“Role of High Resolution Computed Tomography in Evaluation of Pulmonary Diseases”

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Abstract:

Introduction: The pulmonary diseases are very common in any rural setup; but as the patients prefer to take over the counter medicines to treat themselves, the disease is not diagnosed and only symptomatic relief is achieved, which usually results into worsening of the situation.

Study Design: A prospective observational study was done over a period of two years to study the patterns of Pulmonary Diseases identifiable in patients in a rural setup using High Resolution Computed Tomography (HRCT) of chest. Out of the total 50 patients that were with clinically suspected to have Pulmonary Parenchymal Diseases, and hence referred for HRCT; Interstitial Lung Diseases were observed in 26 cases (26%), Focal lung diseases were seen in 11 cases (22%), destructive lung diseases were noted in 7 cases (14%) while Alveolar Diseases were found in 19 cases (38%). HRCT could satisfactorily demonstrate the location and extension of these lesions as well as the associated interstitial pathologies and effects in all cases.

Results: When compared with Plain Radiograph of Chest, HRCT provides finer details of the pulmonary parenchyma even up to the level of secondary pulmonary lobule and thus facilitates not only the identification and localization of lung pathology but also enables accurate follow up of the pathology.

Keywords: High Resolution Computed Tomography, Chest Radiograph, Alveolar Lung Disease

Introduction:
The pulmonary diseases are very common in any rural setup; but as the patients prefer to take over the counter medicines to treat themselves, the disease is not diagnosed and only symptomatic relief is achieved, which usually results into worsening of the situation. Diseases of lungs can be broadly divided into:A) Interstitial lung diseases like-Interstitial fibrosis, Interstitial edema, Tumor infiltration in the connective tissues, Lymphangitic carcinomatosis; B) Alveolar diseases like-Infections, Hemorrhage and Alveolar proteinosis;C) Focal lung diseases like- Bronchiectasis, Bronchoelitis and Granuloma; D) Destructive diseases like- Cavitation secondary to infection or neoplasm, honey combing secondary to fibrosis and all forms of emphysema.

Primary evaluation of the lesions of the lung is possible by using chest radiographs (CXR). But it is inadequate in deciding various lung pathologies as the resolution is limited. In addition plain X-Ray Chest radiography has limitations like superimposition of structures and poor contrast resolutions, so finer details of the pulmonary parenchymal lesions are often missed.

High-resolution computed tomography (HRCT) techniques are capable of imaging the lung with excellent spatial resolution, providing anatomical detail similar to that available from gross pathological specimens and
paper-mounted lung slices. HRCT can demonstrate the normal and abnormal lung interstitium and morphologic characteristics of both localized and diffuse parenchymal abnormalities. Hence HRCT proves superior to the plain radiographs. The cross-sectional perspective and high special resolution makes HRCT superior to other imaging modalities like plain X-Ray Chest, Tomography and Conventional CT Scanning. With this background in mind the present study was undertaken to see how HRCT can evaluate various pulmonary parenchymal lesions in the patients presenting in this rural setup.

**Materials and Methods:**
This prospective study was officially permitted by the Institutional Ethical Committee. The study included a total of fifty cases referred by the clinicians as cases suspected/detected to have pulmonary parenchymal pathologies were included. Those patients, who were uncooperative and could not hold the breath for optimum examination, could not lie on the CT Table due to overweight or some back problems, and those who were not willing for the study were excluded.

The study was conducted over a period of two years from August-2010 to July-2012. The High Resolution CT imaging was done on Whole Body - Toshiba Astieon (Tsx-021a) Multi Slice CT Scan System. The method of scan is as follows: The patient was placed on gantry table in the supine position with both arms above the head and no gantry tilt was done.

A digitized AP scanogram was obtained in suspended full inspiration. The patients were taught prior to procedures to hold breaths in deep inspiration and expiration wherever required. Axial scans were obtained at 10 mm intervals from lung apices to bases in suspended full inspiration.

CT scan technique consisted of slice thickness 1-2 mm and 10 mm interval. High spatial frequency or “Sharp” reconstruction algorithm; with kV (p) 120 and 100-200 mAs was used. Scan time was kept as short as possible [1-2 sec]. Matrix size used was- 512 x 512. Field of view was 35 cm. Window mean / width value - 600-700 HU/1000-1500HU or 600-1500 HU. Image was displayed on lung windows setting as 12 on 1 on 17 x 14 inches film.

**Results:**
HRCT evaluation was done in total 50 cases of pulmonary diseases.

Clinical presentation ranged from breathlessness, cough with or without expectoration, dyspnoea &/or fever. Of the 50 patients 10 were suffering from Idiopathic Pulmonary Fibrosis, 9 had Bronchiectasis, 7 were victims of Tuberculosis, 5 had Non Specific Interstitial Pneumonia, and 3 patients of malignancy who received radiation therapy were suffering from Radiation Induced Lung Diseases.

Other pathologies detected were Hypersensitivity Pneumonitis, Allergic Bronchopulmonary Aspergillosis, Acute Interstitial Pneumonia, Klebsiella Pneumoniae Infection, Lymphangitic Carcinomatosis, Cryptogenic Organizing Pneumonia, Emphysema, etc. The age and sex wise distribution of various diseases is shown graphically in Figure1. Largest number of patients (15) were found to be in age group of 51-60 years and 11 out of these 15 were males.

The broad categories of various pulmonary diseases are shown in **Figure 2**. In this study; Interstitial lung diseases accounted for 26% of the cases, Alveolar Diseases for 38%, Focal Lung Diseases for 22% and Destructive Diseases for 14 % of the cases.
Figure 1: Graphical Distribution of Various diseases according to age and sex

Figure 2: Broad categories of various pulmonary parenchymal diseases
Discussion:
A total number of 50 patients with suspected or known pulmonary parenchymal disease were studied by HRCT over a period of 24 months.

**Idiopathic Pulmonary Fibrosis**

In the present study we came across ten (20%) cases of IPF. Out of them six (60%) were males and four (40%) were females. Chest radiograph of all patients taken prior to CT examination showed reticular pattern most predominantly involving lower zone and probable changes of fibrosis with few cystic areas associated. Almost all cases had probable diagnosis of interstitial lung disease on chest radiograph.

Typical HRCT findings are shown in Figure 3. On HRCT, most of the patients showed changes in basal zones alone or associated with upper lobe or as a combination of lower lobes with associated pathologies in middle or lingular lobes. Few of the patients had involvement of all the lobes. It was suggestive of that the pathology begins with the involvements of the lower lobes and then progresses to involve other regions of the lungs. These findings were correlated with findings of Lim MK et al. and Battista G et al. and were found to be in agreement with their findings as well.

“Honeycombing” was the commonest finding observed in 7 cases and was seen predominantly in sub pleural and basal regions. Honeycombing indicates irreversible and end stage disease. Finding of honeycombing; that is seen as a thick walled small air containing cystic spaces sharing walls and lying in layers in posterior basal regions, is in agreement with findings of Nishiyama O. “Ground-glass opacity” were seen diffusely in 10(100%) patients showing active disease process if seen alone. These cases were associated with findings of fibrosis hence representing irreversible disease process. Akira M et al.

Intralobular interstitial thickening producing fine reticular pattern seen in all patients predominantly in subpleural region also irregular thickening of interlobular septa and traction bronchiectasis were seen causing distortion of lung architecture and corresponded with the findings of Nishiyama O et al.

![Idiopathic Pulmonary Fibrosis, HRCT](image)

Figure 3: Idiopathic Pulmonary Fibrosis, HRCT shows intralobular interstitial thickening, bronchiectasis, ground-glass opacities and peripheral, subpleural honeycombing.

**Tuberculosis** : Study included seven (14 %) cases of tuberculosis out of which four (57.14 %) were male and three (42.85 %) were female. Plain chest radiographic findings were infiltrates, pleural thickenings, cavitatory lesions, fibrotic bands, air-fluid collections suggesting loculations in pleural cavity &/or miliary pattern. These findings were isolated or a mixed presentation.

The HRCT findings observed were a combination of either of Tree in Bud appearance, traction bronchiectasis, fibrotic bands, emphysematous changes, bronchiectasis, cavitations, consolidation, collapse, honeycomb changes, pleural / fissural thickenings and pleural effusion, are consistent with reports of Hong SH et al. Cavitating lesion as shown in Figure 4 may also be seen.
Out of these seven cases four cases were diagnosed cases of Koch’s who were receiving anti tubercular treatment. It is noted that the cavitatory lesions usually, at the time of presentation are moderately thick walled which turn into thin walled cavities on receiving treatment. Randomly distributed nodules, majority of them ranging between 1 to 3 mm, few of them seen up to 5 mm, are consistent with reported findings of Hong SH et al ⁸ and Voloudaki AE et al. ⁹

**Figure 4:** HRCT shows thick walled cavitatory lesion in the apico-posterior segment of left upper lobe in a diagnosed case of Pulmonary Koch’s.

**Nonspecific Interstitial Pneumonia**

Nonspecific Interstitial Pneumonia were identified in Five (10%) cases. All were female (100%) HRCT findings revealed patchy areas of consolidation which are peripheral and subpleural in location with patchy ground-glass opacities and reticulations which are corresponded pathologically to the areas of interstitial thickening caused by interstitial inflammation. Most of the cases showed areas of fine honeycombing with thickening of intralobular septa and adjacent patchy ground-glass opacities predominantly distributed in middle and lower zones posteriorly, correlated well with findings observed by Nishiyama O et al. ⁶

**Emphysema:** Three cases (6%) of various types of emphysema were included in the present study.

The HRCT findings in above patients were centrilobular &/or panlobular &/or paraseptal emphysema. According to American Thoracic Society, emphysema is defined as “a condition of the lung characterized by permanent, abnormal enlargement of airspaces distal to the terminal bronchiole, accompanied by the destruction of their walls”. As per David P Naidich ¹⁰, emphysema is classified into three main subtypes, (a) proximal acinar, centriacinar or centrilobular emphysema; (b) panacinar or panlobular emphysema and (c) distal acinar or paraseptal emphysema.

**Bronchiectasis:** As mentioned by David P Naidich ⁹⁰, W. Richard Webb ¹¹, Bronchiectasis is defined as localized, irreversible dilatation of the bronchial tree. Traditionally bronchiectasis is classified in three types as cylindrical, varicose, and cystic. The condition was assessed using descriptive schema based on the identification of abnormal airways regionally by lobes and zones. Some of them were showing air-fluid levels within as shown in **Figure 5**.

**Figure 5:** HRCT section shows chronic cystic Bronchiectasis with air-fluid in it.
Thus in this study the anatomical details of lung were studied by using High Resolution Computed Tomography sections of thorax. Secondary pulmonary lobule with its morphology and pattern of involvement of lobular structures in various pulmonary parenchymal diseases were assessed with the help of High Resolution Computed Tomography which is impossible by using plain Chest Radiography due to very poor spacial resolution and superimposition of the structures.

In this study identification of various pathologies involving lungs like, interstitial lung diseases, Alveolar diseases, Focal lung diseases and Destructive diseases was possible with the help of HRCT, which enabled demonstration and evaluation of the fine morphological characteristics of localized as well as diffuse lung diseases. The limitations of the study are that not all patients with suspected pulmonary abnormalities can be evaluated as many times the cost involved is an issue. Also, patients who cannot hold their breath cannot be evaluated.

**Conclusion:**
For evaluation of pulmonary pathologies, clinical evaluation is the first step. Chest Radiography and HRCT examination should be regarded as integral components of the investigation protocol in patients with various pulmonary parenchymal diseases; as these confirm the clinical suspicion and provide direct evidence of the affected portion. HRCT evaluation proves to be the best in studying the lesions in different stages and diagnose the pathologies in early phases. Moreover, HRCT helps to evaluate different phases and progression of disease in relation to prognosis and therapy.

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**References:**


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