosis, pulmonary hemosiderosis, eosinophilic pneumonia, pneumonitis associated with AIDS etc [6, 7, 8].

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High resolution computed tomography (HRCT) has revolutionized the imaging of interstitial lung disease (Idiopathic Interstitial Pneumonias) as it enables early detection of disease, allows a histospecific diagnosis to be made in certain cases and provides insight into disease reversibility and prognosis.

In this present study of 40 patients, who were clinically suspected of having interstitial lung disease (Idiopathic Interstitial Pneumonias) were included. The age group of the subjects ranged from 30 to 89 years and most (40.3%) were found in the age group of 60-69 years. In present study overall mean age of patients with interstitial lung disease is 61.01 years. The p-value is 0.985, which is not significant.

In the present study of 40 patients, 26(58.3%) were male and 14(41.7%) were female. In that, UIP 27(58.7%) and HSP 10(21.7%) were common in men, while NSIP 12(35.3%) were female. The p-value is 0.00122, which is significant. Out of total of 40 patients, maximum no of smoker 20(69.0%) had UIP, but patients with NSIP had no smoking history? The p-value is 0.0026, which is significant.

Out of the total of 40 patients, 22(61.1%) patients showed changes of UIP, 10(19.4%) patients showed changes of NSIP. HSP was present in 5(15.3%) patients and 2(2.8%) patients showed changes of COP as well as 1(1.4%) patient had changes of RB-ILD. DIP, AIP and LIP were not seen in any of the 80 patients.

Out of total of 40 patients, maximum no of patients 17(80.9%) with dry cough had UIP, 9(28.1%) with cough had NSIP, 6(18.8%) with cough had HSP and 5(100%) patients with consolidation had COP.

UIP is characterized by a variegated pattern with foci of normal lung, interstitial cellular infiltrates and zones of active fibrosis [9, 10]. The characteristic thin-section CT findings of UIP consist of intralobular linear areas of increased attenuation and honeycombing that predominantly involves the basal and subpleural regions [63, 96] [11, 12]. In this study, 32(43.1%) had honeycombing and 48(56.9%) were not associated with honeycombing. Only UIP was associated with honeycombing. Out of total of 20 patients of UIP, only 1(2.2%) patient showed regression in follow-up scan, while others showed progression 44(97.8%). The regression was seen in ground glass opacities but honeycombing was still persisting. The alveolitis had regressed but other changes had not regressed.

UIP are more common in smokers and ex-smokers than in non-smokers and more common in men than women [13, 14]. In this present study the 20(69.0%) patients out of a total of 40 patients with UIP were smokers.

The HRCT manifestations of NSIP usually consist of predominantly ground glass opacities often with a basal and peripheral predominance with or without associated reticulation and/or traction bronchiectasis [15]. In the present study 63(80.6%) had bronchiectasis and 17(19.4%) were not associated with bronchiectasis. Maximum no of patients with UIP 40(63.5%) and NSIP 16(25.4%) associated with bronchiectasis. The p-value is 6.35E-06, which is significant.

Most of the patients having NSIP with reticulation show changes of bronchiectasis and bronchiectasis. In the present study all patients (100%) with NSIP showed areas of bronchiectasis with 2 patients showing ground glass opacities with bronchiectasis in the absence of reticulation. Out of 16 patients of NSIP, 4(25%) show progression, while the rest show regression 12(75%). The progression had seen in fibrotic changes, which is seen in subpleural and peribronchovascular locations.

HSP is characterized by diffuse areas of ground glass opacities with areas of air trapping. Out of total of 40 patients, 29(44.4%) had ground glass opacities and 11(55.6%) were not associated with ground glass opacities. Maximum no of patients with HSP 13(33.3%) and NSIP 12(30.8%) associated with ground glass opacities. The p-value is 1.01E-05, which is significant. Out of 13 patients of HSP, 4(30.7%) showed progression in follow-up scan, while the rest showed regression 9(69.3%). The 4 patients with subacute HSP were progressed into

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the chronic HSP.

COP is characterized by consolidation in 90% with a subpleural or peribronchial distribution in up to 50% of cases [11]. Ground-glass opacities are present in all of cases. In this study 5 patients presented with COP and showed patchy area of consolidation with ground glass opacities. In the present study, 5(2.8%) had consolidation and 75(97.2%) were not associated with consolidation. Only patients with COP 5(100%) associated with consolidation. The p-value is 0.00593, which is significant. In follow up scan, all showed regression.

RB-ILD is characterized by ground glass opacities with centrilobular nodules [16]. In this study only 1 patient presented with RB-ILD, which has ground glass opacities with nodules. The findings of this study correlate well with many other studies reported in literature.

A confident diagnosis can often be made on the basis of high-resolution computed tomographic findings and the clinical context. Serologic testing can be helpful in selected cases [4]. Improvements in CT scanner technology has now made it possible to image the lung parenchyma with excellent anatomic detail [17]. The morphologic characteristics of diffuse parenchymal lung diseases can be demonstrated with very high resolution. HRCT or high resolution computed tomography is more sensitive than conventional chest radiography in the detection of interstitial lung diseases. However, sensitivity is not 100% [17]. The specificity for the characterization of different lung diseases has been documented and appears to be better than conventional radiography. The ability to characterize different disease processes and to provide a specific diagnosis by HRCT is a big advantage in clinical situations.

To date, numerous reports have documented that HRCT is more sensitive and specific than chest radiography in establishing a diagnosis in diffuse lung diseases. HRCT has proved particularly accurate in establishing the diagnosis of silicosis, idiopathic pulmonary fibrosis, lymphangitic carcinomatosis, and sarcoidosis. In general, the accuracy of plain film diagnosis in the same disorders was much lower [18].

Mathieson *et al*., [19] analyzed the accuracy of HRCT and chest radiography in establishing a specific diagnosis in patients with chronic diffuse infiltrative lung disease. The highest confidence level was reached with 49% of CT scans and 23% of plain chest films, and a correct diagnosis was made with 93% and 77%, respectively.

In a large study of patients with chronic diffuse infiltrative lung disease, Grenier *et al*., [20] demonstrated that high resolution CT was of particularly high value when CT images were analyzed together with clinical and radiographic information. Based on clinical information alone, a confident correct diagnosis could be made in 29% of the cases. Combined interpretation of clinical data and plain film findings increased the confidence in a correct diagnosis to 54%, and to 80% when clinical, radiographic, and HRCT findings were analyzed together. Consequently, most patients with a diagnosis of diffuse lung disease based on plain films will proceed to HRCT to narrow down the differential diagnosis or even to establish a specific diagnosis and to do so with a higher confidence level [18]. Hence HRCT is currently the most sensitive tool for non-invasive imaging of the lung parenchyma in patients with suspected ILD.

Conclusion

High resolution computed tomography (HRCT) is very effective in visualizing the interstitial changes in Idiopathic Interstitial Pneumonias. Based on the HRCT features a histospecific diagnosis can be reached in most cases of Idiopathic Interstitial Pneumonias obviating the need for biopsy. The disease activity can also be depicted, thereby guiding the treatment strategy.

Conflict of Interest: None to declare.

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