ROLE OF HIGH RESOLUTION COMPUTED TOMOGRAPHY IN THE EVALUATION OF INTERSTITIAL LUNG DISEASES

Radiology

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ABSTRACT

BACKGROUND: Interstitial lung diseases are classified into those with known causes and with unknown causes. Those with known causes include Connective tissue disease associated ILD, Pneumoconiosis, Drug-induced, Smoking-related ILD, Radiation-induced and Toxic inhalation-induced ILD. Those with unknown causes include Idiopathic pulmonary fibrosis, Sarcoidosis, Pulmonary lymphoma, alveolar proteinosis and pulmonary alveolar proteinosis. **AIMS:** To utilize HRCT in evaluation of pulmonary interstitium in patients having clinical features of interstitial lung diseases. To compare the accuracies of chest radiography and HRCT in the prediction of specific diagnosis of interstitial lung disease. **MATERIAL AND METHODS:** Hospital based observational study. CT section at Dept. Of Radio diagnosis, Medical College Kolkata (Philips brilliance 16 slice) and EKO diagnostics at Medical College, Kolkata. Dept. Of Radio diagnosis, Medical College, Kolkata. January 2018 to June 2019. **RESULT:** 2(4.0%) patients had ≤ 30 years of age, 9(18.0%) patients had 31-40 years of age, 15(30.0%) patients had 41-50 years of age, 18(36.0%) patients had 51-60 years of age, 3(6.0%) patients had 61-70 years of age and 3(6.0%) patients had > 70 years of age. **CONCLUSION:** HRCT is the most accurate non-invasive imaging modality for evaluation of lung parenchyma in the cases of interstitial lung diseases. The cross sectional perspective and high spatial resolution makes HRCT superior to chest radiography.

KEYWORDS

Interstitial Lung Diseases, High Resolution Computed Tomography, Pulmonary Lymph, Sarcoidosis.

INTRODUCTION

Interstitial lung diseases (ILD) also called as diffuse infiltrative lung diseases are heterogeneous group of disorders that predominantly affect the lung parenchyma and are characterized by alveolar, septal thickening, fibroblast proliferation and pulmonary fibrosis. Although over 100 distinct entities of ILD are recognized, idiopathic pulmonary fibrosis, sarcoidosis and connective tissue disease related ILD account for most of ILD. The prevalence of the IPF is around 54 per 100000 adults using broad case definition and 17 per 100000 using narrow case definition. Although ILDs are more commonly seen in adults, some forms such as hypersensitivity pneumonitis and idiopathic interstitial pneumonias are encountered in children¹. Patients with ILD most commonly present with shortness of breath with exertion, fatigue, weakness, loss of appetite, loss of weight, dry cough and discomfort in chest. These people have a diffuse infiltrative pattern on chest radiograph. This study is aimed at the imaging features of various common interstitial lung diseases so that the diagnosis is made early and irreversible complications avoided.

Interstitial lung diseases are manifested radiographically as either reticular pattern, nodular pattern or reticulonodular pattern. Interlobular septae contains lymphatics and veins along with connective tissue. Diseases that involve these structures will result in thickened interlobular septae and irregular appearances of the pleural surfaces like in IPF, lymphangitic carcinomatosis and pulmonary edema².

For many years, the plain chest radiograph was the only imaging used in the diagnosis of interstitial lung diseases. With the advent of CT, came the first opportunity to assess gross lung structure. Conventional 8-10 mm collimation scans allowed better assessment of lung parenchyma. However CT only played minor role in diagnosis of interstitial lung diseases until the introduction of High Resolution Computed Tomography (HRCT). By eliminating superimposition of structures, CT allows for a better assessment of the type, distribution and severity of parenchymal abnormalities³. Since its introduction in the 1980s, HRCT scanning with its greater ability to visualize fine detail within the lung, has replaced conventional chest radiography as the preferred imaging method for the ILDs. The characteristic radiographic features of many ILDs (especially for IPF) and correlations of these features with histopathology have been described. HRCT has been found useful in the evaluation of ILDs in the following areas: Identification of the presence of disease (often being abnormal when other studies are normal or only mildly impaired), evaluation of the extent of disease, characterization of the patterns of the disease, narrowing the differential diagnosis, as a guide to the site of biopsy and

assessing the clinical course of the disease and response to therapy.

Interstitial lung disease (ILD) are group of pulmonary disorders characterized by inflammation and fibrosis of gas exchanging portion of the lung and diffuse abnormalities on lung radiograph.

Conventional plain film radiography remains the first and foremost imaging modality used in initial assessment and follow up evaluation of virtually all patients. However, a normal chest radiograph does not exclude the presence of interstitial lung disease. Approximately 4% of patients with dyspnea had normal chest radiograph are limited in sensitivity, specificity and diagnostic accuracy. Conventional computerized tomography plays a limited role in evaluation of interstitial lung disease due to its inability to demonstrate fine parenchymal details. First introduced in 1982 High Resolution Computed Tomography (HRCT) is currently the most accurate non-invasive modality for evaluating lung- parenchyma.⁴

HRCT findings in patients with ILD include thickened interlobular septa, reticular, nodular or ground glass area of attenuation, subpleural lines, architectural distortion, and honeycombing. The other uses of HRCT in ILD besides detection and characterization included detecting co- existing diseases, detecting and assessment of complications, providing a guide to the type and site of lung biopsy, follow-up for evaluation for response to therapy.⁵

The interstitium of the lung can be divided into two anatomically continuous but conceptually different component i.e. the axial interstitium consisting of the connective tissue around the airway, pulmonary arteries and veins within the pleura and interlobular septa and parenchymal interstitium which is a potential space interposed between the basement membrane of the alveolar lining epithelium and capillary endothelium. So the purpose of the study was to assess high resolution computed tomography in the diagnosis of interstitial lung disease.⁶

OBJECTIVES OF RESEARCH

1. To utilise HRCT in evaluation of pulmonary interstitium in patients having clinical features of interstitial lung diseases.
2. To categorize the involvement pattern of the pulmonary interstitium with the help of HRCT and then to arrive at a conclusive diagnosis wherever possible.
3. To use HRCT to determine the extent of involvement in case of interstitial lung diseases.
4. To compare the accuracies of chest radiography and HRCT in the prediction of specific diagnosis of interstitial lung disease.

MATERIAL AND METHOD

- Study Design: Hospital based observational study.
- Study Setting: CT section at Dept. Of Radiodiagnosis, Medical College Kolkata (Philips brilliance 16 slice) and EKO diagnostics at Medical College, Kolkata from January 2018 to June 2019
- Study population: OPD and indoor patients attending CT section at Dept. Of Radiodiagnosis, Medical College Kolkata and EKO CT at Medical College, Kolkata.
- Sample size: 50 patients referred to the Dept of Radiodiagnosis, Medical College, Kolkata was taken after informed consent for HRCT
- Inclusion criteria: Patients having clinical features and/or pulmonary function test suggestive of interstitial lung disease, irrespective of age and sex.
- Exclusion criteria: Patients diagnosed to have tuberculosis or any malignancy was excluded from the study

RESULT AND DISCUSSION

In our study 2(4.0%) patients had ≤ 30 years of age, 9(18.0%) patients had 31-40 years of age, 15(30.0%) patients had 41-50 years of age, 18(36.0%) patients had 51-60 years of age, 3(6.0%) patients had 61-70 years of age and 3(6.0%) patients had > 70 years of age. The mean age (mean $\pm$ s.d.) of patients was 49.6000 ± 10.6962 years. 30(60.0%) patients were female and 20(40.0%) patients were male. 6(12.0%) patients had anti-CCP, 3(6.0%) patients had ANA, 7(14.0%) patients were diagnosed by biopsy, 6(12.0%) patients had dyspnoea (DYSP), 2(4.0%) patients had exposure (EXPO), 3(6.0%) patients had fever, 16(32.0%) patients had positive PFT finding and 7(14.0%) patients had Scl70 antibody.

Satija B et al ⁷ (2013) found that damage to the lungs caused by dusts or fumes or noxious substances inhaled by workers in certain specific occupation is known as occupational lung disease.

Rohatgi PK et al ⁸ (2011) found that chest radiograph, computed tomography and high-resolution computed tomography (HRCT) are an integral part in the diagnosis and evaluation of diffuse interstitial lung disease (DILD) and are reviewed briefly. Use of two-dimensional HRCT has made it possible to automate identification and quantification of patterns associated with DILD with an overall accuracy of 89%.

Gupta S et al ⁹ (2017) found that the imaging findings of the common interstitial lung diseases and to assess the severity of the disease and determine the reversibility capability of the pulmonary parenchymal damage in ILDs. This was a prospective, observational study in which we evaluated 50 patients suspected of having interstitial lung diseases based on radiographic or clinical findings, by high resolution computed tomography (HRCT) over a period of one year.

Our study showed that 2(4.0%) patients had COP, 2(4.0%) patients had HP, 13(26.0%) patients had IPS, 13(26.0%) patients had NSIP, 7(14.0%) patients had PSS, 5(10.0%) patients had RA, 5(10.0%) patients had SAR (sarcoidosis) and 3(6.0%) patients had SLE. 8(16.0%) patients had well defined nodule present. 3(6.0%) patients had ill-defined nodule present. 2(4.0%) patients had < 3 mm size, 9(18.0%) patients had > 3 mm size and 39(78.0%) patients had no nodule. In our study, all 5 patient of sarcoidosis shows well defined nodules, which were of both < 3 mm and > 3 mm in size. 2 patients of RA showed well defined nodules, which were sub pleural in location, showing a size of > 3 mm. 2 patient of HP shows ill-defined nodule, showing size of > 3 mm. out of 2 patient with COP, one showed ill-defined nodules, with size of > 3 mm.

It was found that 6(12.0%) patients had centrilobular nodule present. 5(10.0%) patients had peribronchovascular nodule present. In our study, all 5 patient of sarcoidosis shows well defined nodules in perilymphatic distribution. 2 patients of RA showed well defined nodules in centrilobular distribution. 2 patient of HP shows ill-defined nodule in centrilobular distribution. Out of 2 patient with COP, 1 showed ill-defined nodules in centrilobular distribution. 39(78.0%) patients had interlobular septal thickening. 33(66.0%) patients had intralobular septal thickening.

In our study 28(56.0%) patients had peribronchovascular interstitial thickening. In our study, the interstitial lung disease were analysed based on HRCT visualisation of peribronchovascular interstitial thickening, interlobular and intralobular interstitial thickening and

parenchymal bands. Interlobular septal thickening and intralobular interstitial thickening were seen predominantly in idiopathic pulmonary fibrosis, nonspecific interstitial pneumonia, rheumatoid arthritis, progressive systemic sclerosis and SLE and was due to fibrosis and scarring. Peribronchovascular interstitial thickening was seen predominantly in sarcoidosis and also most cases of IPF and NSIP.

Elicker BM et al ¹⁰ (2017) found that HRCT also plays an important role in the follow-up of patients with established DLD. Important roles of HRCT in this context include assisting in determining prognosis, monitoring for the efficacy of treatment, detecting progression of disease or complications, and evaluating patients with worsening or acute symptoms. The goals of this paper are to discuss: 1) the expected evolution of HRCT findings over time in common DLDs; 2) the role of serial HRCT examinations in formulating an initial diagnosis; and 3) the role of HRCT in the follow-up of patients with known DLD.

Sabri YY et al ¹¹ (2017) found that the role of minimum intensity projection (MinIP) images with that of volumetric high resolution computed tomography (HRCT) images in the diagnosis of interstitial lung diseases (ILD). MinIP is one of the multiplanar techniques of HRCT that proved throughout their study to be an informative complementary tool increasing the observer confidence and agreement regarding some findings as compared with HRCT alone.

Salaffi F et al ¹² (2015) found that the performance of a computerized-aided method (CaM) for quantification of interstitial lung disease (ILD) in patients with systemic sclerosis and to determine its correlation with the conventional visual reader-based score (CoVR) and the pulmonary function tests (PFTs). Wells AU et al ⁴⁹ (2008) found that formal CT scoring is not realistic in routine practice, rapid semi-quantitative estimation of disease extent on CT in combination with a forced vital capacity threshold has been used to stage disease as limited or extensive. The distinction between a higher and lower risk of progression of lung disease, made using this system, has important implications for both routine practice and the enrolment of higher risk patients in therapeutic studies.

Bhat IM et al ¹³ (2016) found that the age of the patients ranged from 22 to 85 years with mean age of 53.5 years, the majority of the patients were in age group 21-40 years (38%). There were 44% male patients and 56% female patients. The most common presenting clinical feature was dyspnea on exertion present in 64% of patients followed by a cough which was present in 60% of cases. In conclusion, high-resolution computed tomography is a valuable technique for evaluating the extent of lung involvement in various ILDs even when chest X-rays are normal.

Assayag D et al ¹⁴ (2012) found that interstitial lung disease commonly develops in patients with Systemic sclerosis (SSc). High resolution computed tomography (HRCT) has become the gold standard for detection and evaluation of lung involvement in SSc. Several HRCT scoring methods have been described and used to characterize and quantify the disease.

Our study showed that 41(82.0%) patients had ground glass opacity present. In our study, ground glass opacity was seen in all the disease entities. In NSIP, HP, COP all cases showed ground glass opacity. In idiopathic pulmonary fibrosis, rheumatoid arthritis and progressive systemic sclerosis, maximum cases had ground glass opacities. Ground glass opacity was extensive in most cases of NSIP, where it was less extensive in idiopathic pulmonary fibrosis, rheumatoid arthritis and progressive systemic sclerosis. 50(100.0%) patients had crazy paving opacity absent. 13(26.0%) patients had consolidation present. 33(66.0%) patients had bronchiectasis present. 8(16.0%) patients had air trapping present. 2(4.0%) patients had mosaic perfusion. 9(18.0%) patients had emphysema present.

In our study, we have analysed the cases based on air trapping, mosaic perfusion, bronchiectatic changes and emphysema. The maximum number of cases showing bronchiectatic changes in our study was seen in IPF, NSIP, and PSS. We found evidence of air trapping in 2 cases of HP, 1 case in RA, 3 in IPF. Mosaic perfusion was found in the 2 cases of HP. Emphysema was seen maximum in case of IPF, PSS, RA. 21(42.0%) patients had honeycombing present. In our study, honeycombing was extensively found in cases of IPF, RA, and PSS. The honeycombing was predominantly seen in the posterior, basal area

and at sub pleural location.

It was found that association between X ray vs HRCT was statistically significant. 40 patients had both Chest Radiograph and HRCT abnormal and 2 patients had both normal Chest Radiograph and normal HRCT. 7 patients had HRCT abnormal but Chest Radiograph normal and 1 patient had HRCT normal but Chest Radiograph abnormal. HRCT did not show any characteristic findings of interstitial lung disease in three cases (clinically diagnosed, one RA, one PSS and one SLE) One case of SLE showed false positive findings in HRCT due to motion arte fact and gravity dependent opacity.

Elicker B et al ¹⁵ (2008) found that the most common HRCT patterns seen in cases of diffuse interstitial lung diseases are the nodular pattern, linear/reticular opacities, cystic lesions, ground-glass opacities and consolidations. This article reviews the correlations between HRCT patterns and pathologic findings, summarizing the most common causes, as well as detailing the methods of investigation employed in order to diagnose the most common types of chronic diffuse lung disease.

Raniga S et al ¹⁶ (2006) found that it was seen that IPF is most commonly manifested by the combination of HRCT findings, which includes peripheral (100%) and lower lobe predominance (80%) of the distribution of the lesions, evidences of intralobular septal thickening (100%), honeycombing (90%), traction bronchiectasis (90%) and parenchymal distortion (100%). HRCT is accurate and superior in the confident diagnosis of IPF. HRCT findings in advance stage of IPF are characteristic. HRCT determines the disease activity and extent of IPF better than chestradiograph.

Mathur M et al ¹⁷ (2017) found that 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). HRCT and spirometry are two simple and reliable noninvasive modalities for the diagnosis. Each

Nurmi HM et al ¹⁸ (2018) found that HRCTs from 60 RA-ILD patients were independently evaluated and re-categorized into usual interstitial pneumonia (UIP), nonspecific interstitial pneumonia (NSIP), organizing pneumonia (OP), diffuse alveolar damage (DAD) and unclassified subtypes by two radiologists. The presence and extent, which was reported using a semi-quantitative scoring system, of e.g. reticulation, ground-glass opacity, honeycombing, emphysema, traction bronchiectasis and architectural distortion were further evaluated and compared between the subtypes.

Jo HE et al ¹⁹ (2016) found that multidisciplinary meetings (MDM) are the current “gold standard” in interstitial lung disease (ILD) diagnosis and comprise inter-disciplinary discussion of multiple forms of information to provide diagnostic and management outputs.

CONCLUSION

As a result of the study, the following conclusions can be drawn:

- HRCT is the most accurate non-invasive imaging modality for evaluation of lung parenchyma in the cases of interstitial lung diseases. The cross sectional perspective and high spatial resolution makes HRCT superior to chest radiography.
- HRCT helps to categorize the involvement pattern of the pulmonary interstitium to arrive at a conclusive diagnosis.
- HRCT also evaluates extent of disease in relation to prognosis and therapy on the basis that.

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