Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: www.saspublishers.com

OPEN ACCESS

Radiology

Evaluation of Using High Resolution Computed Tomography in diagnosis of the Diffuse Parenchymal Lung Diseases

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DOI: 10.36347/sjams.2019.v07i09.044 | **Received:** 17.09.2019 | **Accepted:** 23.09.2019 | **Published:** 30.09.2019

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Abstract **Original Research Article**

Introduction: High-resolution CT (HRCT) of the chest refers to a CT technique in which thin-slice chest images are obtained and post-processed in a high-spatial-frequency reconstruction algorithm. This technique obtains images with exquisite lung detail, which are ideal for the assessment of diffuse interstitial lung disease. The present study was undertaken to detectHRCT findings in diffuse parenchymal lung diseases and identifying the pattern, extent and distribution of the disease. ***Methodology:*** The present study comprised of 241 patients (143 males and 98 females) who underwent HRCT Chest with suspected diffuse parenchymal lung diseasesduring the period from June 2017 to September 2019 in CT departments of Alamal Diagnostic Center, Military hospital and Alyaa hospital-Omdurman. ***Results:*** The most commonly identified diffuseparenchymal lung disease was Nonspecific Interstitial Pneumonia (68) followed by Idiopathic pulmonary fibrosis (IPF)(65) and chronic bronchiectasis (53) of the total cases. ***Conclusion*:** HRCT is a simple non-invasive method for detecting diffuse parenchymal lung diseases. HRCT is of great value in patients with normal or questionable chest radiograph and with symptoms of diffuse parenchymal lung diseases. It has been concluded that High-resolution CT (HRCT) is the best modality for the evaluation of patients with diffuse pulmonary diseases because it provides detailed visualization of the lung parenchyma and identifying the pattern and distribution of disease helps in formulating a differential diagnosis, and detecting the diffuse parenchymal lung diseases in the early course of disease.

Keywords: Chest radiograph; high-resolution computed tomography (HRCT); HRCT patterns; differential diagnosis; interstitial lung disease (ILD); diffuse lung diseases (DLDs).

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INTRODUCTION

The lungs are the vital organs of respiration. Their main function is to oxygenate the blood by bringing inspired air into close relation with the venous blood in the pulmonary capillaries [8]. They are composed of a spongelike material, the parenchyma, and surrounded by a layer of serous membrane [6]. Each lung, consisting of two lobes on the left and three on the right, lies within its own side of thethoracic cavity and is surrounded by the visceral layer of the pleura [12]. The lungs receive blood from both the pulmonary arteries and bronchial arteries [11].

Diffuse lung diseases (DLDs) are a heterogeneous group of lung disorders, consisting of inflammation and/or fibrosis of the pulmonary parenchyma, classified together because of some similar clinical, radiographic, physiologic or pathologic manifestations [13].

The two imaging modalities that are used almost routinely in the assessment of patients with interstitial lung disease (ILD) are the chest radiograph and high-resolution computed tomography (HRCT) [10].

High-resolution computed tomography (HRCT) is a critical tool for the evaluation of lung disease. Because HRCT provides a global anatomic assessment of the lung, this imaging technique improves significantly the sensitivity and specificity of clinical and histopathological diagnosis. HRCT is

particularly helpful in the evaluation of diffuse interstitial lung disease (DILD), as clinical presentation and histopathologic patterns can show significant overlap and there can be significant heterogeneity of disease throughout the lung [15].

HRCT protocols use thin sections (1.5 mm or less), a fast acquisition to reduce motion artifact, and optimal spatial resolution. In addition to the thin sections, spatial resolution is optimized by the selection of an edge-enhancing algorithm (such as a bone algorithm) and a display field of view (DFOV) that is just large enough to include the lungs [14].

The patient is typically scanned in the supine position. Data acquisition occurs with suspension of respiration at full inspiration. HRCT images with the patient in the prone position can be acquired to differentiate the dependent edematous changes often seen in the lung bases [7].

The primary role of HRCT is in the identification of specific abnormalities that allow a characterization of diffuse lung disease and formulation of a differential diagnosis. The type and specific location of lung abnormalities may be determined using HRCT, and it may be suggested whether the disease present is primarily inflammatory or fibrotic or whether it is an airways disease, interstitial disease, or alveolar (airspace) disease [1].

High-resolution CT (HRCT) has become a valuable tool for the evaluation of patients with diffuse pulmonary diseases. HRCT is now widely recognized as more sensitive and specific than chest radiography for the assessment of such patients, and it has been integrated into the diagnostic algorithms for the assessment of a number of diffuse lung processes, most notably the idiopathic interstitial pneumonias, eosinophilic lung diseases, and obstructive lung diseases [3].

The radiologist must become proficient in the identification and characterization of critical HRCT findings that may include nodules, micronodules, cysts, pseudocysts, mosaic attenuation, linear opacities, ground-glass opacities, interlobular septal thickening, and consolidation. Knowledge and understanding of the cross-sectional imaging anatomy of the lung allows determination of the anatomic distribution of these abnormalities, which is useful for formulating an appropriate differential diagnosis [9].

METHODS

This a retrospective and prospectivestudy comprised of 241 patients (143 males and 98 females) who underwent HRCT Chest with suspected diffuse parenchymal lung diseases. Their age varies from 5-90 years. There was a male preponderance in the study (59.3 %). Patients were evaluated during the period from June 2017 to September 2019 in CT departments of Alamal Diagnostic Center, Military hospital and Alyaa hospital-Omdurman. Allthe patients of either sex, clinically suspected andradiographically diagnosed of Diffuse Parenchymal Lung Diseases underwent CT (Toshiba Aquilion 64 slices, 3rd generation CT scan, slice thickness: 1 mm).

RESULTS

The following results represent data obtained from a sample of 241 patients (143 males and 98 females) who underwent HRCT Chest with suspected diffuse parenchymal lung diseases.

The main findings included that ninety-four patients were diagnosed to have Obstructive pulmonary diseases (39 %) and one hundred-forty seven patients had interstitial (restrictive) lung diseases (61 %) (Table-1).

The common frequent findings in Obstructive pulmonary diseases were emphysema (26.6 %), chronic bronchitis (13.8 %), asthma (3.2%), and chronic bronchiectasis (56.4 %) (Table-2).

The common frequent findings in interstitial (restrictive) lung diseases were Idiopathic pulmonary fibrosis (IPF) (44.2%), Nonspecific Interstitial Pneumonia (46.2 %), Sarcoidosis (7.6%), Hypersensitivity Pneumonitis (2 %) (Table-3).

The HRCT patterns of diffuse parenchymal lung diseases included irregular reticular (19.9 %), honey combing (23.7%), septal thickening (22.4%), nodules (14.1%), cystic (27.4%), consolidation (27.4%), ground glass opacity (24.9%), mosaic Attenuation (1.2%), traction bronchiectasis (10.4%), pleural Thickening (4.1%), peribronchovascular thickening (6.2%), and emphysematous changes (10.4 %) (Table-4).

Diffuse parenchymal lung diseases HRCT findings distribution among the lung fields included right side (14.6 %), left side (26.5 %), bilateral (58.9 %), upper zone (71.4 %), middle zone (36.5%), and (96.3 %) for the lower zone (Table-5).

Table-1: Diffuse parenchymal lung diseases HRCT findings

Diseases	Frequency	%
Obstructive pulmonary diseases	94	39 %
Interstitial (restrictive) lung diseases	147	61 %
Total	241	100 %

Table-2: Obstructive pulmonary diseases HRCT findings

HRCT findings	Frequency	%
Emphysema	25	26.6 %
Chronic bronchitis	13	13.8 %
Chronic bronchiectasis	53	56.4 %
Asthma	3	3.2 %
Total	94	100 %

Table-3: Interstitial (restrictive) lung diseases HRCT findings

HRCT findings	Frequency	%
Idiopathic pulmonary fibrosis (IPF)	65	44.2 %
Nonspecific Interstitial Pneumonia	68	46.2 %
Hypersensitivity Pneumonitis	3	2 %
Sarcoidosis	11	7.6 %
Total	147	100 %

Table-4: Diffuse parenchymal lung diseases HRCT patterns distribution

HRCT patterns	Frequency	%
Irregular reticular	48	19.9 %
Honey combing	57	23.7 %
Septal thickening	54	22.4 %
Nodules	34	14.1 %
Cystic	66	27.4 %
Consolidation	66	27.4 %
Ground glass opacity	60	24.9 %
Mosaic Attenuation	3	1.2 %
Traction bronchiectasis	25	10.4 %
Pleural Thickening	10	4.1 %
Peribronchovascular thickening	15	6.2 %
Emphysematous changes	25	10.4 %

Table-5: Diffuse parenchymal lung diseases HRCT findings distribution among the lung fields

HRCT findings	Lung fields					
	Side			Zone		
	Right	Left	Bilateral	Upper	Middle	Lower
Emphysema	6	4	15	29	16	29
Chronic bronchitis	5	5	1	13	-	-
Chronic bronchiectasis	19	11	23	22	15	33
Asthma	-	1	2	2	-	3
Idiopathic pulmonary fibrosis (IPF)	9	5	51	37	20	75
Nonspecific Interstitial Pneumonia	19	7	42	54	33	92
Hypersensitivity Pneumonitis	1	-	2	4	1	-
Sarcoidosis	5	-	6	11	3	-
%	14.6%	26.5%	58.9%	71.4%	36.5%	96.3%

DISCUSSION

The clinical value of HRCT in the evaluation of suspected patients with diffuse parenchymal lung diseases is no longer in doubt. It is not merely the increased confidence that this technique brings to the confirmation or exclusion of the diagnosis of diffuse parenchymal lung diseases, it is the added information about the likely histological diagnoses, precise extent of the disease, the optimal site for biopsy when indicated and in some cases the state of the disease activity.

Despite Chest radiograph usually is the first method of detecting a diffuse lung process, Detecting diffuse lung infiltrates on chest radiography is a common clinical problem especially early in the disease course because the pattern of opacities seen on chest radiography may be interpreted differently when compared with the pattern seen on High-Resolution Computed Tomography (HRCT) of the chest and also chest radiographs represent a two dimensional summation of overlapping shadows obtained from a three dimensional structure. Although Conventional computed tomography of the chest allows assessment of the entire chest, it has limited ability to demonstrate fine parenchymal detail because it use thicker slices.

HRCT use thin-section slices (i.e., < 1.5 mm) which improves depiction of anatomic structures and pathologic processes that were previously not well visualized (e.g., interlobular septa, micronodules, centrilobular structures, etc.). HRCT also included image postprocessing with a high-spatial-frequency or sharpening algorithm, often referred to as the bone algorithm. The resultant image sharpening allows identification of small anatomic structures and pathologic lesions.

Several technical problems may arise when performing HRCT. Perhaps the most common is the extremely “grainy” resultant images. Graininess may be due to several factors, some of which can be modified in the interest of improved image quality. Large body habitus &/or obesity typically result in increased mottle artifact and greater image graininess. While increasing the CT technique (i.e., kVp and mA) may partially alleviate this problem. Selection of the wrong postprocessing algorithm may also result in grainy images. Another common problem that frequently defeats the purpose of the test is breathing/motion artifact. In a percentage of studies, respiratory motion relates to the inability of the patient to maintain apnea. Thus, the patient’s ability to perform a short breathhold should be assessed before proceeding with the study, as HRCT imaging of severely dyspneic patients will not result in diagnostic quality images and will not provide useful information. It is extremely helpful to coach the patient before the study and perform a few breathholds with the same directions that will be provided during

the exam. This will not only train the patient in the interest of a better study but will also allow the identification of patients who are not able to perform the breath hold and are therefore not good candidates for HRCT.

Recent HRCT protocol known as volumetric HRCT is replacing the HRCT axial protocols. Volumetric HRCT protocols use a helical mode to acquire images of the entire lung which cover the entire lung so they result in a more complete assessment of the lung.

HRCT protocols (both volumetric and axial) often include more than one series of scans. When the patient is supine the effect of gravity results in a gradual increase in attenuation and vessel size from posterior to anterior lung regions. An additional series of prone images can help to differentiate actual disease from densities caused by the effects of gravity that mimic disease in some patients. In addition, anatomic detail is displayed somewhat differently in inspiratory scans compared with expiratory scans. When the lungs are fully expanded the contrast between low-attenuation aerated air space and high-attenuation lung structure is maximized. However, expiratory images are useful in many instances. For example, expiratory images better depict bronchiolitis and air trapping.

Hence, HRCT protocols may include three series of scans: inspiratory supine, expiratory supine, and inspiratory prone. In volumetric protocols, only the inspiratory supine series is done in a helical mode. The additional images are done in the representative axial fashion to reduce the radiation dose.

Avinash Gupta *et al*., undertaken study to detect and study the profile of computed tomographic (CT) patterns of diffuse parenchymal lung diseases. The study concluded that most commonly identified diffuse parenchymal lung disease was idiopathic interstitial pneumonia (26.7%) followed by tuberculosis and post tubercular disease (16.7%) of the total cases. Dyspnea was the main presenting complaint in 75% of our study group. On HRCT, diffuse ground glass haze was present in all the patients in our study. Idiopathic interstitial pneumonia forms the major group of diffuse parenchymal lung diseases in our society. The extent and distribution of disease identified on HRCT scans correlates well with the clinical impairment [16].

S. J. Copley *et al*., assess the accuracy of thin-section CT as compared to chest radiography to diagnose pediatric interstitial lung disease with histopathologic confirmation of interstitial lung disease. Two observers independently assessed chest radiograph and CT images and concluded that a higher proportion of pediatric interstitial lung diseases can be diagnosed on thin-section CT than on chest radiographs [2].

Danielle M. Seaman *et al.*, illustrated and described the spectrum of diseases associated with air cysts at high-resolution CT (HRCT) to increase the awareness of the spectrum of HRCT findings associated with these diseases may help the trained observer narrow the differential diagnosis [17].

Deborah Assayag *et al.*, reported that High resolution computed tomography (HRCT) much more sensitive diagnostic test than traditional chest radiograph, especially for detection of early or mild disease [4].

Dr. Yasir Gafar Abdel Rahim, the purpose of his study was to describe the High Resolution Computerized Tomography (HRCT) findings of diffuse parenchymal lung disease and to assess the disease character, extent, distribution and to evaluate disease activity and he concluded that HRCT is the modality of choice in assessing diffuse parenchymal lung disease especially in the aspects of disease activity and earlier detection and characterization of disease [5].

The purpose of the present study was to evaluate using of High Resolution Computed Tomography (HRCT) in diagnosis of the diffuse parenchymal lung diseases and comprised of 241 patients (143 males and 98 females) who underwent HRCT Chest with suspected diffuse parenchymal lung diseases. Their age varies from 5-90 years. There was a male preponderance in the study (59.3 %).

The main findings included that ninety-four patients were diagnosed to have Obstructive pulmonary diseases (39%) and one hundred-forty seven patients had interstitial (restrictive) lung diseases (61%). The common frequent findings in Obstructive pulmonary diseases were emphysema (26.6%), chronic bronchitis (13.8%), asthma (3.2%), and chronic bronchiectasis (56.4%). The common frequent findings in interstitial (restrictive) lung diseases were Idiopathic pulmonary fibrosis (IPF) (44.2%), Nonspecific Interstitial Pneumonia (46.2%), Sarcoidosis (7.6%), Hypersensitivity Pneumonitis (2%).

The HRCT patterns of diffuse parenchymal lung diseases included irregular reticular (19.9 %), honey combing (23.7%), septal thickening (22.4%), nodules (14.1%), cystic (27.4%), consolidation (27.4%), ground glass opacity (24.9 %), mosaic Attenuation (1.2 %), traction bronchiectasis (10.4%), pleural Thickening (4.1%), peribronchovascular thickening (6.2%), and emphysematous changes (10.4 %).

Diffuse parenchymal lung diseases HRCT findings distribution among the lung fields included right side (14.6%), left side (26.5%), bilateral (58.9%), upper zone (71.4%), middle zone (36.5 %), and (96.3 %) for the lower zone.

Because of using thin sections, a fast acquisition to reduce motion artifact, and optimal spatial resolution to acquire images of the entire lung, they result in a more complete assessment of the lung and Lung nodules are not missed. and the central airways can be evaluated at the same time, previous studies and recent study reported that HRCT become the gold standard and a valuable tool for the evaluation of patients with diffuse pulmonary diseases because it provides detailed visualization of the lung parenchyma and identifying the pattern and distribution of disease helps in formulating a differential diagnosis, and detecting the Diffuse Parenchymal Lung Diseases in the early course of disease.

CONCLUSION

Diffuse parenchymal lung diseases commonly occur in the middle age, the presenting complains were Cough, Dyspnea, SOB, and Fever in most cases. The most frequent diffuse parenchymal lung diseases were emphysema, chronic bronchitis, asthma, and chronic bronchiectasis, Idiopathic pulmonary fibrosis (IPF), Nonspecific Interstitial Pneumonia, Sarcoidosis, Hypersensitivity Pneumonitis. The most frequent HRCT patterns of diffuse parenchymal lung diseases included cystic, consolidation, ground glass opacity. HRCT findings distribution among the lung fields concluded that diffuse parenchymal lung diseases most common bilaterally and in the lower zone. HRCT is a simple non-invasive method for detecting diffuse parenchymal lung diseases. HRCT is of great value in patients with normal or questionable chest radiograph and with symptoms of diffuse parenchymal lung diseases. It has been concluded that High-resolution CT (HRCT) is the best modality for the evaluation of patients with diffuse pulmonary diseases because it provides detailed visualization of the lung parenchyma and identifying the pattern and distribution of disease helps in formulating a differential diagnosis, and detecting the Diffuse Parenchymal Lung Diseases in the early course of disease.

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