

Interpretation of High Resolution CT of the Lung

Dr Parveen Chandna¹, Dr Rohtas K Yadav²

Senior Resident¹, Director² DEPTT. OF RADIO-DIAGNOSIS , PT.B.D.SHARMA POST GRADUATE
INSTITUTE OF MEDICAL SCIENCES , ROHTAK, HARYANA, INDIA

*Correspondence: Dr. Parveen Chandna

Abstract

Background and Objectives:

High-resolution computed tomography (HRCT) imaging of the lungs with high quality spatial resolution may reveal the normal and abnormal lung interstitium and morphological features of parenchymal disorders. High-resolution computed tomography (HRCT) has an added advantage to diagnose critically affected individuals with chronic diffuse infiltrative lung disease in patients with normal chest radiographs. Hence, this provides a precise assessment of the pattern and peculiar distribution of lung disease, it furnishes a concrete assessment and improves the accuracy of differential diagnosis.

To demonstrate usefulness of Toshiba lightning aquilion 16 slice multi detector computerized tomography (MDCT) scan in distinguishing areas of potentially reversible disease from irreversible fibrosis and to assess the severity of the disease.

Material and Methods:

The study had been carried out in the Department of Radiodiagnosis, PGIMS , Rohtak for a period of 3 months from December 2018 to February 2019. In this method potential possibility has been explored confirming through cumulative observational study in which we evaluated 50 patients suspected of having interstitial lung diseases based on radiographic or clinical findings .

After taking a brief note of properly informed written consent and complete history, thorough clinical examination was done and these patients were subjected to CT scan.

Results

Bronchiectasis ,septal lines, ground glass opacity,paraseptal emphysema and Mediastinal lymph node enlargement were found to be more prevalent findings as compared to other findings on HRCT of lung. Idiopathic pulmonary fibrosis exceeded other kinds of disorders during HRCT examination. However , Drug induced ILD and lymphangiomyomatosis were encountered in a small scale .

Conclusion

HRCT can facilitate in formulating a differential diagnosis and to establish the pattern and distribution of disease especially when biopsy is essentially required.

Key words: High-resolution computed tomography (HRCT), lung interstitium, Bronchiectasis ,opacity , resolution, reconstruction and lung parenchyma

Date of Submission: 24-03-2019

Date of acceptance: 08-04-2019

I. Introduction

HRCT enables to distinguish areas of potentially reversible disease from irreversible fibrosis and preferably is of immense use indicating the best pattern and site of lung biopsy. Eventually disorders resulting in an increase in reticular or linear opacities on high-resolution computed tomography (HRCT) have displayed and highly appreciated interstitial lung diseases in vivo. Structural alterations in the lungs can be perfectly visualized in patients with normal findings on the chest radiographs. 1,8,14

Computed Tomography with onset of new techniques as high resolution computed tomography and spiral CT with 3D reconstructions provides new avenues relating to pulmonary perfusion and ventilation. HRCT dominates chest radiography in diagnosis of interstitial lung disease. Although chest radiography will be the initial imaging modality in these patients, CT diagnosis has been found to be more authentic depicting more accuracy to diagnose silicosis , sarcoidosis and lymphangitis carcinomatosis. HRCT is preferable when clinical, other radiological and structural observations do not permit a specific diagnosis and can be carried out in patients prior to biopsy. 2,10,16

HRCT scans are taken from the level of the aortic arch through the lung bases with the patient in both the prone and supine position. However, prone position is essentially important in assessing the interstitial lung disease involving dependent portions of the lung. HRCT of the lungs explores new dimensions for identification of secondary pulmonary lobule and to assess the vessel number, distribution and caliber. Window level ranging (-600 to -700 H U) and width (+1000 to +1500 H U) are critical for requisite findings of HRCT .4,15

Reconstruction of images using a sharp, high spatial frequency, or high-resolution algorithm curtails image smoothing and enhances spatial resolution, depicting sharper requisite structures .3,4,7

Interstitial lung diseases (ILD) also defined as diffuse infiltrative lung diseases which are heterogeneous group of disorders that excessively affect the lung parenchyma and depicting alveolar, septal thickening, pulmonary fibrosis and fibroblast proliferation.12,13

It is of immense use to derive significant conclusion relating to alterations of density in lung parenchyma (mosaic pattern)

MD-HRCT facilitates isotropic scans, duly permitting contiguous 3D characterization of the lung parenchyma and an immense potency to produce high-quality two-dimensional (2D) and 3D reformatted images .5,7,11

3D reconstruction associated with fixed densitometric value permits the alveolographic reconstruction of lung ventilation just like scintigraphic approach. Joint venture related to 3D CT and HRCT evaluation can be employed in the morphologic-functional diagnosis of respiratory pathophysiology. 1,3 ,10

The pertinent aim of the study was to evaluate the role of HRCT in the assessment of interstitial lung disease with peculiar attempt to explore interstitial lung disease in symptomatic patients with normal or ambiguous chest radiograph findings precisely and authentically evaluating the pattern, distribution and severity of the disease process intending requisite treatment and management. Hence to further analyse and differentiate HRCT reversible disorders from those of irreversible changes that conclude the future prognosis in such patients. HRCT plays a vital role to assess the peculiar interstitial lung disease in determining real approach to a particular and preferred treatment.5,6,9

II. Material and Methods

The study had been carried out in the Department of Radiodiagnosis, PGIMS , Rohtak for a period of 3 months from December 2018 to February 2019. In this method potential possibility has been explored confirming through cumulative observational study in which we evaluated 50 patients suspected of having interstitial lung diseases based on radiographic or clinical findings .

After taking a brief note of properly informed written consent and complete history, thorough clinical examination was done and these patients were subjected to CT scan.

- Total 50 patients were studied based on inclusion exclusion criteria having clinical suspicion of ILD. Patients of all age and sex were included in the study.
- Inclusion criteria :
- Known cases of infective etiology (Tuberculosis, HIV) with disseminated disease status.
- Cases of idiopathic interstitial pneumonias , hypersensitivity pneumonias, chronic obstructive pulmonary disease, congestive cardiac failure and lung Malignancy.
- Suspected cases of diffuse parenchymal lung disease by clinical history, physical examination, radiographic findings.
- Patients presenting with industrial exposure related diseases like silicosis, coal worker's pneumoconiosis and asbestosis etc
- Subjects who are under concurrent therapy for collagen vascular diseases like rheumatoid disease, systemic sclerosis and SLE
- Subjects suffering with terminal illness and medical emergencies.
- Subjects with other medication, drugs and radiation exposure related cases.
- Subjects who are diagnosed as systemic vasculitides like Wegener's granulomatosis.
- Subjects suffering from allergic bronchopulmonary aspergillosis, invasive aspergillosis and lymphangitic spread of tumours.

Exclusion Criteria:

- hemodynamically unstable patients .
- Patients who are pregnant.
- Uncooperative, very sick patients

1) Statistical Analysis :

Proportions and Correlation co-efficients will be calculated from the data gathered and analysed. Descriptive statistics like mean (SD) and percentages were used to interpret the results.

III. Results

Bronchiectasis ,septal lines, ground glass opacity,paraseptal emphysema and Mediastinal lymph node enlargement were found to be more prevalent findings as compared to other findings on HRCT of lung revealed in the table as under:

Table 1: DIFFERENT HRCT findings relating to specific disorders in various patients	
FINDINGS	NO.OF PATIENTS
BRONCHIECTASIS	25
CRAZY PAVING APPEARANCE	15
SEPTAL LINES	25
GROUND GLASS OPACIFICATION	20
AIRWAY IRREGULARITY	02
HONEY COMBING	12
ARCHITECTURAL DISTORTION	03
PARENCHYMAL BANDS	11
SUBPLEURAL NODULES	10
CONSOLIDATION	08
CONSOLIDATION WITH THE HALO SIGN	03
PARA SEPTAL EMPHYSEMA	18
SUBPLEURAL CYSTS	05
DILATED ESOPHAGUS	03
CENTRILOBULAR NODULES	09
TREE – IN – BUD PATTERN	09
EFFUSION	06
MOSAIC	04
SCAR CARCINOMA	02
MEDIASTINAL LYMPH NODE ENLARGEMENT	17

Idiopathic pulmonary fibrosis exceeded other kinds of disorders during HRCT examination. However , Drug induced ILD and lymphangioleiomyomatosis were encountered in a small scale revealed in the table as under:

Table 2: interstitial lung diseases examined on HRCT	
ILD	NO.OF PATIENTS
IDIOPATHIC PULMONARY FIBROSIS	14
NON SPECIFIC INTERSTITIAL PNEUMONIA	08
SYSTEMIC SCLEROSIS	03
SYSTEMIC LUPUS ERYTHEMATOSUS(SLE)	04
SARCOIDOSIS	02
OCCUPATIONAL DISEASE	03
RHEUMATOID ARTHRITIS	03
MYCOSIS FUNGOIDES	02
SCLERODERMA	02
PROTEIN ALVEOLAR PROTEINOSIS	02

DRUG INDUCED ILD	01
LYMPHANGIOLEIOMYOMATOSIS	01
HYPERSENSITIVITY PNEUMONITIS	05

CASE 1

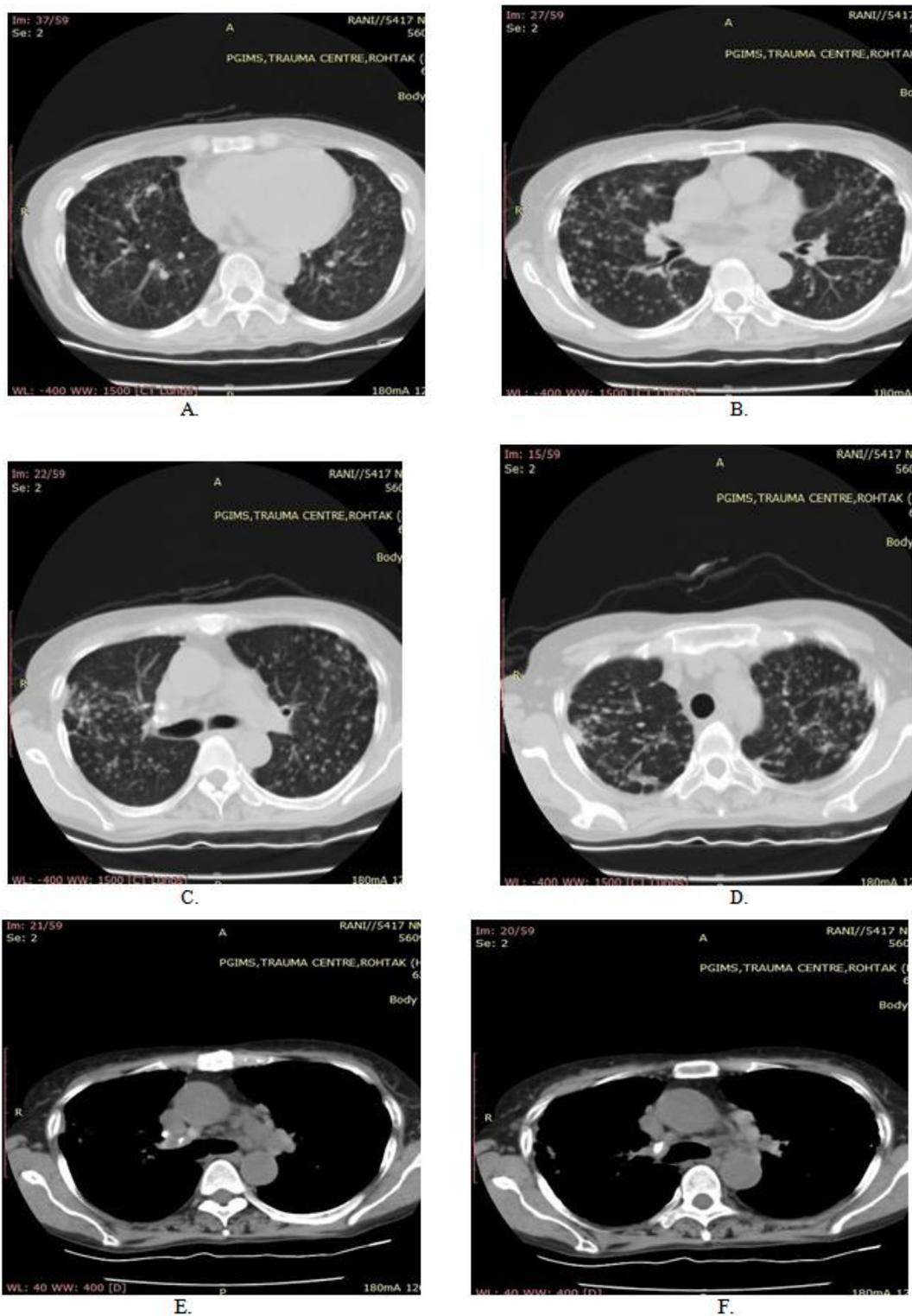


FIGURE 1 HRCT (A-D) SARCOIDOSIS: Multiple Reticulo nodular opacities with interstitial infiltrates are seen in random distribution involving b/l lung fields . (E-F) Calcified subcentimetric mediastinal lymphnodes also noted.

CASE 2

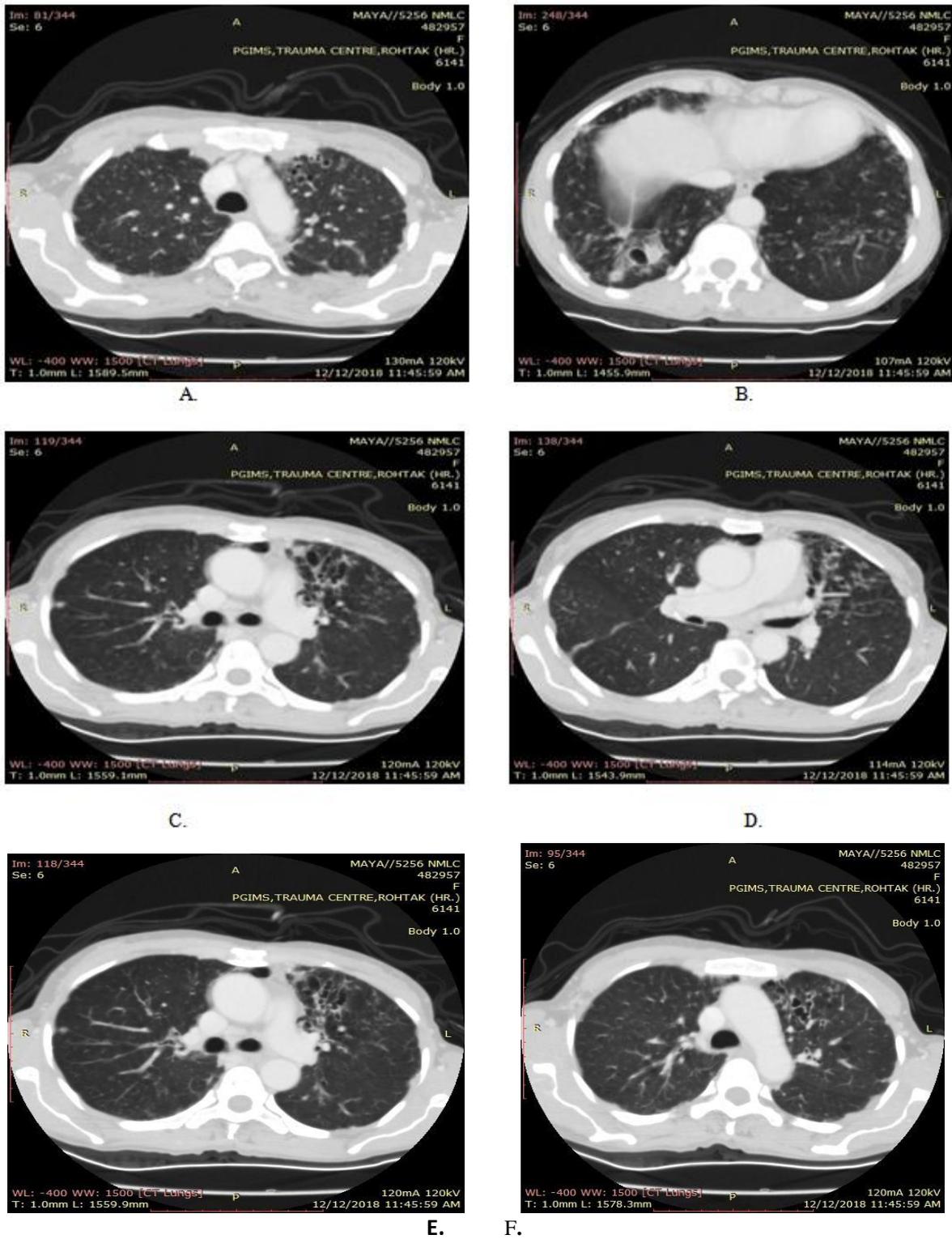


FIGURE 2 HRCT (A-F) CHRONIC TUBERCULOSIS: Tractional bronchiectasis with fibroatelectatic changes noted in left upper and Lingular lobe and right lower lobe.

CASE 3

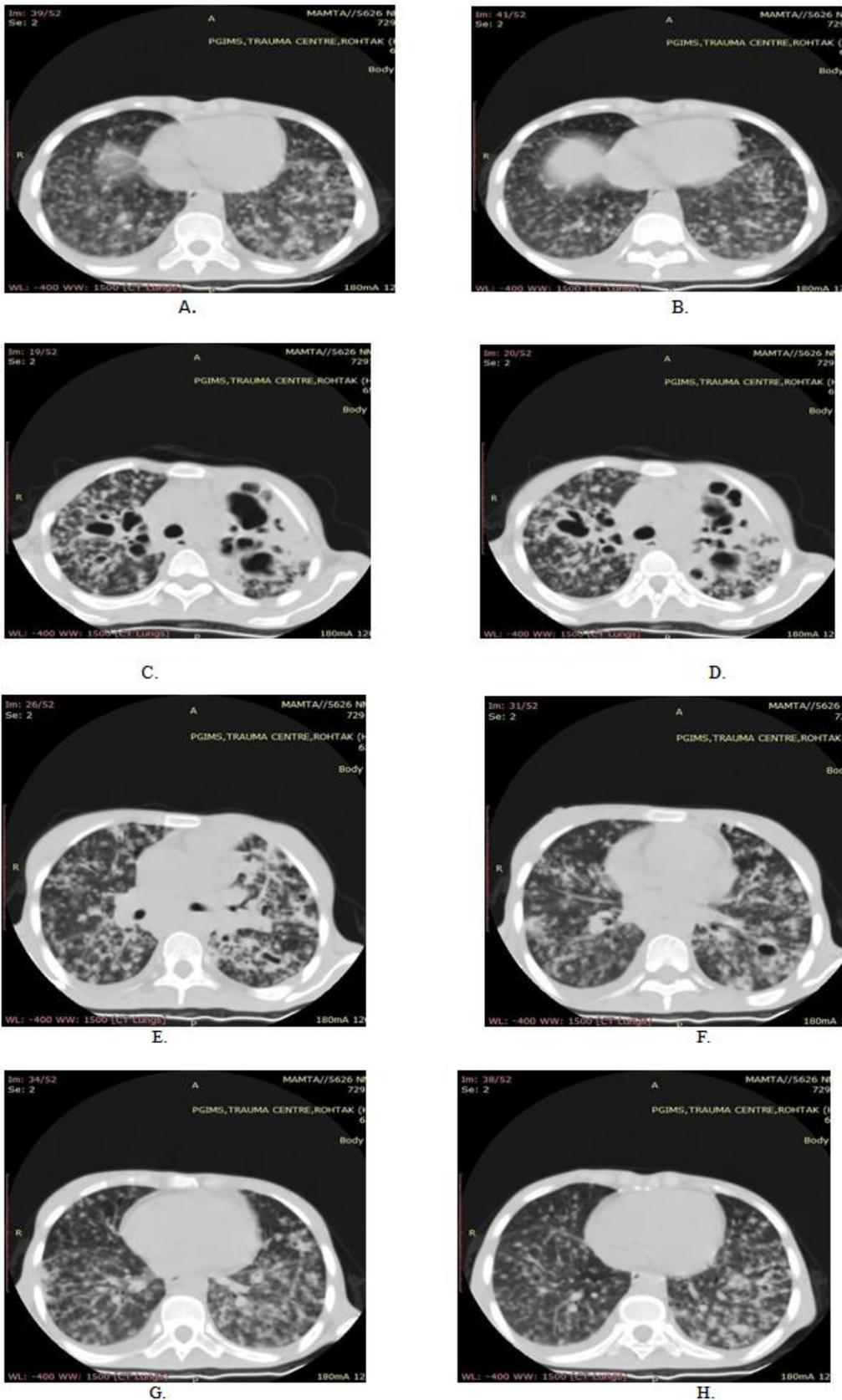


FIGURE 3 HRCT (A-H) MILIARY TUBERCULOSIS: Multiple nodules distributed randomly in tree in bud pattern in b/l lung fields with fibrocavitary changes .

CASE 4

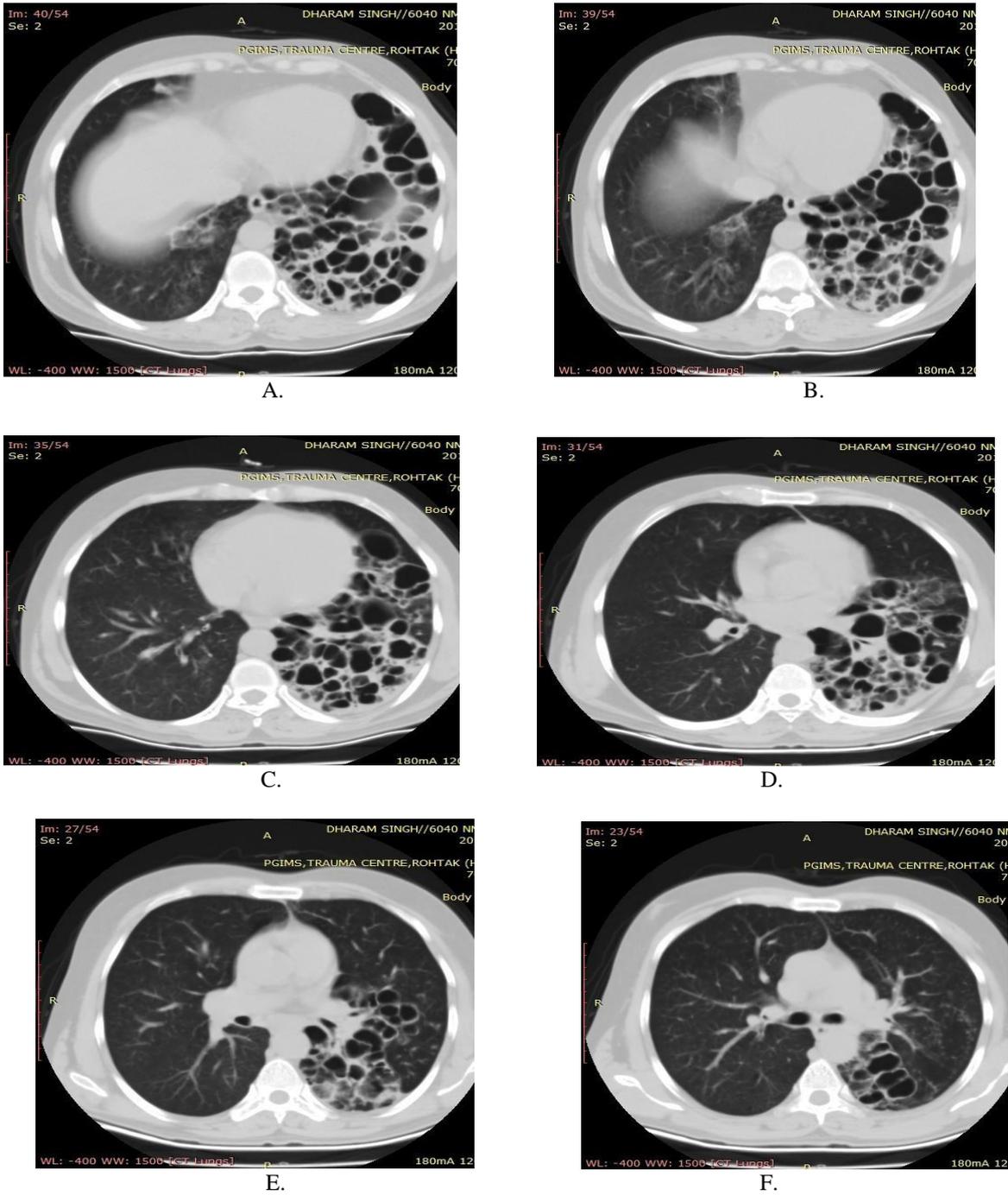
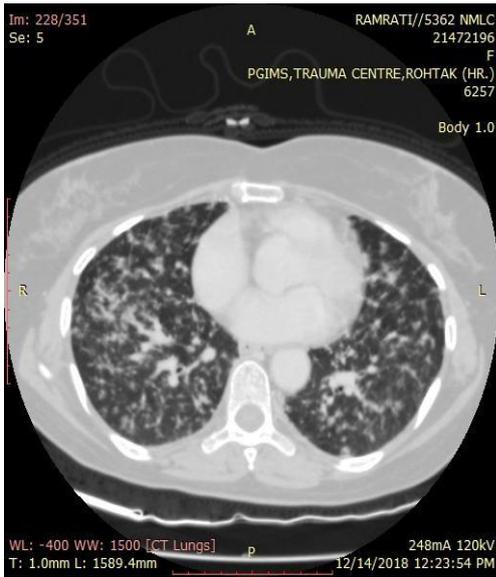
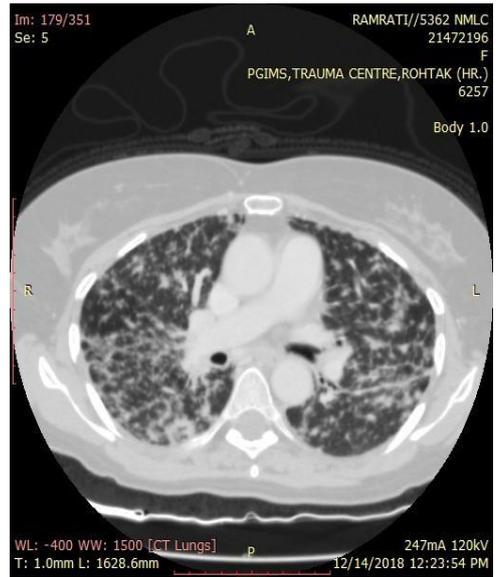


FIGURE 4 HRCT (A-F) SEQUELAE OF CHRONIC TUBERCULOSIS: (BRONCHIECTASIS) :
Cystic bronchiectasis changes noted in left lower lobe segments and superior lingular segment

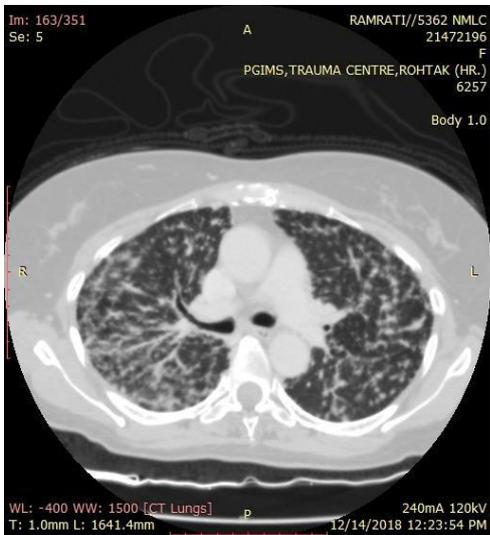
CASE 5



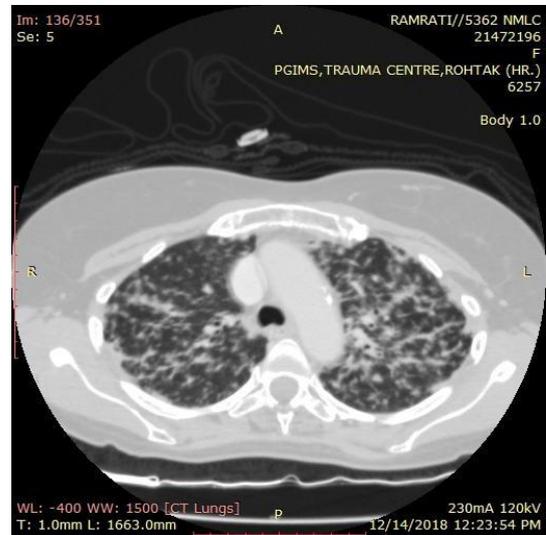
A.



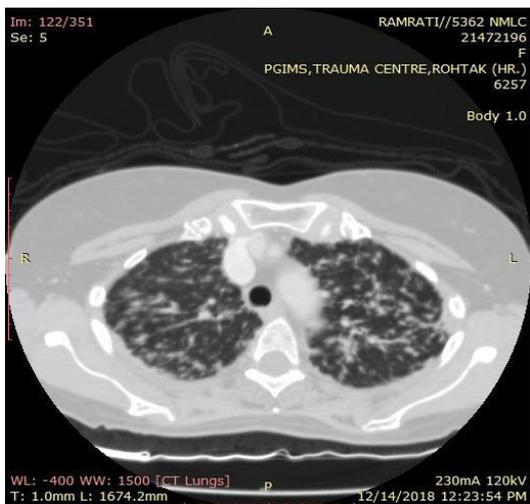
B.



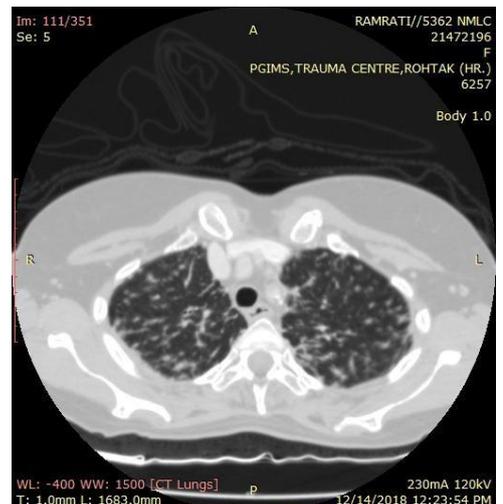
C.



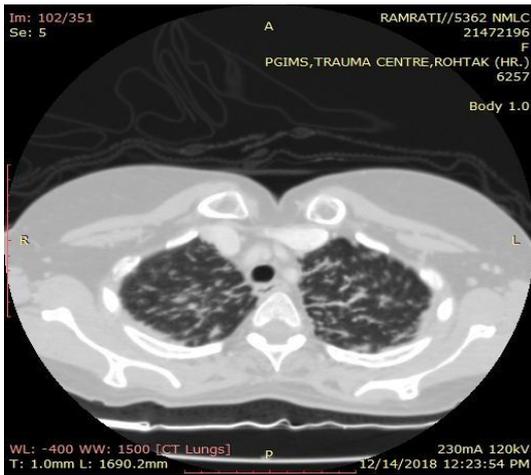
D.



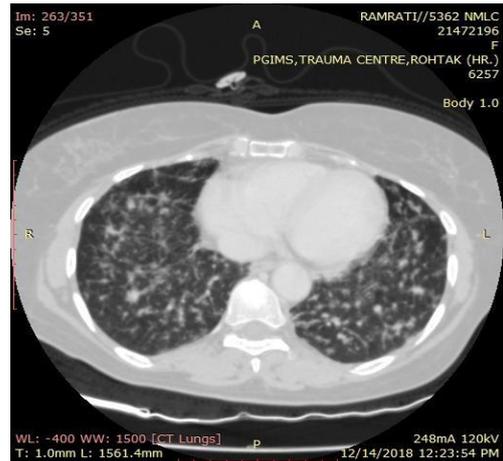
E.



F.



G.

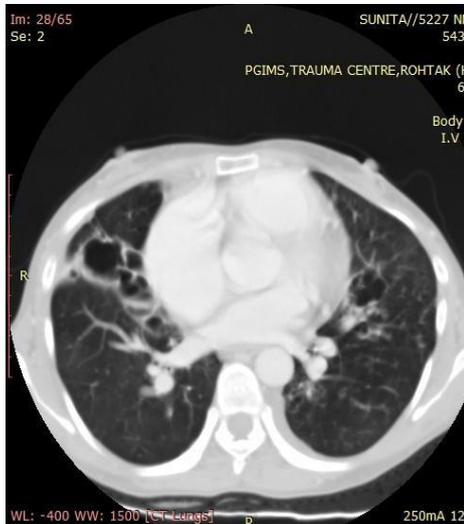


H.

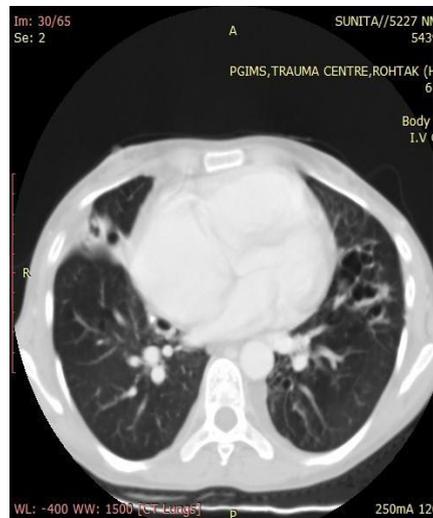
FIGURE 5 HRCT (A-H) LYMPHANGITIS CARCINOMATOSIS:

K/C/O CARCINOMA BREAST : Multiple nodules arranged in perilymphatic location with interlobular septal thickening noted in b/l lung fields and fibroatelectatic changes.

CASE 6



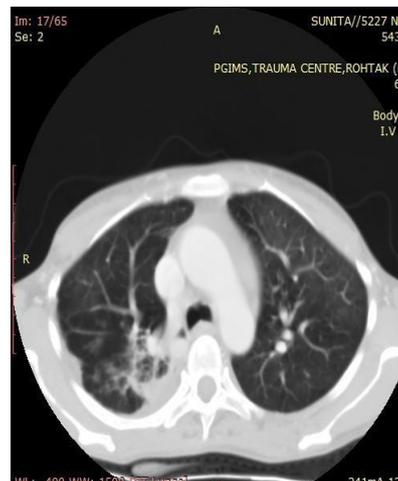
A.



B.



C.



D.

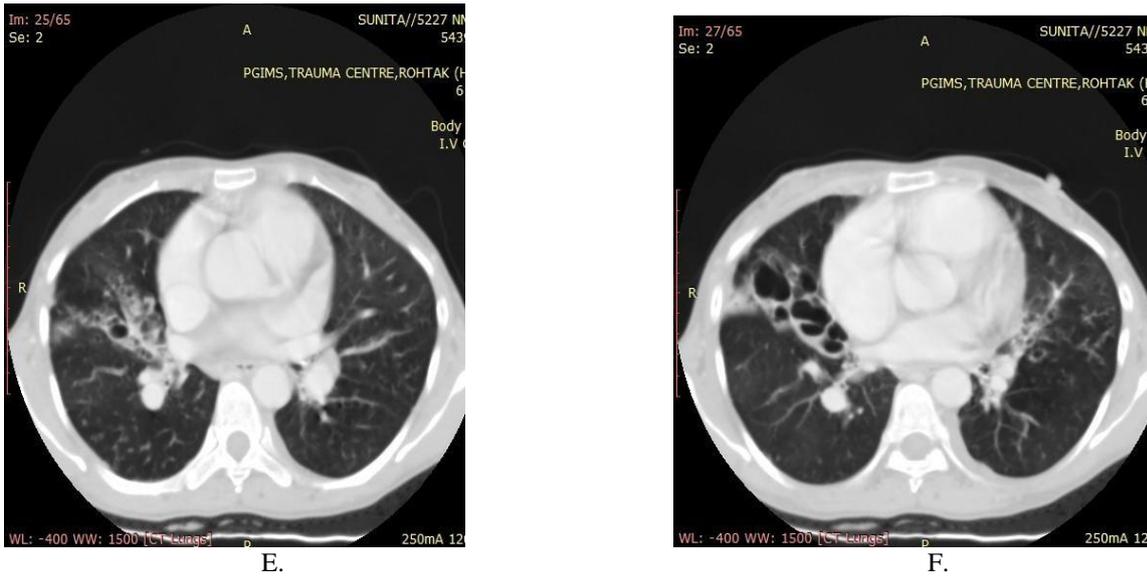
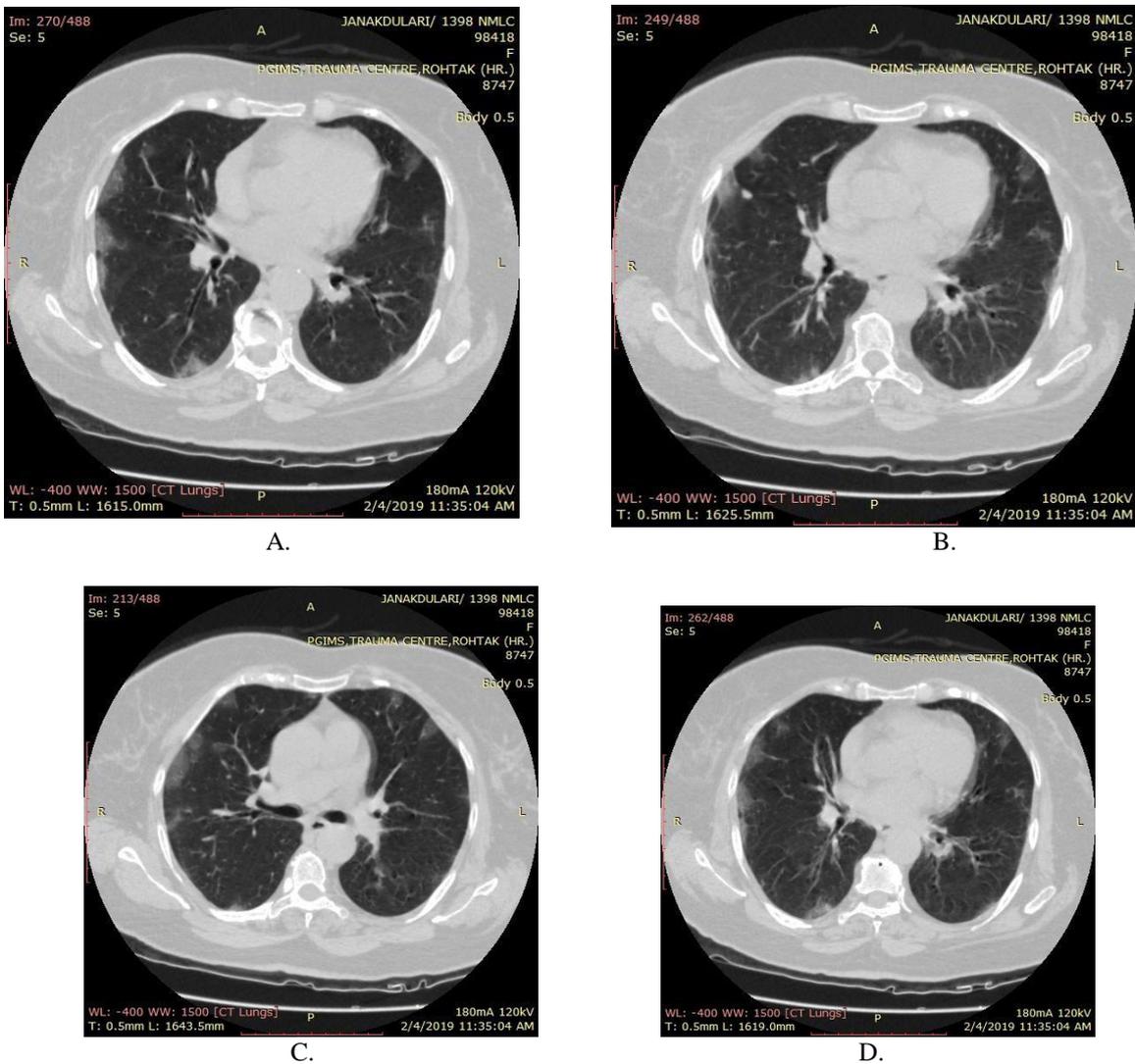
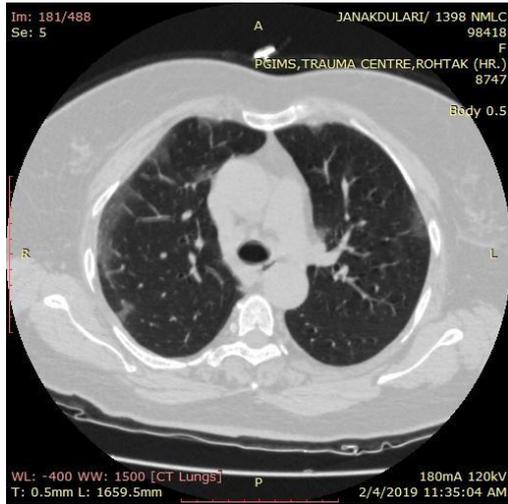


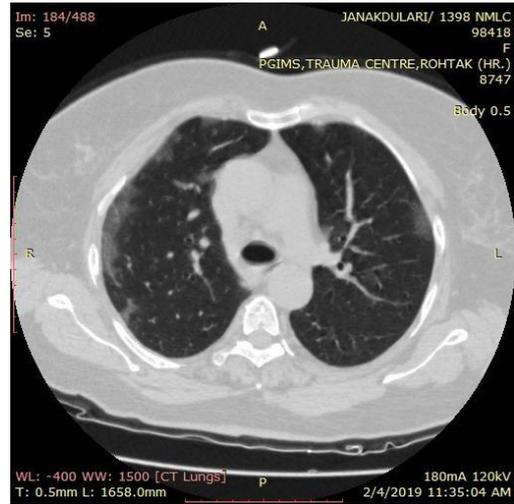
FIGURE 6 HRCT (A-F) SEQUELAE OF CHRONIC TUBERCULOSIS: Cystic bronchiectasis changes noted in b/l lung fields (R>L) with areas of traction bronchiectasis and fibroatelectatic changes noted in right lower lobe. pleural thickening noted at multiple areas in right hemithorax .

Case 7

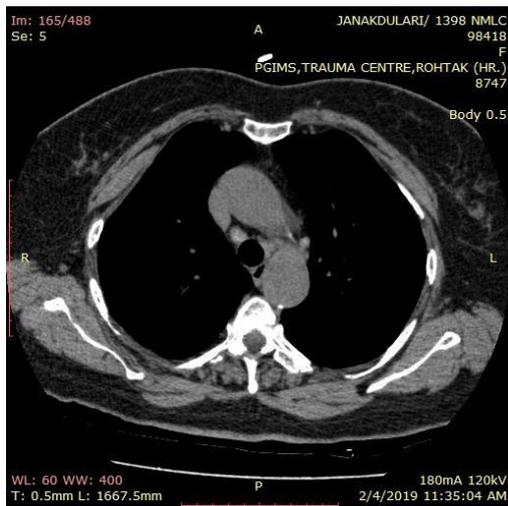




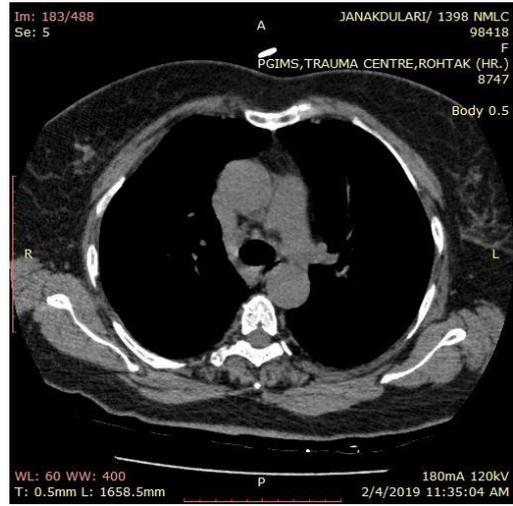
E.



F.



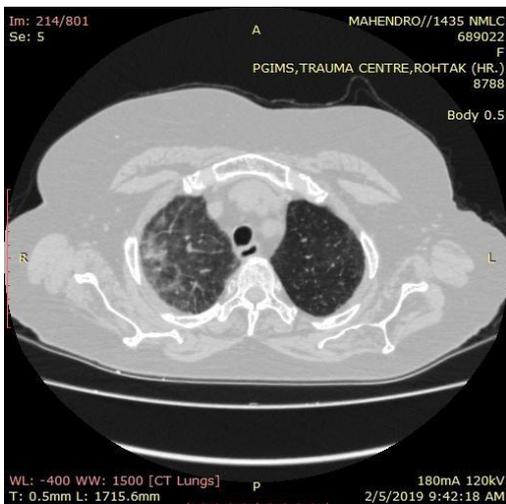
G.



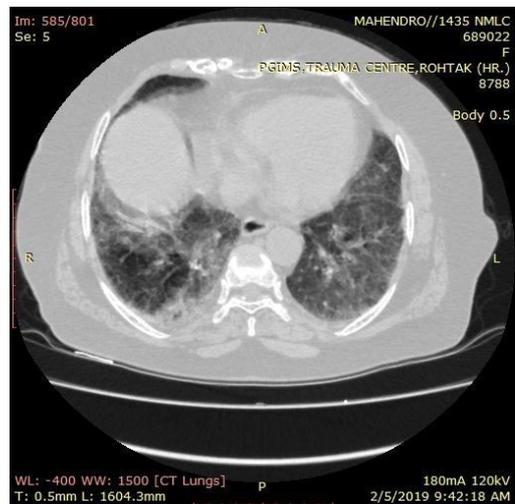
H.

FIGURE 7 HRCT (A-H) ATYPICAL PNEUMONIA : Multiple peripheral wedge shaped ground glass opacities involving B/L lung fields . Few subcentimetric prevascular and right paratracheal lymph nodes noted. Laboratory findings revealed normal eosinophilic count.

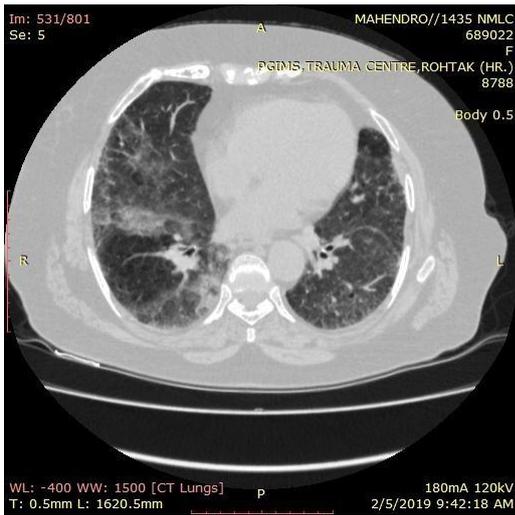
CASE 8



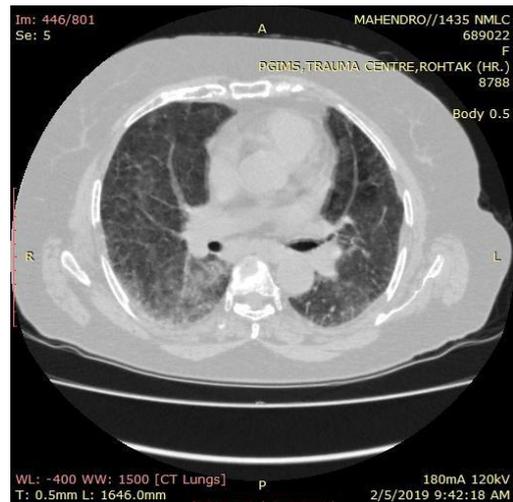
A.



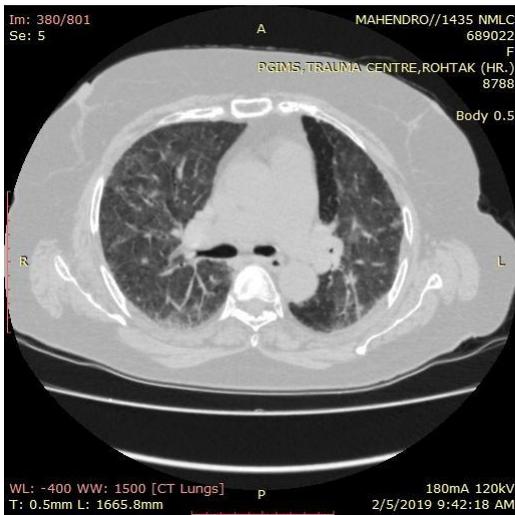
B.



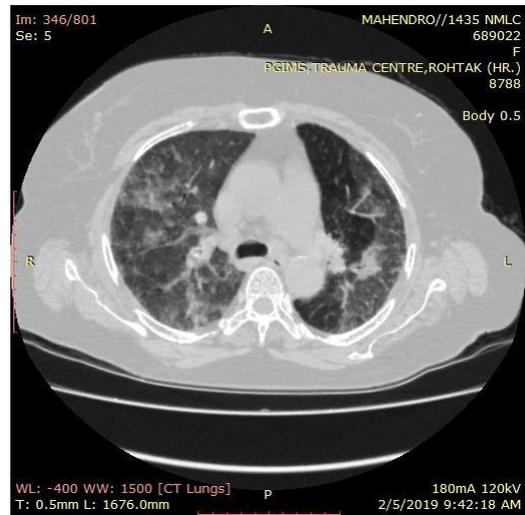
C.



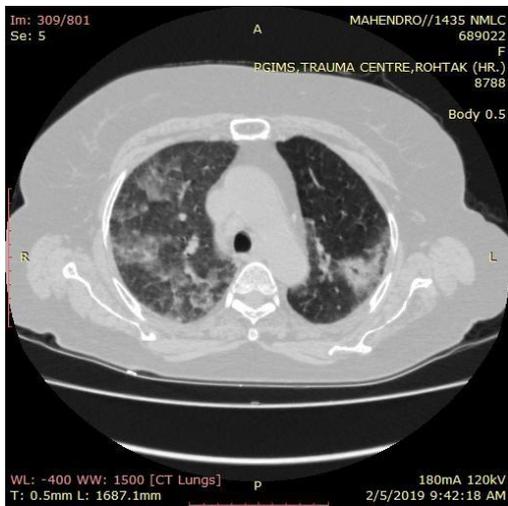
D.



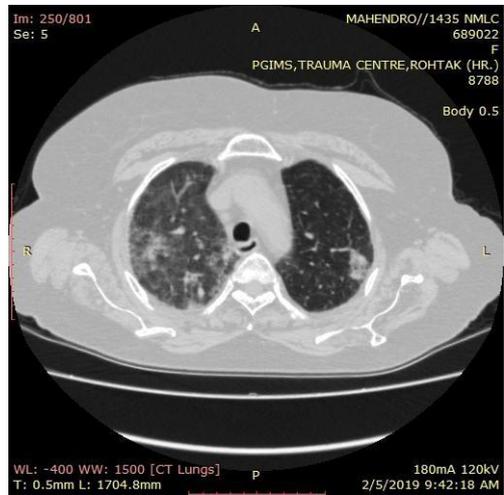
E.



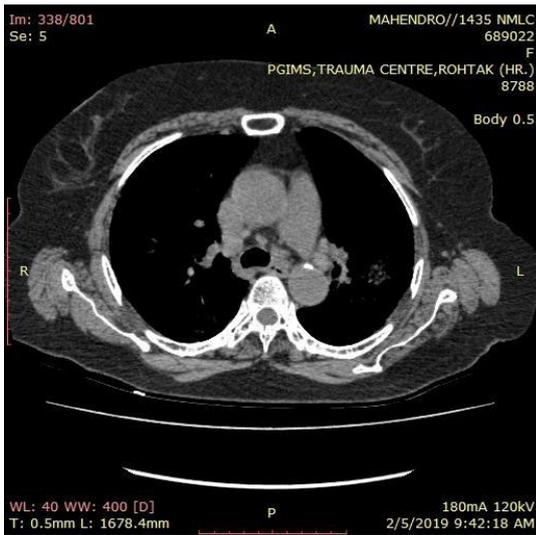
F.



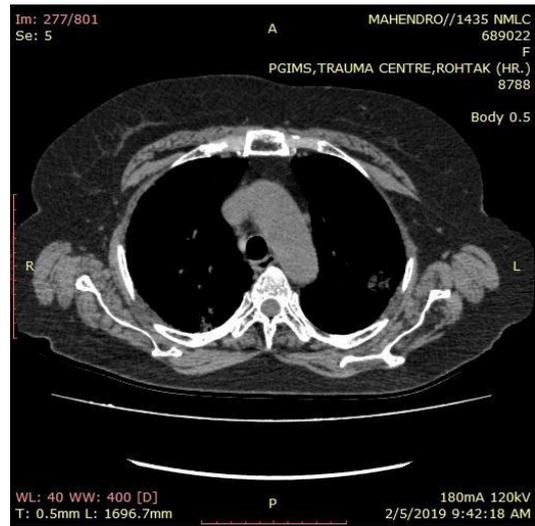
G.



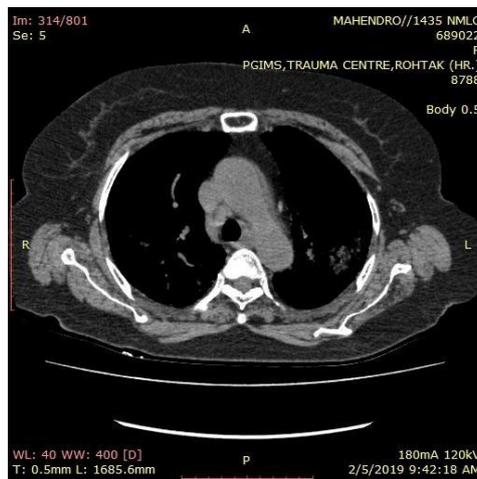
H.



I.



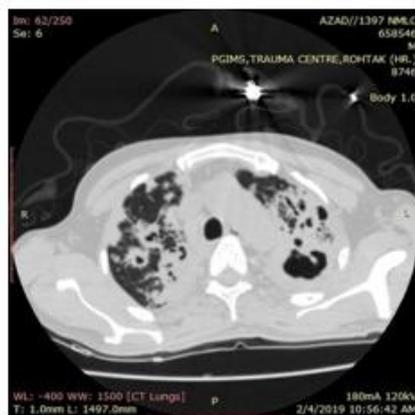
J.



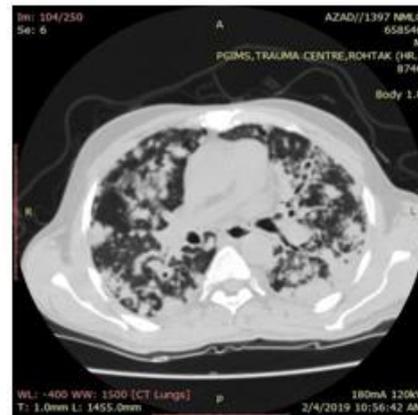
K.

FIGURE 8 HRCT (A-H) INTERSTITIAL LUNG DISEASE : Patchy ground glass opacities noted involving entire right lung and left lower lobe. Areas of interlobular septal thickening with interspersed GGO seen in anterior and posterior segment of right upper ,anterior segment of left upper ,superior segment and basal segment of bilateral lower lobe. Patch of consolidation seen in apico posterior segment of left upper lobe. (I-K) Few mediastinal lymph nodes in prevascular and paratracheal region also noted.

CASE 9



A.



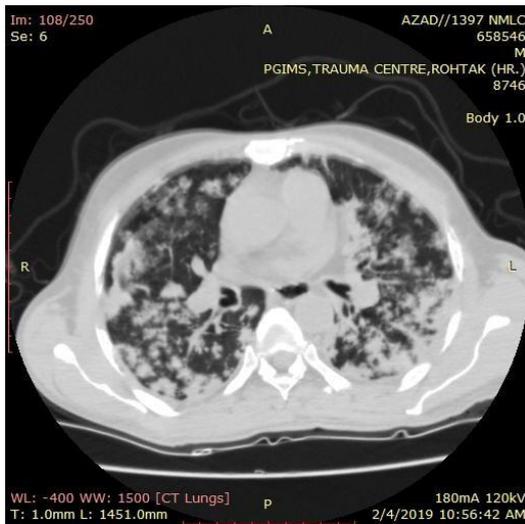
B.



C.



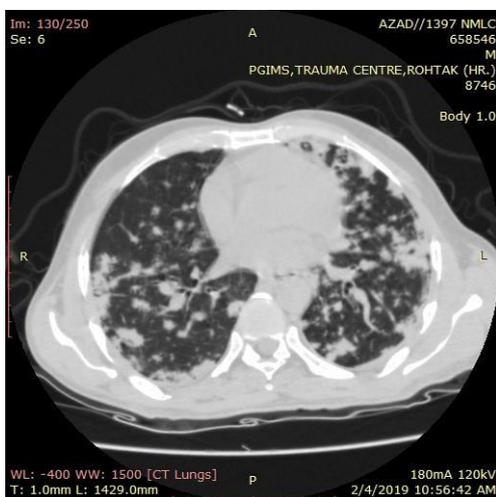
D.



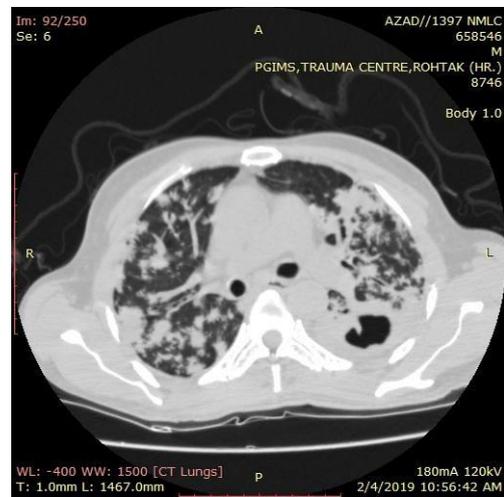
E.



F.



G.



H.

FIGURE 9 HRCT (A-H) INFECTIVE ETIOLOGY : Irregular thick walled cavitary lesion seen in left upper lobe apico posterior segment. A small cavitary lesion also seen in right upper lobe . These cavities show communication to segmental bronchi. Multiple alveolar radioopacities seen scattered throughout b/l lung fields predominantly in b/l upper, medial and lingular lobe. A Few radiodensities show cavitation .

The diagnosis was authenticated in the mentioned experiments which further reveal exclusion of bronchiectasis employing 16-slice chest CT (1 mm cuts) as compared to conventional HRCT of the chest. Reconstructed HRCT images produced from multidetector CT (MDCT) scanner data acquisition have been reckoned to be of highly comparable towards qualitative images produced employing conventional HRCT ,therefore the approach was confirmed as the best application to compare HRCT and MDCT, whilst limiting the radiation dose and not subjecting the patients to both the scans. The radiation dose for MDCT of the chest has been determined much more as compared to HRCT .13

However , the concordance between scans 16-slice chest CT (1 mm cuts) vs 5mm and 10 mm upgraded the diagnosis of bronchiectasis in most of the patients and downgradation was noticed to be much less,thus determining that 1 mm cuts dominated and found to be superior pertaining to diagnosis of bronchiectasis.

IV. Discussion

Lung disease is categorized according to pattern (areas of decreased attenuation and areas of ground-glass attenuation, linear areas, nodular areas,) and distribution (axial, peripheral and parenchymal).

HRCT evaluation on serial axial scans during inspiration and expiration permits functional assessment of componentary structures requiring spirometry and tests pertaining to respiratory function.14,15

This original article briefs the latest findings of HRCT of the chest in differential diagnosis of patients with bronchiectasis,emphysema,asbestosis,sarcoidosis,pulmonary alveolar proteinosis,acute lung disease, chronic infiltrative lung disease,lymphangitic carcinomatosis and pneumoconiosis. Consequently,commencing of HRCT has revolutionized our ability to detect thickening of the lung interstitium by fibrous tissue, fluid or cellular infiltration.3,8,12

Idiopathic pulmonary fibrosis exceeded other kinds of disorders during HRCT examination. However , Drug induced ILD and lymphangioleiomyomatosis were encountered in a small scale

The diversity of diseases as visualized on HRCT Scans can also be useful in planning and executing the biopsy in a fair way. Bronchiectasis ,septal lines, ground glass opacity,paraseptal emphysema and Mediastinal lymph node enlargement were found to be more prevalent findings as compared to other findings on HRCT of lung.

To perform HRCT both inspiratory and expiratory imaging must be procured eventually acquiring probable approach to determine the particular disorder. Furthermore, observation of air trapping to be identified on inspiratory images and expiratory images is highly ambiguous which are much valuable to asses the presence of ground glass opacity. 6,11

To fully understand the HRCT findings, knowledge of the anatomy of the secondary pulmonary lobule becomes very important. 13,16

Identifying the pattern and distribution of disease assists to formulate a differential diagnosis. A comparative study of the vessels and density between healthy and impeded areas has also been considered. 8,13

Hence, HRCT is of immense use in the detection and diagnosis of chronic diffuse infiltrative lung disease.The technique of HRCT involves use of short Scan (rotation) time , 1-2-mm-thick collimation scans with a “sharp” algorithm / high spatial frequency algorithm.9 ,11,12

V. Conclusion

High-resolution computed tomography (HRCT) of the lung enables detailed display and appreciation of the lung parenchyma which is being employed to evaluate chronic interstitial lung disease and to achieve detailed morphologic and comparative view of minute anatomical structures. HRCT can facilitate in formulating a differential diagnosis and to establish the pattern and distribution of disease especially when biopsy is essentially required.

The distribution of lung disease, as viewed on HRCT scans, can help to derive the conclusion pertaining to planning and execution of the particular disorder . Spiral CT allows volumetric acquisitions in a single breath which can be properly reconstructed and processed.

Prone and supine HRCT imaging is generally employed for the evaluation of patients with suspected idiopathic interstitial pneumonia or with restrictive patterns during examination related to pulmonary dysfunctioning . This evaluation depicts to discriminate dependent density (Atelectasis) from pulmonary inflammation or fibrosis.

Acknowledgement

No words can ever express my deep sense of gratitude for my parents & my younger brother, for their affections, endurance, inspiration, support, unending blessings, innumerable sacrifices and unceasing encouragement that has moulded me into the person I am today. The expression of my gratitude's will remain

incomplete if I fail to register my deep sense of indebtedness to my family members without whose perseverance and affection it would have not been possible for me to undertake this arduous assignment.

Funding : No funding sources.

Conflict of interest: None declared.

Ethical approval: The study was approved by the Institutional Ethics Committee.

Bibliography

- [1]. Müller NL, Miller RR. Computed tomography of chronic diffuse infiltrative lung disease: part 1. *Am Rev Respir Dis* 1990;142:1206–1215.
- [2]. Zwirewich CV, Terriff B, Müller NL. High-spatial-frequency (bone) algorithm improves quality of standard CT of the thorax. *AJR Am J Roentgenol* 1989;153:1169–1173.
- [3]. Müller NL, Miller RR. Computed tomography of chronic diffuse infiltrative lung disease: part 2. *Am Rev Respir Dis* 1990;142:1440–1448.
- [4]. Gotway MB, Reddy GP, Webb WR, Elicker BM, Leung JW. High-resolution CT of the lung: patterns of disease and differential diagnoses. *Radiol Clin North Am*. 2005 May;43(3):513–42.
- [5]. Mayo JR, Webb WR, Gould R, et al. High-resolution CT of the lungs: an optimal approach. *Radiology* 1987;163:507–510.
- [6]. Brody AS. Imaging considerations: interstitial lung disease in children. *Radiol Clin North Am*. 2005 Mar;43(2):391–403.
- [7]. Mayo JR, Aldrich J, Muller NL. Radiation exposure at chest CT: a statement of the Fleischner society. *Radiology* 2003;228:15–21.
- [8]. Schurawitzki H, Stiglbauer R, Graninger W, Herold C, Polzleitner D, Burghuber OC et al. Interstitial lung disease in progressive Systemic Sclerosis: High resolution CT versus Radiography. *Radiology* 1990;176(3):755-759.
- [9]. Murata K, Khan A, Rojas KA, et al. Optimization of computed tomography technique to demonstrate the fine structure of the lung. *Invest Radiol* 1988;23:170–175.
- [10]. Mathieson JR, Mayo JR, Chatherine AS, Muller NL. Chronic diffuse infiltrative lung disease: Comparison of diagnostic accuracy of CT and chest radiography. *Radiology* 1989; 171(1):111-116.
- [11]. Mayo JR. The high-resolution computed tomography technique. *Semin Roentgenol* 1991;26:104–109.
- [12]. Mayo JR. High resolution computed tomography: technical aspects. *Radiol Clin North Am* 1991;29:1043–1049.
- [13]. Studler U, Gluecker T, Bongartz G, Roth J, Steinbrich W. Image quality from high resolution CT of the lung: comparison of axial scans and of sections reconstructed from volumetric data acquired using MDCT. *AJR Am J Roentgenol* 2005;185:602–7
- [14]. Heinz Schurawitzki, MD, Rudolf Stiglbauer, MD, Winfried Graninger, MD, Christian Herold, MD, Doris Polzleitner, MD, Otto Chris Burghuber, MD, et al. Interstitial Lung Disease in Progressive Systemic Sclerosis : High Resolution CT versus Radiography. *Radiology* 1990;176:755-759
- [15]. S Raniga, S Sharma, A Arora, Y Khalasi, PA Vora. Utility of High Resolution Computed Tomography(HRCT) in diagnosis and management of Idiopathic Pulmonary Fibrosis- a study of 10 cases. *Ind J Radiol Imag* 2006 ;16: 4:841-846
- [16]. Martin Remy-Jardin, Jacques Remy, Catherine Deffontaines, Alain Duhamel. Assessment of Diffuse Infiltrative Lung Disease: Comparison of Conventional CT and High Resolution CT. *Radiology* 1991;181:157-162

Dr. Parveen Chandna. “Interpretation of High Resolution CT of the Lung.” IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 04, 2019, pp 60-75 .