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Role of High Resolution Computed tomography in Diffuse Lung Diseases

[1]Gattani Chandrashekhar M, Professor, Dept. of Radiodiagnosis, Mamata Medical College, Khammam

[2]Samala Snigdha, Junior Resident, Dept. of Radiodiagnosis, Mamata Medical College, Khammam

Corresponding Author: Gattani Chandrashekhar M, Professor, Dept. of Radiodiagnosis, Mamata Medical College, Khammam

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Abstract

Introduction: Diffuse lung diseases are those in which the disease process is widespread involving both the lungs but need not affect all lung regions uniformly. It includes acute as well as chronic lung diseases having wide array of causes such as infections, inhalational, neoplastic, cardiovascular, airway abnormalities, immunological and idiopathic.

Aims and objectives: 1. To study the normal anatomy of the lung with respect to secondary pulmonary lobule which is the smallest unit of the the lung. 2. To evaluate the importance of high resolution computed tomography in the diagnosis of diffuse lung diseases. 3. To detect diffuse lung diseases in patients who had normal or questionable radiographic abnormalities with symptoms or pulmonary function tests suggestive of diffuse lung disease. 4. To study the various high resolutions computed tomographic patterns of diffuse lung diseases. 5. To limit the differential diagnosis and to make the specific diagnosis. 6. To determine the site of CT guided lung biopsy in various diffuse lung diseases for confirmation of diagnosis in suspicious diseases.

Materials and methods: A total number of 50 patients with suspected or known interstitial lung disease were studied by high-resolution computed tomography (HRCT) over a period of 24 months. Axial sequential scans of 1mm thickness were obtained at 10 mm intervals from lung apices to bases in suspended full inspiration.

Results: Ground glass opacity (68%) was most commonly observed morphological finding followed by reticular (36%), bronchiectasis (28%). Fifteen cases which appeared normal on chest radiographs were detected as abnormal on HRCT whereas all cases abnormal on chest radiograph were also abnormal on HRCT. HRCT 30% more sensitive in detection of diffuse lung disease abnormalities than chest radiograph in my study.

Conclusion: High resolution computed tomography is a standard investigation to identify and quantify anatomic pattern and distribution of various interstitial lung diseases.

Keywords: HRTC, Lung Disease, CT scanner

Introduction

Diffuse lung diseases are those in which the disease process is extensive and affects both lungs, but not all

lung areas are affected uniformly [1]. Infections, inhalational, neoplastic, cardiovascular, airway abnormalities, immunological, and idiopathic causes are among the causes of acute and chronic lung disorders.

Clinical evaluation of a patient suspected of having widespread pulmonary disease might be difficult. A plain chest radiograph is a cheap, good, and necessary modality for the study of such illness, and it is the first line of defence. However, the radiographic picture of diffuse lung disease is generally vague, and there is a lot of variety. Due to weak contrast resolution and superimposition of features, plain radiography offers limited diagnostic accuracy.

Zerhouni et al. created high resolution computed tomography (HRCT) in 1985, making it the ideal imaging modality for characterization and diagnosis of diffuse lung disorders. HRCT is a type of radiological imaging that is particularly useful for detecting changes in lung anatomy. When many HRCT findings are combined, they might show common patterns. These patterns, when combined with clinical information and anatomical distribution, can help narrow down the differential diagnosis of diffuse lung disorders. HRCT gives a global anatomic assessment of the lung, considerably increasing the clinical diagnosis' specificity and sensitivity.

HRCT may identify both localised and diffuse lung illnesses, as well as normal and pathological lung interstitium and morphological features. As a result, it's become a powerful tool for diagnosing diffuse lung illness in the right clinical situation. HRCT, when used in conjunction with laboratory testing, physiological investigations, and invasive procedures, proved to be an effective technique for determining the differential diagnosis or final diagnosis.

Thin collimation with a high spatial frequency algorithm distinguishes it from standard CT (Bone algorithm). With developments in CT technology, the HRCT procedure has improved during the previous 15 years. It has enabled high-resolution imaging of the lung, revealing anatomical characteristics comparable to those found in gross diseased lungs specimens.

In accordance with diffuse lung diseases HRCT plays major role in finding out:

Presence of disease in lung, type of disease, changes of active lung disease, site and type of biopsy to be performed and change in disease activity following treatment.

Hence HRCT is the most accurate noninvasive imaging modality for evaluation of lung parenchyma. The cross sectional perspective and high spatial resolution makes HRCT superior to other imaging modalities like chest X-Ray, lung tomography and conventional CT Scanning.

Materials and methods

A total number of 50 patients with 35 were males (70%) and 15 were females (30%) with suspected or known interstitial lung disease were studied by high-resolution computed tomography (HRCT) over a period of 24 months. The age group of patients varied from 11 years to 70 years.

Patients were selected on the basis of: Clinical history suggestive of interstitial lung disease, Known cases of interstitial lung disease, Abnormal chest radiographs (with an interstitial pattern), Abnormal restrictive pulmonary function tests. Data collected from these patients included their name, age, sex, occupation, clinical history and relevant investigation reports.

Siemens somatom scope CT scanner CT machine was used, patient was placed on gantry table in the supine position with both arms above the head and no gantry tilt. A digitized AP scanogram was obtained in suspended full inspiration. The patients were taught prior to procedures to hold breath in deep inspiration and expiration wherever required. Axial sequential scans of 1mm thickness were obtained at 10 mm intervals from lung apices to bases in suspended full inspiration.

Observations and results

Total 50 cases of Diffuse Lung Disease were studied by High resolution computed tomography scanning of lungs in the Department of Radiology, Mamata Medical College & Hospital, Khammam.

The age group in which maximum number of patients (10) presented was 41-50,51-60 and 61-70 years each, which included 23(76.66%) males and 7(23.33%) females. Diffuse lung diseases are slightly more common in males than in females. Out of 50 cases 35(70%) were males and 15(30%) are females.

In the current study the most common cases are of COVID-19 15(30%) in last few months due to pandemic. Otherwise TUBERCULOSIS comprises the most common cases. 10(20%) out of 50 were observed during the course of this study out of which seven were active TB cases and three were old TB cases. 3 cases of military tuberculosis were reported among the active TB cases.

Next common condition observed was Bronchiectasis 8(16%) cases out of 50 cases. UIP/IPF comprises 5(10%) and most of them were having changes of end stage lung disease and had short lived history during the course of this study. Followed by emphysema, NSIP and pulmonary edema.

Idiopathic pulmonary fibrosis was most commonly observed in the age group of 61-70. Out of 50 cases, 36 (72%) patients were primarily presented with dyspnea. Most of them were of COVID-19, idiopathic pulmonary fibrosis and tuberculosis involving lungs. Rest of 14 (28%) patients was having varied symptoms like fever and cough. One patient of miliary TB seropositive for HIV.

Ground glass opacity (68%) was most commonly observed morphological finding followed by reticular (36%), bronchiectasis(28%).

- The most common radiographic finding in COVID-19 infection is bilateral, peripheral, subpleural, multifocal ground glass opacities in early stages(active). In resolution stages, fibrotic bands were seen predominantly.
- Idiopathic Pulmonary Fibrosis showed bilateral irregular linear opacities causing a reticular pattern and honeycombing. HRCT findings of IPF were predominant in peripheral, sub pleural regions, and in lung bases.
- Nodularity was commonly observed in Miliary Tuberculosis.
- Old cases of TB showed findings of bronchovascular distortion, bronchiectasis, fibrosis and cavities in all patients.
- Cases of active endobronchial disease in TB showed characteristic tree in bud appearance.
- The three pathological types of bronchiectasis were observed with predominance of cystic bronchiectasis.
- Patchy areas of ground-glass opacities with interlobular septal thickening which is smooth and uniform were the predominant findings observed in Pulmonary Edema.

- Diffuse ground-glass opacity was observed in case of Progressive Systemic Sclerosis (Scleroderma) along with cysts.
- Centrilobular emphysema characterized by bilateral multiple, small centrilobular lucencies with ill-defined walls scattered throughout the lungs was observed and paraseptal emphysema was observed in the upper zone.
- Usual interstitial pneumonia (UIP) showed diffuse ground glass opacification with honeycomb pattern in bilateral lung fields.
- Hematogenous Metastases to lung from an occult tumor showed multiple discrete nodules of varying sizes in bilateral lung fields with random distribution.
- Diffuse lung diseases are predominantly bilateral.

Table 1: HRCT findings in Diffuse lung diseases observed in 50 patients.

Sn.	HRCT Findings	Covid	TB	Bronchiectasis	IPF/UIP	Emphysema	NSIP	DAD	Radpneu	HM
1	Reticular	1	7	-	4	2	3	1	-	-
2	Nodular	-	5	1	-	-	-	-	-	1
3	Ground-glass opacity	15	3	6	1	1	3	3	1	1
4	Consolidation	5	4	-	-		-	-	-	-
5	Honeycombing	-	-	-	5	-	-	-	-	-
6	Cysts	1	-	1	2	3	-	-	-	-
7	Cavity	-	7	-	-	-	-	-	-	1
8	Bronchiectasis	2	-	8	3	-	1	-	-	-
9	Emphysema	1	-	-	-	4	-	-	-	-
10	Fissural thickening	1	5	-	1	1	-	-	-	-
11	Fibrotic strands	3	4	-	2	1	-	-	-	-
12	Pleural thickening	3	3	-	-	-	-	-	-	-
13	Pleural effusion	1	4	-	-	-	-	3	-	-
14	Lymphadenopathy	1	2	-	-	-	-	-	-	-

Table 2: Last three are associated findings

Total Patients	Unilateral involvement	Bilateral involvement
50	3	47

Distribution of Fifty cases according to lung involvement.

Table 3: Sensitivity of HRCT compared to chest radiograph

Total no of patients with normal chest radiography	15	30%
Total no of patients with abnormal chest radiography	35	70%
Total no of patients with normal CXR and abnormal HRCT	15	30%
Total no of patients with abnormal CXR and abnormal HRCT	35	70%
Total no of patients abnormal CXR and normal HRCT	NIL	NIL

Fifteen cases which appeared normal on chest radiographs were detected as abnormal on HRCT whereas all cases abnormal on chest radiograph were also abnormal on HRCT. HRCT 30% more sensitive in detection of Diffuse lung disease abnormalities than chest radiograph in my study.

Discussion

Study included ten (20%) cases of tuberculosis out of which three were old patients with symptoms suggestive of reactivation of the disease. Centrilobular nodules were seen in 5 patients and consolidation as seen in 4 patients. Signs of old disease such as bronchiectasis, bronchovascular distortion and fibrosis were seen in 4 patients. Cavities were seen in 7 patients. Other findings such as pleural thickening were seen in 3 patients and mediastinal lymphadenopathy in 2 patients were described as explained by Im J G et al[3].

Three new cases were diagnosed all of which were diagnosed as military tuberculosis on HRCT showed randomly distributed nodules, majority of them range between 1 to 3 mm few of them seen up to 5mm, but perivascular and subpleural are commonly involved regions consistent with reported findings of Hong SH et al[4] and Voloudaki AE et al.[5]

On HRCT, posterior basal and subpleural areas were most commonly affected and seen in all patients (100%). Middle lobes and anterior segments of upper lobe involvement were seen in 3 patients suggesting disease process begins in posterior basal region and progressively involves upper regions of lungs. These findings were correlated with findings of Lim MK et al[6] and Battista G et al.[7]

Honeycombing was a common finding observed in these cases seen predominantly in subpleural and basal regions. Finding of honeycombing formed as a thick walled small air containing cystic spaces sharing walls and lying in layers in posterior basal regions corresponded with findings of Nishiyama O et al.[8]

In two patients over the follow up after six months of gap, areas of honeycombing progressively increased and involved also the midzones, which has corresponded with findings of Akira M et al.[9]

Intralobular interstitial thickening producing fine reticular pattern seen in 4 patients predominantly in subpleural region also irregular thickening of interlobular septa and traction bronchiectasis seen in 3 (60%) patients causing distortion of lung architecture and corresponded with the findings of Nishiyama O et al.[10] None of the patients in our study showed findings of pleural thickening or mediastinal lymphadenopathy. Bronchiectasis was detected in 8 patients out of which 4(50%) were males and 4(50%) were females ranging from age group of 21-50 years.

The commonest lobes to be affected were the right middle lobe and left lower lobe in 5 patients each. Lobar as well as segmental dilatation was possible in all patients as stated by Cooke J S et al [11]. The characteristic signet ring appearance described by Grenier P et al [12] was identified in 6 patients.

The three pathological types of bronchiectasis described by Reid L M [13] were identified. Cylindrical bronchiectasis having tram track appearance was identified in 2 patients and varicose bronchiectasis, with beaded appearance was seen in 2 patients. Cystic bronchiectasis was seen in 4 patients along with cylindrical bronchiectasis in 2 of the cases. Study included three (6%) case of pulmonary edema. Patchy areas of ground-glass opacities with interlobular septal thickening which is smooth and uniform were the predominant findings observed in these cases as reported by Storto ML et al[14]. and Ribeiro CM et al[15].

Centrilobular emphysema characterized by bilateral multiple, small centrilobular lucencies with ill-defined walls scattered throughout the lungs was seen in 3 cases. This is in accordance to findings of Stern E J and Frank M S [16], Webb W R et al [17] and Murata K et al [18] who described centrilobular emphysema as areas of lucency near the centers of secondary pulmonary lobules surrounding the centrilobular artery branches.

Para-septal emphysema was identified in one case and was seen as multiple thinned walled subpleural air spaces located in the upper zones. This correlated with the findings Stern E J and Frank M S [16].

Three (6%) case of scleroderma with lung involvement was included in this study. Diffuse ground-glass opacity was observed in these cases along with reticular pattern.

Abnormalities were predominantly seen in subpleural regions and lower zone involvement as described by Chan TY et al, Devenyi K et al [19]. and JM Seely et al.[20]

Five cases (10%) of usual interstitial pneumonia (UIP) was included in the study. All patients showed basal subpleural honeycombing pattern. 3 patients showed traction bronchiectasis on HRCT. The common HRCT findings in UIP would be honeycombing, reticulation, fibrosis and mild ground glass opacities. The fibrosis and honeycombing involve mainly the basal and subpleural lung regions.

Elliot TL et al [21] in 2005 assessed high resolution computed tomography accuracy in diagnosis of NSIP against UIP with proven NSIP (25) and UIP (n=22), total of 47 patients and found that predominant pattern of ground- glass and / or reticular opacity with minimal to no honeycombing was demonstrated in 96% of patients with NSIP. The presence of honeycombing as a predominant feature had a predictive value of 90% for UIP. NSIP has subpleural and patchy distribution but less in frequency to that of UIP.

Conclusion

Clinical evaluation, chest radiography and HRCT examination should be regarded as integral components of the investigation protocol in patients with various interstitial lung diseases.

Hence high resolution computed tomography is a standard investigation to identify and quantify anatomic pattern and distribution of various interstitial lung diseases and also evaluates activeness and

progression of disease in relation to prognosis and therapy.

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