

Original Article

# HRCT Imaging of Pulmonary Tuberculosis

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**Abstract** - Worldwide rate of incidence of TB has shown a declining trend, yet pulmonary TB is a burning concern with respect to all other dreadful infectious diseases. It has been considered the biggest cause of disease dissemination concerning individual morbidity and mortality. To the desired extent, CT scan has been regarded as the speedy, convincing and very much authentic modality of choice capable of detecting even the tiniest initial finding pertaining to pulmonary TB, which facilitates early management, prevention and control of this particular disease. HRCT is of immense use and an authentic modality to discriminate between active and inactive TB. To explicitly explain the utility of SIEMENS somatom sensation cardiac 16 slices multidetector computerized tomography (MDCT) scan after reconstruction of images in early detection of TB and to assess the severity of the disease.

HRCT is a reliable and recommended investigation to distinguish active from inactive disease. It gives a better resolution for subtle areas of consolidation, tree in the bud (centrilobular nodules), cavitation, miliary and bronchogenic spread of disease compared to chest radiography. Early treatment and decisions can be implemented to prevent the disease's spread. In our study, in particular, men are affected more than women. HRCT is recommended tool when the chest radiographic findings are inconclusive and for early detection and the confirmation of diagnosis.

**Keywords** - Tuberculosis (TB), Computed Tomography (CT), High Resolution Computed Tomography (HRCT), Cavitation, Lung Parenchyma, Consolidation, Reconstruction And Primary MTB (*Mycobacterium Tuberculosis*).

## 1. Introduction

Critical finding concerning post-primary MTB improvises poorly defined areas of consolidation favouring the apical and posterior segments of the upper lobes and, to a smaller extent, the superior segments of the lower lobes. Opacities can also be visualized in other segments. Generally, tiny, poorly defined opacities or satellite nodules have been observed on the periphery of the dominant foci of consolidation. On HRCT, such nodules particularly reveal centrilobular branching, linear patterns, or so-called tree-in-bud opacities.<sup>1,4,12,13</sup>

These opacities reveal heavy impact upon small airways filled with pus. Areas of cavitation have been observed in 20% to 45% of patients with active post-primary MTB on chest radiographs, but still, tiny cavities can be generally recognized with CT and HRCT. Cavities may be thick or thin-walled; air-fluid levels are seen rarely.<sup>2,5,14,18</sup>

Lymphadenopathy is not common in post-primary MTB, being associated with pleural effusions. When effusions arise, they are generally observed in elderly patients. HRCT with high-quality spatial resolution may reveal the abnormal lung interstitium with varied TB and deadly respiratory ailments. The value of sputum culture in diagnosis remains the same or even better compared to the HRCT. Tuberculosis has been considered a chronic granulomatous infection with characteristics as revealed by caseation necrosis and with

higher propensity and affinity for fibrosis and calcification.<sup>15,16,17</sup>

MTB infection may lead to a miliary pattern. This pattern manifests as multiple, well-defined nodules that measure 1 to 2 mm in size, diffusely distributed throughout the lungs. On HRCT, these small nodules are distributed randomly. The miliary pattern displays hematogenous dissemination of infection from a pulmonary nidus and may be visualized in both primary and post-primary diseases. Radiographs have been detected as normal in patients on certain occasions with miliary tuberculosis.<sup>3,6,19</sup>

Determining and confirming the diagnosis and potential activity in patients infected with pulmonary tuberculosis generally implies the detection of acid-fast bacilli in sputum smear or culture.

Lymphadenopathy has been generally revealed in children with primary MTB infection. Often hilar lymph nodes are involved, and mediastinal lymph nodes, particularly in the right paratracheal region, may get enlarged as usual. Unilateral lymphadenopathy occurs more than bilateral disease, and in a few cases, lymph node enlargement has been the only persistent radiographic sign present. Lymphadenopathy is not common in adults with primary MTB until and unless they have been immunocompromised.



Lymph nodes in patients actively infected with MTB critically reveal low central attenuation, recognized as necrosis, on contrast-enhanced CT.<sup>7,8,20,24</sup>

Augmentation of High-resolution computed tomography (HRCT) has an added advantage to streamlining lung involvement patterns and diagnosing critically affected individuals with active pulmonary tuberculosis. The most important imaging findings observed in our observational study - are miliary disease, patchy unilateral or bilateral air-space consolidation, tree-in-bud pattern appearance (multiple centrilobular nodules in linear branching pattern), cavitation, pleural effusion/empyema, hilar/mediastinal lymph nodes, fibrosis, Traction bronchiectasis, emphysema, pleural thickening and calcified nodule.<sup>21,22,23</sup>

Patients treated with corticosteroids or those who have undergone organ transplantation have also shown an increased risk of *M. tuberculosis* infection. Immunosuppressed patients, especially AIDS patients, are at higher risk than the ordinary population for getting infected with *M. tuberculosis*. Chronic illnesses, including diabetes mellitus, alveolar proteinosis, and silicosis, have been crucial factors in acquiring *M. tuberculosis*. Men are more commonly affected than women. Very young and elderly patients also reveal an increased risk of *M. tuberculosis* infection.

Poor Patients deficient in nutrition are generally prone to risk for acquiring tuberculosis infection and generally prevalent in patients dwelling in crowded unhealthy conditions.<sup>9,10,11,25</sup>

The tuberculous lesion can appear in the lung in various ways: bronchogenic dissemination, local progression, or hematogenous dissemination. Tuberculosis results from *Mycobacterium tuberculosis*- *Mycobacteria* are aerobic, non-spore-forming rods with unusually long doubling times. . Structural alterations in the lungs can be perfectly visualized in patients with normal findings on the chest radiographs.<sup>26,28,30,32</sup>

HRCT dominates chest radiography in the diagnosis of pulmonary TB. HRCT can improve a differential diagnosis and streamline disease patterns and distribution. A particular image of CT in initial active tuberculosis is small airway lesions which also predict the spread of the disease. Reliable HRCT features of active tuberculosis combine centrilobular nodules and tree-in-bud appearance.<sup>27,29,31</sup>

The basic objective of the study was to evaluate the role of HRCT in assessing PULMONARY TB in symptomatic patients with normal chest radiograph findings precisely and authentically, evaluating the pattern, distribution and severity

of the disease process intending requisite treatment and management. Commonly the right lung is affected more than the left, with symptoms of weight loss, fever, cough, failure to thrive, hemoptysis and night sweats.

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

## 2. Material and methods

The study was carried out in the Department of Radiodiagnosis, N .C. MEDICAL COLLEGE AND HOSPITAL, ISRANA, PANIPAT, HARYANA, for 6 months from MARCH 2022 to SEPTEMBER 2022. In this choice of modality, the potential possibility has been explored to detect every aspect of the disease, simultaneously confirming through a cumulative observational study in which we evaluated 50 patients suspected of having pulmonary TB based on radiographic or clinical findings.

After taking a brief note of properly informed written consent and complete history, a thorough clinical examination was done, and these patients were subjected to CT scans. To explicitly explain the utility of siemens somatom sensation cardiac 16 slices multidetector computerized tomography (MDCT) scan after reconstruction of images in early detection of TB and to assess the severity of the disease.

### Inclusion Criteria

- Clinically suspected patients with Pulmonary TB, with or without positive chest radiograph findings.
- Clinically suspected patients with symptoms of weight loss, fever, cough, failure to thrive, hemoptysis and night sweats.
- Sputum AFB examinations were positive/negative for tuberculosis.
- Immunocompromised patients.

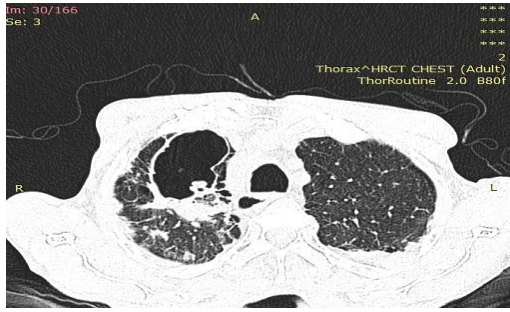
### Exclusion Criteria

- Pregnant women
- Patients or parents of children are reluctant to take part in the study.

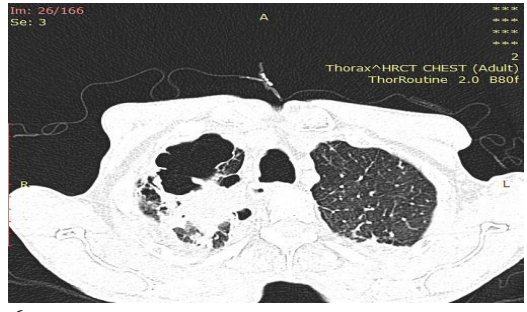
## 3. Results

### Case 1

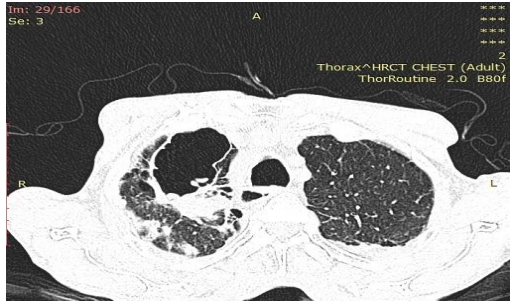
A 70-year male patient came to our hospital in medicine OPD with a history of cough with sputum and complaining of breathlessness on exertion followed by night sweats for 3 months. During his follow-up, he complained of chest pain, body weakness, subjective fever, and weight loss. On clinical examination, his Hb was 9gm/dl.



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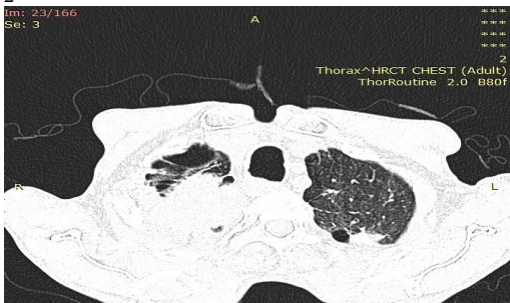
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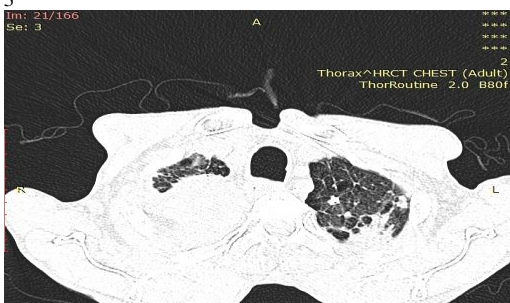
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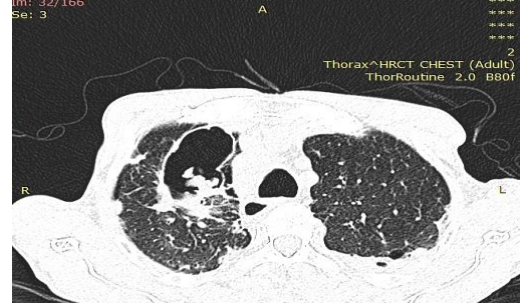
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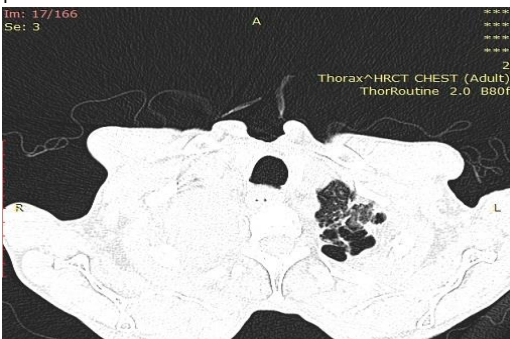
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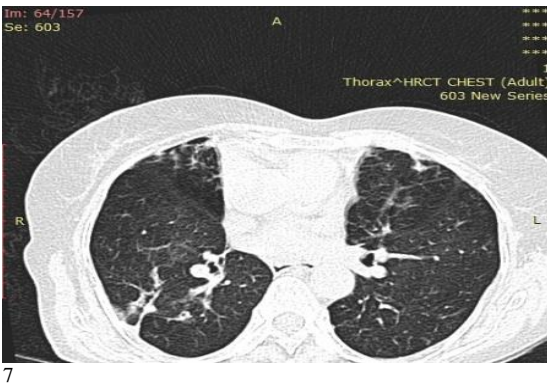
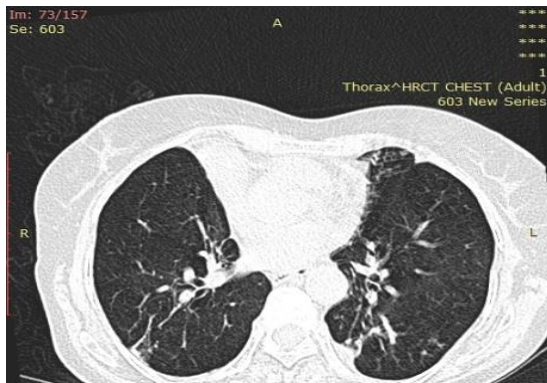
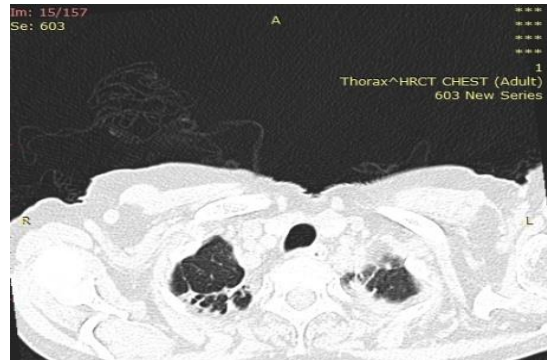
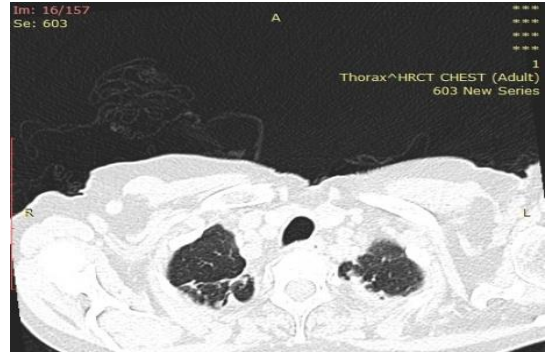
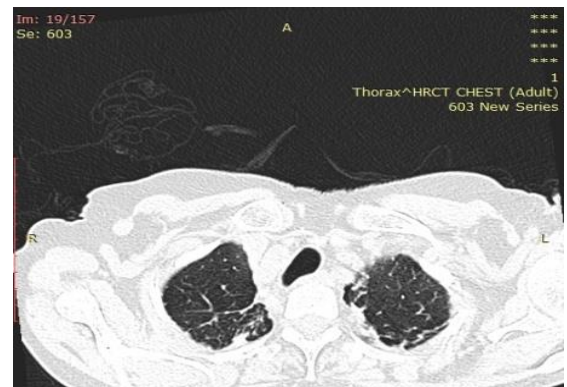
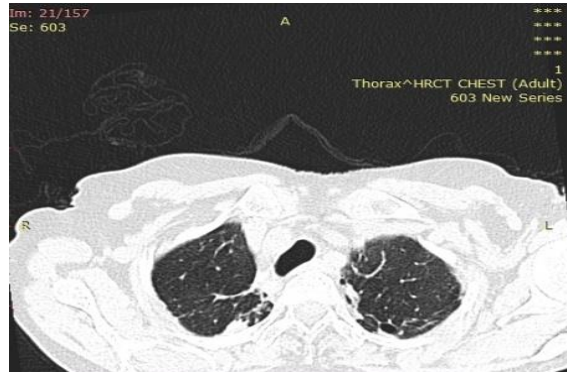
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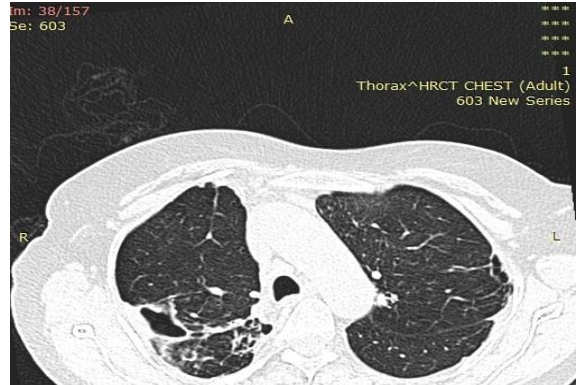
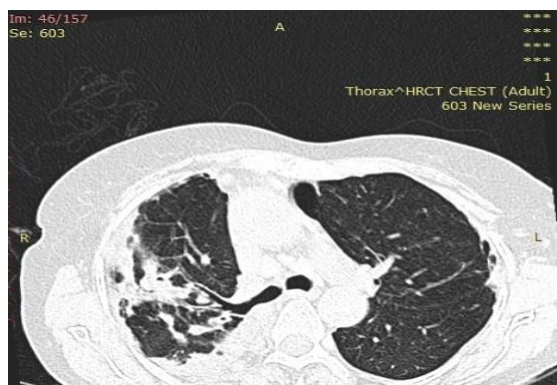
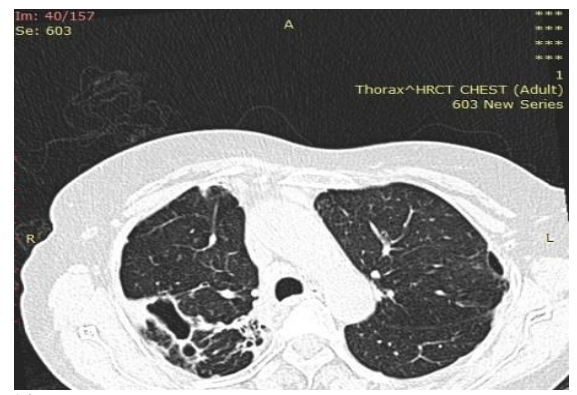
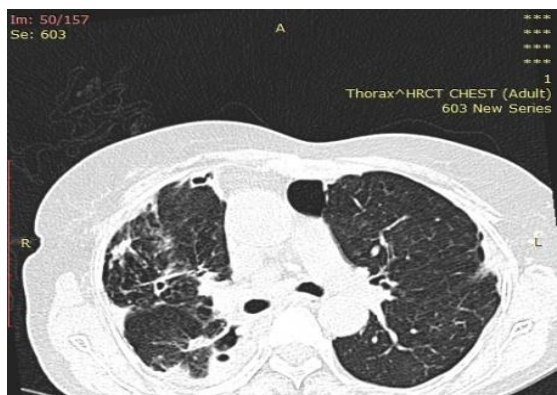
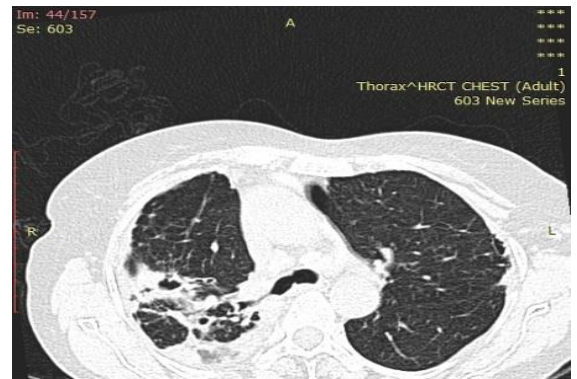
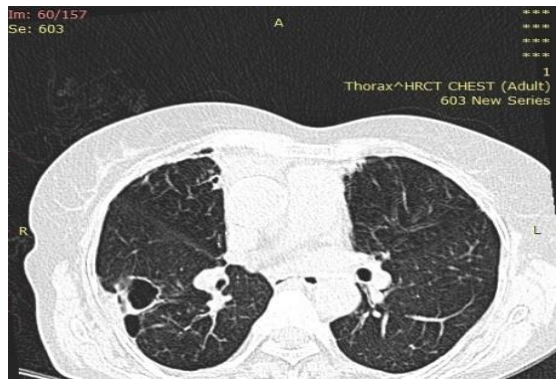
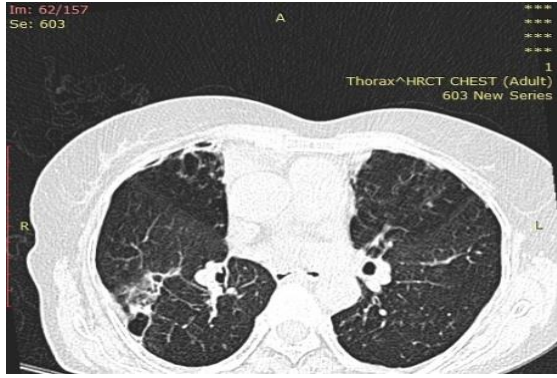
### 3.1. HRCT: KOCH'S ETIOLOGY

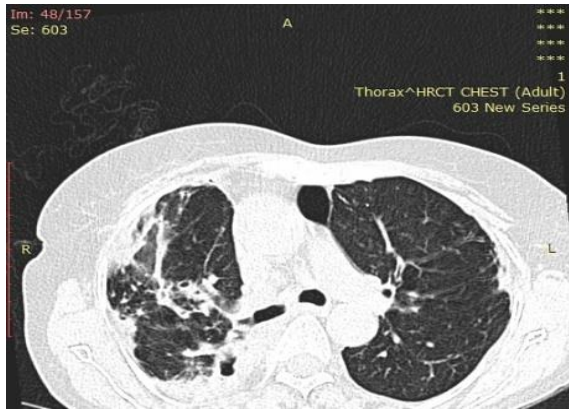
- A thick-walled cavity was seen in the right upper lobe, predominantly in the anterior segment of the right upper lobe, and bronchiectatic changes were seen in the left upper lobe.
- Few reticulonodular opacities and paraseptal emphysema were noted in the b/l upper lobe.

3.1.1. Case 2

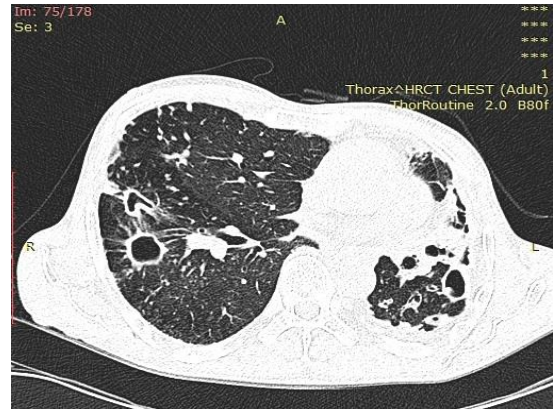
A 62-year female patient visited our hospital in pulmonary OPD with a history of evening rise of temperature and chest discomfort with complaints of cough and yellow sputum for 2 months. On clinical examination, her ESR was found to be raised. She complained of shortness of breath on exertion and fatigue for 1 month. One week ago, she noticed blood in her sputum. On clinical examination, her Hb was 8gm/dl.



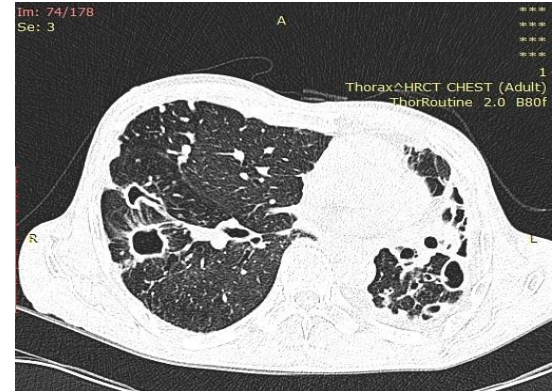




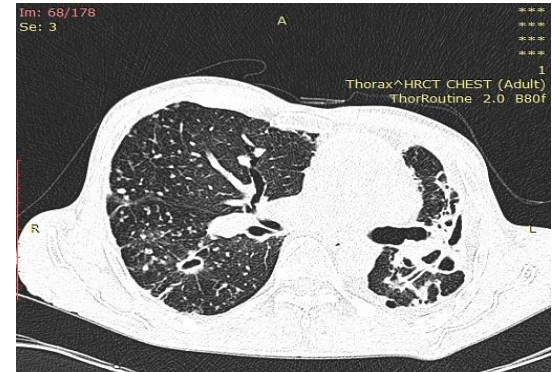
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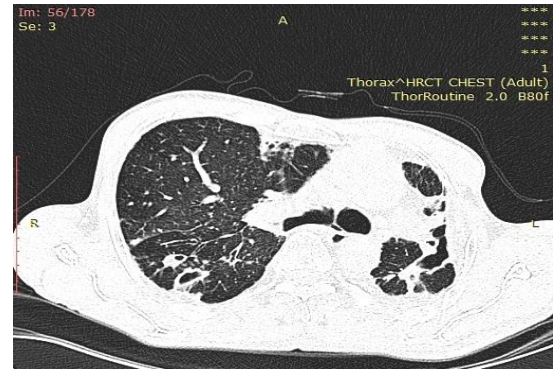
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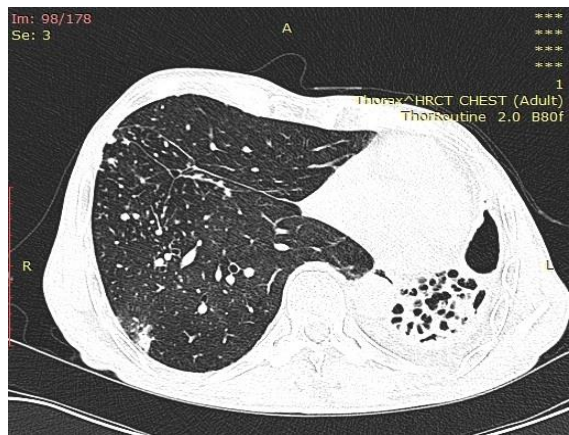
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### 3.2. HRCT: Acute on Chronic Infective Etiology

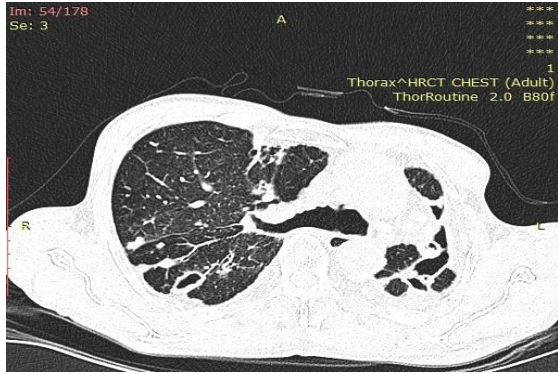
- Fibrocavitary with traction bronchiectatic changes noted at the posterior segment of the right upper lobe, apical and anterior segment of the left upper lobe, and superior segment of the right lower lobe.
- Paraseptal emphysema in B/L apical and paracardiac regions.
- Centrilobular nodules in B/L hemithorax predominantly in the B/L upper lobe and superior segment of the right lower lobe.

#### 3.2.1. Case 3

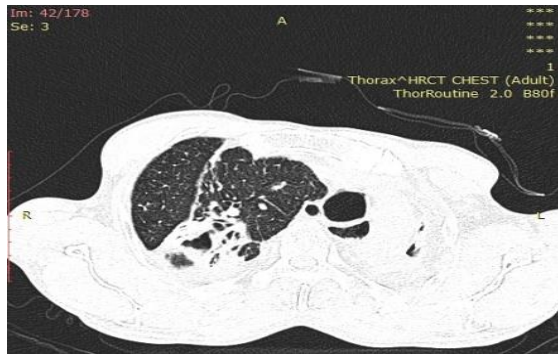
A 67-year male patient came to our hospital in medicine OPD with a history of body weakness and decreased body weight. He complained of a cough with yellow sputum and breathlessness for the last 4 months. He had a history of hemoptysis and fever for the last week. On clinical examination, his Hb was 8gm/dl.



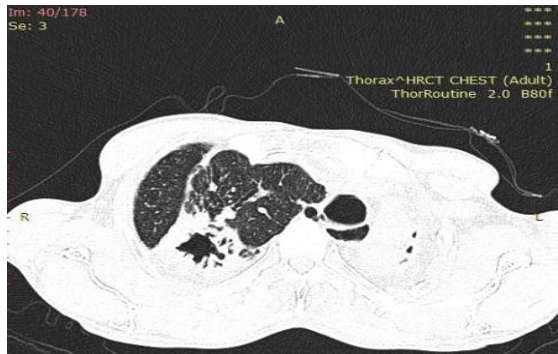
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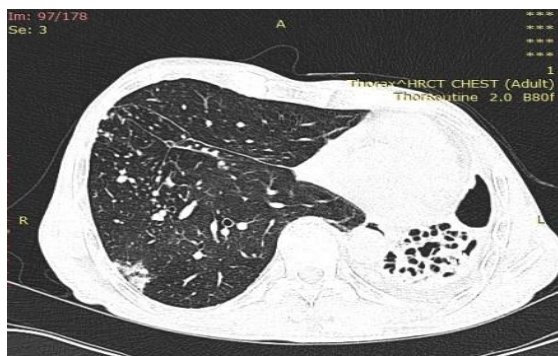
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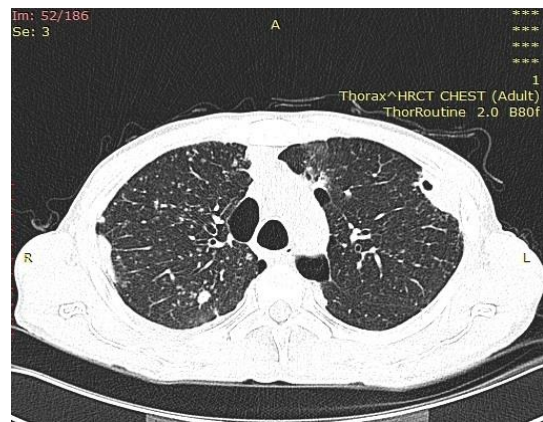
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### 3.3. HRCT: Chronic TB with active disease

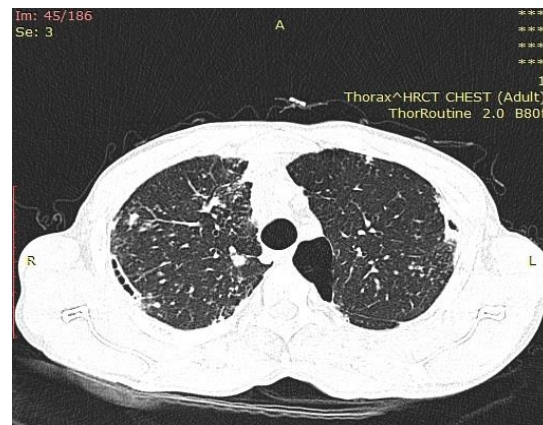
- Left lung volume is reduced.
- Fibrocalcific atelectatic bands with few bronchi communicating cavities were noted at the posterior segment of the right upper lobe, visualized left lung fields, and lateral basal and superior segments of the right lower lobe.
- Bronchiectatic changes in visualized left lung fields.
- Centrilobular nodules with adjacent patchy GGOs were seen at the lateral basal segment of the right lower lobe and medial segment of the middle lobe.
- The mediastinum and trachea shifted to the left side.

#### 3.3.1. Case 4

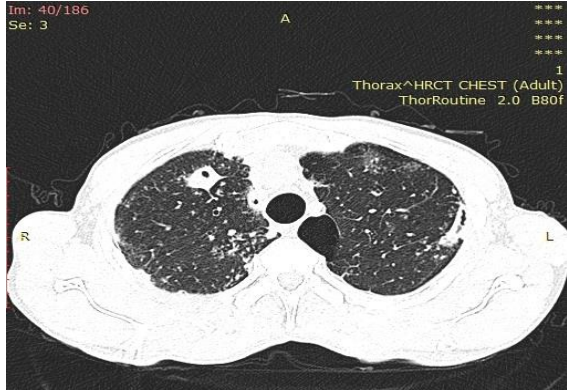
A 55-year male patient presented to our hospital in the emergency department with a history of cough with sputum and shortness of breath on exertion for the last 2 months. He was a smoker. He had symptoms of weight loss, low-grade fever and fatigue.



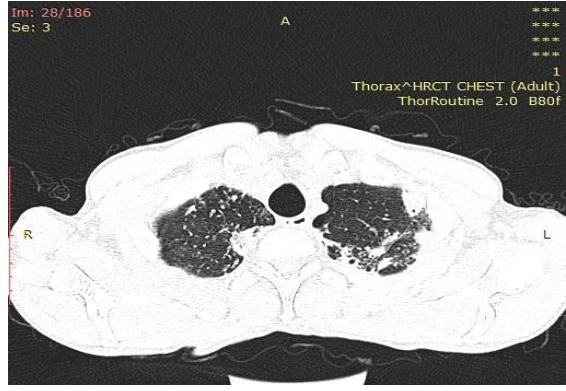
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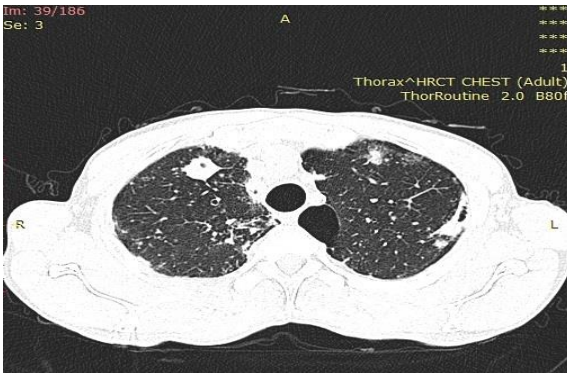
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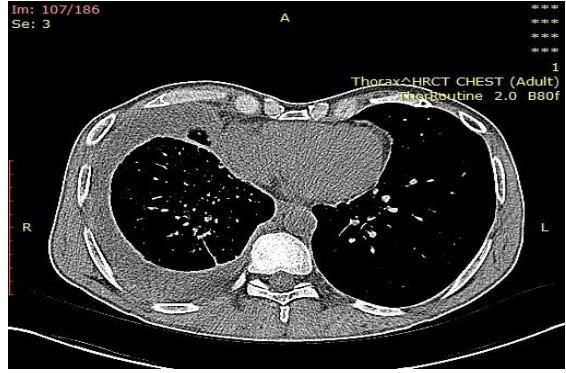
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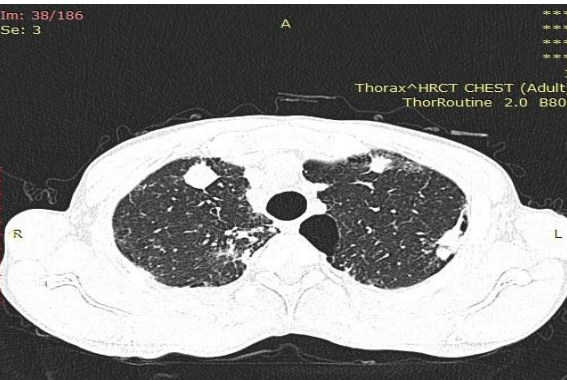
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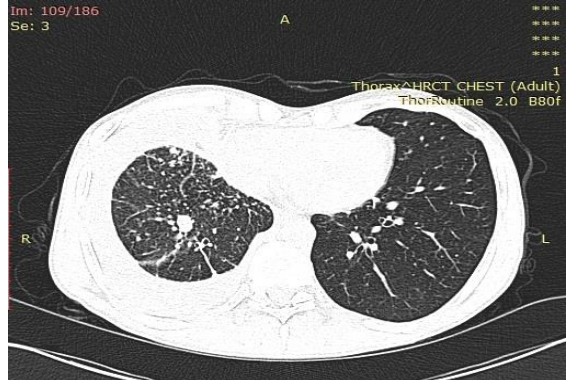
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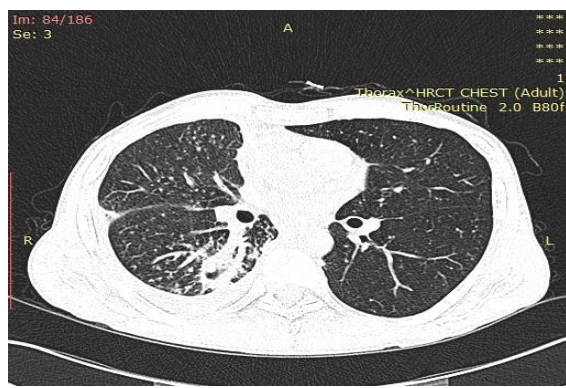
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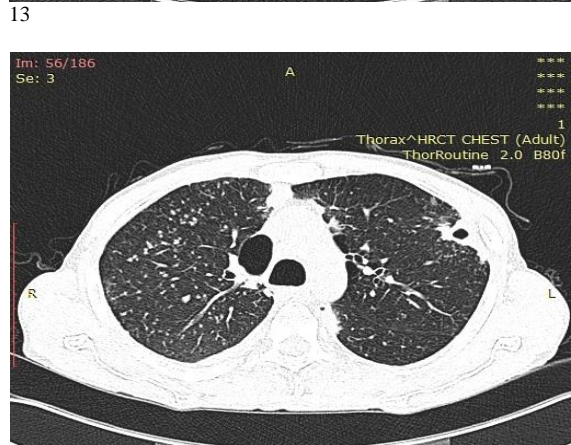
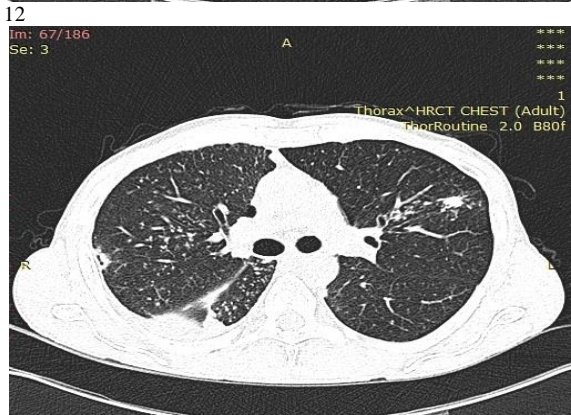
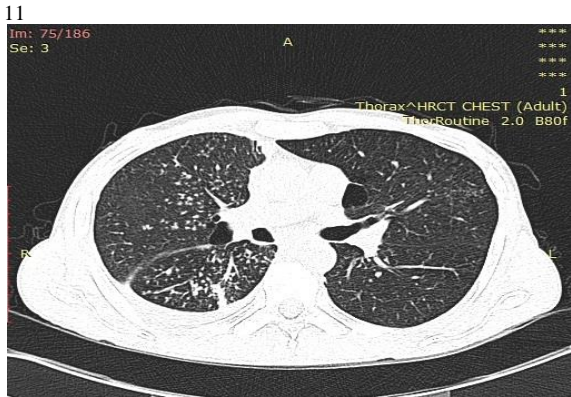
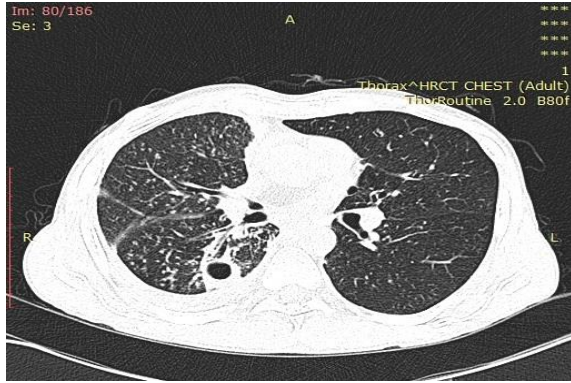


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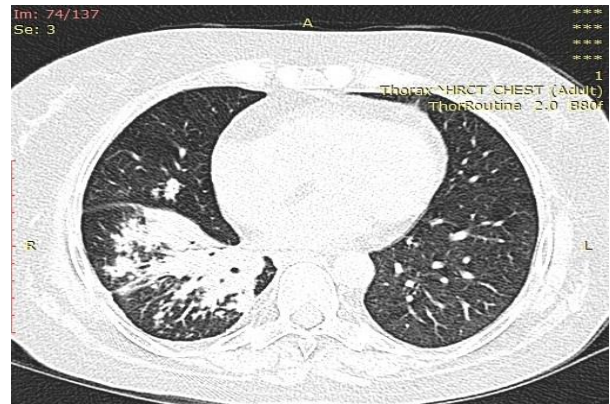
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### 3.4. HRCT: Chronic Infective Etiology Likely KOCH'S With Endobronchial Spread

- The right lung shows mild volume loss.
- Moderate right pleural effusion with adjacent passive atelectasis.
- Reticulonodular opacities are seen in b/l hemithorax predominantly in peri broncho vascular distribution - some of these showing tree in bud appearance s/o endobronchial spread.
- Scattered multiple patchy areas of consolidation and thick-walled cavities were seen in the right hemithorax and left upper lobe in subpleural and peri bronchovascular distribution.
- Emphysematous changes in b/l upper lobes.

#### 3.4.1. Case 5

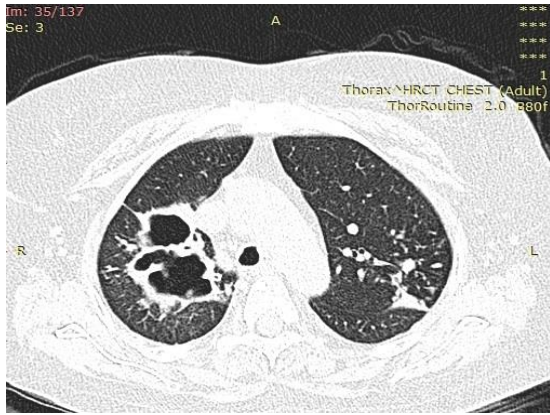
A 60-year female patient presented to our hospital in medicine OPD complaining of breathlessness with night sweats and fatigue for the last one month. She complained of chest pain, fever and cough with yellow sputum for 1 month. Two weeks ago, she noticed blood in her sputum. On clinical examination, her Hb was 7gm/dl.



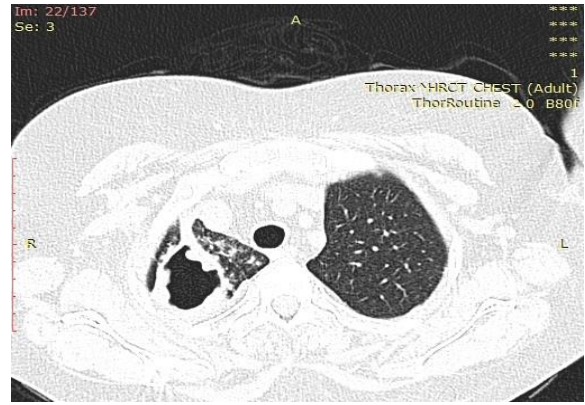
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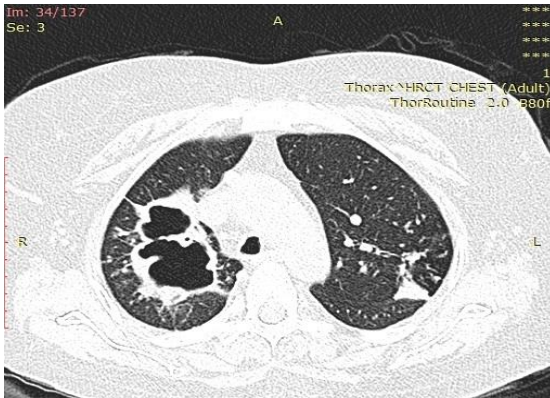
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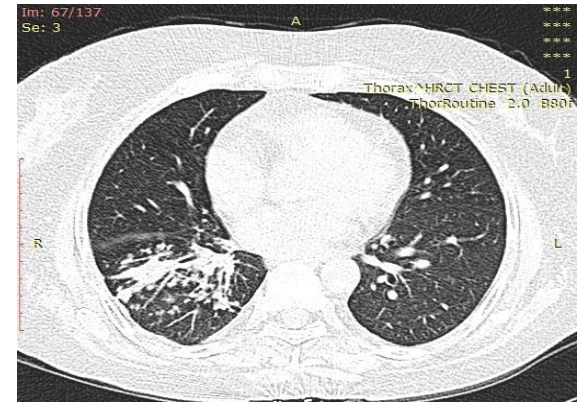
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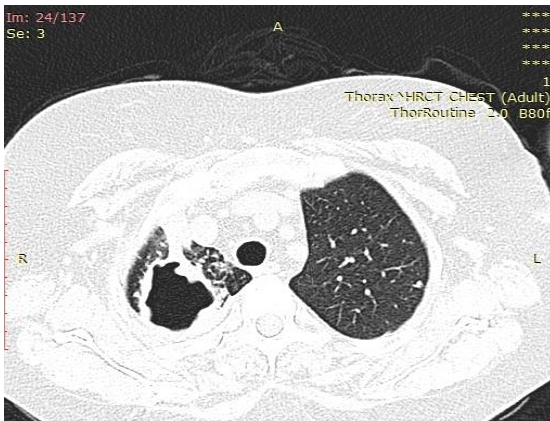
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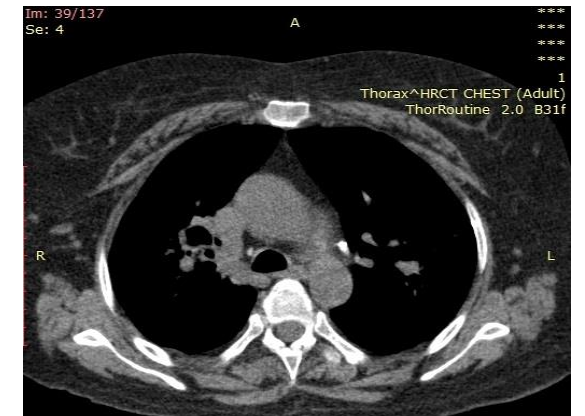
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### 3.5. HRCT: KOCH'S With Active Disease

- A cavitary lesion was seen in the right upper lobe with surrounding reticulonodular infiltrates.
- Air space opacity with surrounding reticulonodular infiltrates in the left upper lobe.
- Reticulonodular infiltrates in peri-bronchovascular location in the right lower lobe with consolidation.
- Few infiltrates in lingular segments and the left lower lobe.
- Few calcified mediastinal lymph nodes.

#### 4. Discussion

Hence, HRCT is of immense use in detecting and diagnosing pulmonary TB. HRCT is the most reliable and highly recommended investigation to distinguish active from inactive disease. It gives better resolution to a larger extent for subtle areas of consolidation, tree in the bud

(centrilobular nodules), cavitation, miliary and bronchogenic spread of disease than chest radiography. Early treatment and fair decisions can be implemented to prevent the disease's spread. Proper results envisage chalking out possible remedies.

HRCT FINDINGS IN PULMONARY TB PATIENTS	TOTAL NO. OF PATIENTS (N= 50)
<b>Cavitation</b>	39
<b>Tree-in-bud opacities</b>	44
<b>Ground glass opacities</b>	37
<b>Consolidation</b>	38
<b>Mediastinal lymphadenopathy</b>	35
<b>Pleural effusion/Empyema</b>	27

HRCT is recommended modality only when the chest radiographic findings are established as inconclusive and inconsistent for speedy detection and confirmation of diagnosis.

#### 5. Conclusion

High-resolution computed tomography (HRCT) of the lung enables a detailed display and appreciation of the lung parenchyma, which is employed to evaluate ACTIVE from INACTIVE TB and achieve a detailed morphologic and comparative view of minute anatomical structures. HRCT can facilitate formulating a differential diagnosis and establishing the pattern and distribution of disease. HRCT is the most reliable investigation of parenchymal abnormalities to its maximum extent. Tree-in-bud appearance

(endobronchial spread) and cavitation suggest active disease, whereas fibrosis and traction bronchiectasis, pleural thickening and calcified granuloma are indicators of inactive disease. CT scan has been considered the modality of choice for early detection of pulmonary TB, therefore establishing a presumptive way for confirmation of diagnosis due to better resolution, authenticity and terrific speed.

Tuberculosis is considered one of India's leading causes of mortality among infectious diseases. It facilitates early detection of the initial alteration of pulmonary TB. It thus enables the prevention, dissemination and management of this particular disease, which has been considered a dreadful health hazard.

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