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Role of Chest X-Ray and HRCT thorax in Diagnosis of Pulmonary Diseases in PLWH Patient

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Abstract: ***The pulmonary manifestations of HIV remain a major cause of morbidity and mortality. Most patients develop a pulmonary complication during the history of HIV infection, mainly of infectious etiology include-Mycobacterium tuberculosis (TB), Pneumocystis carinii (PCP), cytomegalovirus (CMV), other bacterial infection etc. Respiratory infections, especially tuberculosis (TB), are leading causes of illness and death in India. Plain chest radiography is an initial imaging study for an HIV infected patient with suspected pulmonary infection. However, Chest X-ray is normal in many of these patients. High resolution CT of thorax provide a more accurate diagnosis, allowing clarification of findings identified or not identified on plain radiograph, determination of the extent and radiographic pattern of disease; evaluation of the mediastinum. Methods: In our study we included 47 patients who came during the study period. After a detailed clinical work up in pulmonary or medicine department, both chest X-ray and HRCT thorax done in our radiology department. The finding of chest and x-ray and HRCT thorax are analysed and compared and the final result is tabulated. Result: The final result obtained after comparing the finding of Chest X-ray and HRCT thorax, it is found that HRCT was able to detect more abnormalities than conventional chest X-ray in the diagnosis of various parenchymal lung diseases and there is significant statistical difference between finding of plain chest X-ray and finding of HRCT thorax. Interpretation and conclusion: It is found that HRCT is better modality of investigation than conventional chest radiography in the detailed diagnosis of parenchymal lung diseases. HRCT was able to detect abnormalities even in cases when the chest radiograph was normal indicating higher sensitivity and specificity of HRCT in diagnosis of parenchymal lung disease.***

Keywords: PLWH, HRCT, Chest, X-Ray, Tuberculosis

1. Introduction

Respiratory symptoms are a frequent complaint among HIV-infected individuals and are often the initial clinical manifestation of HIV infection[1]. They may be caused by a wide spectrum of illnesses which includes both HIV-related and non-HIV-related conditions. The opportunistic infections has a characteristic clinical and radiographic presentation [2, 3].

Tuberculosis is one of the most common complications associated with HIV worldwide and AIDS complicated by tuberculosis is becoming increasingly common.[6]

HIV is the most important risk factor for tuberculosis[8]. The risk of developing TB is estimated to be between 20-37 times greater in people living with HIV than among those without HIV infection. TB is a leading cause of morbidity and mortality among people living with HIV. In 2009, there were 9.4 million new cases of TB, of which 1.2 (13%) million were among people living with HIV. Of the 1.7 million people who died of TB, 400, 000 (24%) were living with HIV [9].

About 90% of those infected with tuberculosis have asymptomatic, latent TB infections (sometimes called LTBI), with only a 10% life-time chance that the latent infection will progress to overt, active tuberculous disease [12] [13]. The primary site of infection in the lungs, known as the "Ghon focus", is generally located in either the upper part of the lower lobe, or the lower part of the upper lobe [14]. Tuberculosis of the lungs may also occur via infection from the blood stream. This is known as a Simon focus and is typically found in the top of the lung [15].

AIDS promotes progression from latent to active disease in co-infected patients and in co-infected individuals, active tuberculosis development index is 10 to 30 times higher than in individual infected by Mycobacterium tuberculosis alone.[17]

The risk of disseminated tuberculosis increases in patients with AIDS due to advanced level of immunosuppression.

Symptoms and signs of these patients are often non-specific and similar to other opportunistic infections or malignant tutors such as lymphomas. Therefore, radiology plays a significant role in shortening delays in diagnosis and should be performed as early as possible for the cases of tuberculosis suspected, especially in high-risk populations such as AIDS patients.2[0]

Imaging findings which suggest active TB include [21]:

- Consolidation: usually located in lung apices and/or superior segments of lower lobes. CT is more sensitive in detecting subtle and smaller consolidations.2[2]
- Thick-walled cavity [24]
- Cavity with air-fluid levels: indicator of superimposed bacterial or fungal infection [25]
- Acinar/centrilobular nodules (bronchogenic spread):
- Clustered nodules:
- Miliary nodules: Small (1-3 mm), well-defined, randomly distributed nodules that indicate hematogenous spread of infection. These may be inconspicuous on radiographs and evident only on HRCT.2[8]
- Rim-enhancing LNs: Enlarged LNs (short axis dimension >1 cm) with peripheral rim enhancement and central low attenuation suggest active disease, while homogeneous and calcified nodes represent inactive disease.2[9]
- Pleural effusion or empyema:

Miliary pattern on chest radiograph the hall mark of miliary TB, is seen in a majority of patients. The classical miliary pattern on the chest radiograph represents summation of

densities of the tubercles that are perfectly aligned and imperfectly aligned tubercles result in curvilinear densities and a reticulonodular pattern.3[1]

Pneumocystis jirovecii pneumonia (PCP) is one of the most frequent opportuni1stic infections and remains one of the leading causes of morbidity and mortality in HIV patients [32] and patients with impaired cell-mediated immunity.

Chest X-ray findings of HIV patients with PCP include central perihilar Infiltrates, patchy infiltrates, consolidation and hilar lymphadenopathy.3[7]

Chest radiographs are initially normal in up to a quarter of patients with PCP.3[9] The chest radiograph typically demonstrates perihilar infiltrates in mild disease and bilateral, symmetrical interstitial infiltrates emanating from the hila in a butterfly pattern in severe disease. Less frequently, PCP may present with unilateral or asymmetrical opacities.4[0]

Thin-walled cysts or pneumatoceles are seen in 10–20% of cases. Pneumothorax can occur; in fact, suspicion of PCP should increase when pneumothorax is observed in a patient with HIV infection.4[1 42]

High-resolution computed tomography (HRCT) has a high sensitivity for PCP (100%) and a specificity of 89%. A negative HRCT may allow exclusion of PCP.

HIV-related PCP can progress rapidly and can be severe and lethal, but it progresses more slowly than PCP in other immune compromised hosts. Both groups, however, had poor survival.

Non-tuberculous mycobacterial infection, is an important cause of morbidity and mortality in immunocompromised patients, particularly in AIDS patients.[43]

Streptococcus pneumoniae and Haemophilus pneumonia are the common pathogens.

Haemophilus influenzae accounts for 10–15% of cases of bacterial pneumonia with aetiological diagnosis. It mainly affects patients with advanced HIV disease, and a subacute clinical presentation has been observed in ∼30% of cases. More than half of patients have bilateral lung infiltrates [45].

S. aureus is the third most frequent cause of bacterial pneumonia.4[6]

Other uncommon infections include *Rhodococcus* and *Nocardia*. Pneumonia due to *Mycoplasma pneumoniae* and *Chlamydia pneumoniae* appears to be relatively uncommon in patients with HIV infection [49].

The clinical presentation of bacterial pneumonia in HIV-seropositive patients is usually similar to that of patients not infected with HIV. Bacteraemia is frequently associated with bacterial pneumonia.

The most common chest roentgenographic manifestation is unilateral segmental or lobar consolidation, although diffuse reticulonodular infiltrates and patchy lobar infiltrates may also be identified. A subset of persons with *H. influenzae* pneumonia present with bilateral infiltrates that are indistinguishable from PCP. However, pneumonia due to *P. aeruginosa* or *S. aureus* is often associated with cavitation.5[0]

The typical radiographic appearance of bacterial pneumonia CXR in AIDS is the same as that in an immune competent host with lobar or segmental consolidation but progressing rapidly, with frequent multilobar or bilateral disease. Parapneumonic effusions and empyema are common. Cavitation may occur particularly with septic emboli and gram-negative infection.[51]

Fungal infections account for a large number of AIDS-index diagnoses and complicate the course of most patients with HIV disease.

Aspergillus can cause a broad spectrum of pulmonary diseases, usually occurring in patients who have pre-existing lung disease or some degree of immunologic abnormality, either hypersensitivity or immunosuppression[54].

The most common opportunistic fungal infection in HIV positive patients is candidiasis, affecting the mucocutaneous system mainly but the invasive form is also common[55]. Several Candida species are implicated in candidiasis. Although *C. albicans* remains the most common species responsible for candidiasis, disease due to newer species like C. *dubliniensis* are also increasing [56].

On chest X-ray, pulmonary candidiasis has been observed as bilateral bronchopulmonary infiltrates, a large cavitation and even pulmonary abscess.

Infection with Cryptococcus neoformans is the most commonly encountered deep-seated fungal infection in AIDS and represents a major threat to HIV-infected people worldwide[57].

Viral infections are rare and are associated with marked immunosuppression. Influenza is a common cause of respiratory illness in adults with HIV.6[5] Cytomegalovirus (CMV) as a pulmonary pathogen in HIV-infected patients is often unclear. Retinitis and gastrointestinal disease are the most common manifestations, but pneumonitis is infrequent.6[6]

Aims and Objectives

1) To study the role of chest X-ray and HRCT thorax in diagnosis of pulmonary diseases in PLHIV patient
2) To identify the extent of the involvement of lungs among the study participants through chest X-ray and HRCT.
3) To compare the Chest X-ray and HRCT thorax in diagnosis of pulmonary diseases among PLHIV patient.

2. Review of Literature

Im et al[69] described HRCT findings in 41 patients who had newly diagnosed TB (29 patients), and recent activation of disease (12 patients). In 29 patients with newly diagnosed active disease, the HRCT findings included, centrilobular

nodules or branching linear structures in 19%, bronchial wall thickening in 79%, tree in bud appearance in 72%, poorly defined nodules in 69%, cavitatory nodules or consolidation in 66%, thickening of interlobular septa in 34%, bronchovascular distortion in 17% and fibrotic bands in 17%. In 12 patients with history of treated TB, along with above findings was found bronchovascular distortion (58%), bronchiectasis (58%), emphysema (50%) and fibrotic bands.

In 2014, Xiangpeng Zheng, Guozhen Zhang [70] showed that immunocompromised patients are subject to a variety of infectious pathogens involving lungs and that imaging examination of pulmonary conditions could provide valuable information for differential diagnosis, treatment assessment as well as prognostic prediction. Advancement in imaging techniques further improve diagnosis accuracy and timely management, thereby reducing the mortality and morbidity from respiratory diseases.

In 2015, Feng Feng et al.7[1] found out that AIDS complicated by tuberculosis was becoming increasingly common. Disseminated tuberculosis in AIDS patients involved multiple sites. The radiological characteristics of disseminated tuberculosis in AIDS patients includes miliary pattern in the lung with or without those in liver or spleen, widespread lymphadenopathy with dominant distribution and rim enhancement, tuberculoma or abscess with rim enhancement in multiple sites. They councluded that knowledge about its various radiological features can aid the early accurate diagnosis and proper treatment to reduce mortality of disseminated tuberculosis in AIDS.

Lee et al.7[2] have investigated the usefulness of computed tomography (CT) in the differentiation between active and inactive tuberculosis.

Pereira et al.7[3] have described the computed tomographic findings of primary pulmonary tuberculosis initially manifested as lobar consolidation. In 89 patients with active tuberculosis evaluated with thin slice CT, the following findings were most frequently observed: centrilobular linear opacities (92%), lobular consolidation (62%), acinar nodule (61%), cavity (36%) and ground glass opacity (35%).

In another study by Hatipoglu et al.7[4] thin-slice CT, “tree-in-bud” pattern, nodules of up to 8 mm in diameter and consolidations were frequently found in patients with active disease and in none of the patients with inactive disease.

In a study by Lanamar Aparecida de Almeida et al.7[5], the main findings in tuberculosis in AIDS patients were the following:
Mediastinal and/or hilar lymph node enlargement, pleural effusion, centrilobular nodules with segmental distribution and consolidation. The mediastinal/hilar lymph node enlargement and consolidation were significantly more frequent in patients with CD4 count =200 cell/mm^3

In 2015, Xiao Yu et al.7[6] concluded that pulmonary cryptococcosis is one of the most common opportunistic fungal infections in patients with AIDS/HIV and that AIDS related PC is more serious than other pulmonary fungal infections. HIV/AIDS complicated by PC is radiologically characterized by diffuse interstitial infiltrates in both lungs, which resembles PCP. In addition, unilateral pulmonary interstitial infiltrates, focal consolidation, nodules, cavity, pleural effusion as well as mediastinal and hilar lymphadenectasis may also be demonstrated.

In 2015, Mingyue Wang et al.7[7] described the imaging manifestations of caseous pulmonary tuberculosis in patients with type-II diabetes mellitus and showed that X-ray shows big flake and multiple small pieces of integration high-density shadows with edge blur and lightness.

CT showed irregular regiment massive increase with no enhancement and revealed a number of small hollows and obvious air bronchogram in the lesions.

In 2016, a study by Lukas Ebner et al.7[8] found that *Pneumocystis jirovecii* pneumonia (PCP) was a frequent opportunistic infection in immunocompromised patients.

The study was conducted with forty patients: 16 with HIV and 24 renal transplantations. Radiologically, HIV patients had significantly more areas of diffuse lung affection (81% HIV vs.25% RTR; p = 0.02), more ground glass nodules 5±10 mm (69% vs.4%; p = <0.001) and enlarged hilar lymph nodes were found only in HIV patients (44%). Cough and dyspnea were the most common clinical signs (>80%) in both groups. Duration from illness onset to hospital presentation was longer in the HIV patients (median of 18 vs.10 days (p = 0.02)).

Jeffrey P. Kanne et al.7[9] in their study concluded that High-resolution CT can be indicated for evaluation of immunosuppressed patients with suspected pneumonia and normal chest radiographic findings.

In 2018, Sanjay Kumar et al.8[0] concluded that HRCT was a very sensitive tool for detection and characterization of lung parenchymal changes that helped clinicians develop a focussed approach in patient management. They found that 54% patients in their study were diagnosed as having pulmonary TB followed by fungal infection (including PJP and cryptococcosis) and interstitial lung disease (including BOOP, UIP), while 18% of participants did not reveal any significant abnormality. Bacterial pneumonia, bronchiolitis obliterans, Kaposi sarcoma, and pulmonary thromboembolism were found in 1.6% of patients each.

Study by Mathieson et al [81] in 1989, compared the accuracies of chest radiography and computed tomography (CT) in the prediction of specific diagnoses in 118 consecutive patients with chronic diffuse infiltrative lung disease (DILD). The radiographs and CT scans were independently assessed by three observers without knowledge of clinical or pathologic data. The observers listed the three most likely diagnoses in order of probability and recorded the degree of confidence they felt in their first-choice diagnosis on a three-point scale. Confidence level 1 (definite) was reached with 23% of radiographic and 49% of CT scan readings, and the correct diagnosis was made with 77% and 93% of those readings, respectively (P less than.001). The correct first-choice diagnosis regardless of

the level of confidence was made with 57% of radiographic and 76% of CT scan readings (P less than.001).

In study by Padley et al in 1991 [82], One hundred individuals who had undergone both high resolution computed tomography (HRCT) and chest radiography were studied to determine the accuracy of each technique in establishing the diagnosis of diffuse lung disease. The group consisted of 86 patients with a diagnosis of a chronic diffuse infiltrative lung disease and 14 normal subjects. Two independent observers assessed the HRCT examinations and chest radiographs and recorded the three most likely diagnoses. Overall a confident diagnosis was reached more often with HRCT (49%) than with chest radiography (41%). The diagnoses were correct in 82% of HRCT examinations and 69% of chest radiographs. Diagnoses made on HRCT, irrespective of the degree of certainty, were accurate more often than diagnoses made on chest radiography (56% and 47% respectively). Of the patients thought to have a normal chest radiograph, 42% had parenchymal lung diseases. Of the patients thought to be normal on HRCT, 18% had parenchymal lung diseases.

Conversely, normal subjects were correctly identified as such in 82% of chest radiographs and in 96% of HRCT examinations. This study emphasizes the important role of CT in helping to confirm or refute the presence of abnormality when the chest radiograph is normal or questionably abnormal, and underlines the superior diagnostic accuracy of HRCT compared with conventional chest radiography in parenchymal lung diseases.

Grenier et al in 1991 [83] assessed the diagnostic value of chest radiography and high-resolution computed tomography (HRCT) in parenchymal lung diseases in 140 consecutive patients with diffuse infiltration of the lung visible at radiography. Radiographs and HRCT scans were separately read by three independent observers without knowledge of clinical and pathologic data. The observers listed the three most likely diagnoses and recorded the degree of confidence they had in their choice on a 0%-100% probability scale. Findings at radiography and high-resolution HRCT were recorded by each observer and were used for a stepwise Page 6 discriminant analysis between diagnoses. First-choice diagnoses of all three observers that were made with a high level of confidence (probability, greater than or equal to 75%) were more accurate with HRCT than with radiography (P less than.001). The interobserver agreement for the proposed diagnosis was significantly better with high-resolution CT (P less than.001). Twenty-one of 26 radiographic findings and 21 of 25 HRCT findings were discriminant. Stepwise discriminant analysis revealed the superiority of HRCT over radiography, since the ranking of all findings showed that the four most discriminant findings, and eight of the first 12 findings, were revealed with HRCT.

Several studies have subsequently confirmed the superior performance of HRCT in a variety of diffuse lung diseases[84, 85]

Kuhlman et al [86] reviewed 39 patients with PCP to determine the spectrum and frequency of CT manifestations of PCP. Three basic CT patterns were identified a) ground glass pattern (26%) which is bilateral, symmetric, diffuse air space involvement of lung b) patchwork pattern (56%) with mosaic appearance due to bilateral, asymmetric, patchy, involvement with segmental and sub segmental sparing and c) interstitial pattern (18%) with bilaterally increased reticular markings. Atypical CT findings included cystic spaces, bullae, pneumothorax, lymphadenopathy, pleural effusion, centrilobular nodules or opacities. Similar findings were also seen in a study by Boiselle PM et al [87]

Mc Guinness G et al [88] described the “acute phase of PCP” as ground glass opacity or air space consolidation and attributed it to intra-alveolar exudates and alveolar septal thickening. The “subacute phase” is characterized by reticulation due to organization of intra-alveolar exudates producing interlobular and intralobular interstitial thickening.

Primack S L et al [89] in 1995 studied 77 immuno-compromised patients with culture proved pulmonary mycobacterium infection, 45 with pulmonary TB, 32 with mycobacterium avium intracellular (MAI) using HRCT. They found micro nodules, consolidation and cavity formation in similar frequency in both pulmonary TB and MAI. However they observed that interlobular septal thickening was more common in patients with TB and bronchiectasis more common in patients with MAI.

Hatipoglu et al [90] compared HRCT findings in 32 patients who had newly diagnosed active pulmonary TB and 34 patients who had inactive disease. HRCT findings included centrilobular nodules, linear branching opacities or both in 91%, tree in bud appearance in 71%, nodules 5 to 8 mm in diameter in 69% and consolidation in 44%. Cavitation was present in 50% patients with active disease and 12% patients with inactive disease.

Leung NL et al [91] reviewed CT scans and chest radiograph of 42 HIV seropositive and 42 HIV seronegative patients with pulmonary TB. Because of impaired host cell mediated response to MTB, HIV seropositive patients had lower prevalence to consolidation, cavitation and post primary pattern, and higher prevalence of miliary disease in comparison with seronegative patients. Seropositive patients had a higher prevalence of lymphadenopathy on chest radiographs. They concluded that HIV seropositive patients had a lower prevalence of localized parenchymal disease and higher prevalence of disseminated and extra pulmonary disease.

In 1998, Hong SH [92] et al reviewed 25 patients with proven miliary TB.24 of these patients showed miliary nodules measuring 1-3 mm in diameter and 5 mm in diameter in some cases. The nodules had a random distribution within the lung, without cephalo-caudal, central to peripheral or intralobular predominance. In all patients nodules were present in subpleural and perivascular regions. Other findings noted were ground glass opacities in 92%, interlobular septal thickening and intralobular reticulation in 11 patients, mediastinal lymphadenopathy in 32% and pleural effusion in 16% patients.

In a study by Garg K, Newell JD et al in 1994, [93] the HRCT findings of BO included focal, sharply defined areas of decreased lung attenuation, oligemia, and air rapping occurring in absence of parenchymal consolidation which was termed as "mosaic perfusion". HRCT findings were found to be similar regardless of cause of the disease.

A paper published by Greene et al., found that patients with invasive aspergillosis most commonly presented with one or more micronodules in 94% while halo sign was present in 61%. Other features at presentation were consolidation in 30%, infarct shaped nodules in 27%, cavitary lesion in 20% and air crescent sign in 10% patients.9[4]

An aspergilloma is most often associated with pre-existing cavities resulting from tuberculosis and variety of other diseases. On HRCT, there is presence of well defined homogenous nodular opacity with a thin or thick walled cavity associated with an "air crescent sign". The mycetoma may be seen to move if decubitus or prone scans are obtained[95].

Escuissato et [96] reviewed the HRCT findings in 111 consecutive haematopoietic stem cell transplantation recipients who had documented pulmonary infection and HRCT performed with 24 hours of the beginning of symptoms. Nodules that were 1 cm or more in diameter were seen in 62% of patients with fungal infection compared to 19% of patients with bacterial pneumonia, and 12% of patients with viral pneumonia. The halo sign was present in approximately 50% of patients with fungal infection, 18% of patients with bacterial pneumonia, and 10% of patients with viral pneumonia.

Approximately 85% of the fungal infections were due to Aspergillus and 15% due to Candida[97].

Swaminathan et al. examined [98] a total of 498 patients with TB and HIV co-infection were seen during the study period. Thirty-one (6.2%) patients met the criteria for miliary TB of whom 27 were males and four were females.

Pipavath S. N. J. et al.9[9] found on HRCT in 16 patients with miliary TB-miliary nodularity (16/16), alveolar lesions such as ground glass attenuation and/or consolidation (5/16), lymphadenopathy (8/16), peribronchovascular interstitial thickening (1/16), emphysema (1/16), pleural pathology (2/16), and pericardial effusion (2/16).

Radiographic Features of Pulmonary Diseases in Patients with HIV:

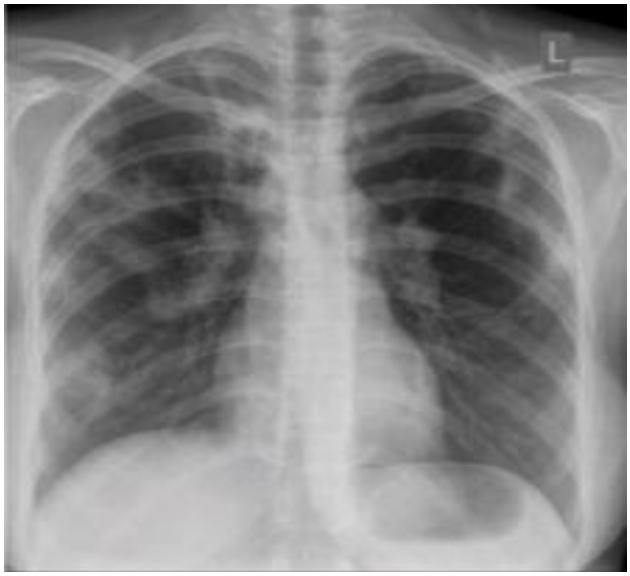
The conventional chest X-ray (CXR) is usually the first line investigation. Despite the variety of overlapping features, the CXR is accurate for diagnosing common complications. High-resolution computed tomography (HRCT) is both more sensitive and more accurate.

1. TUBERCULOSIS

a) Primary TB

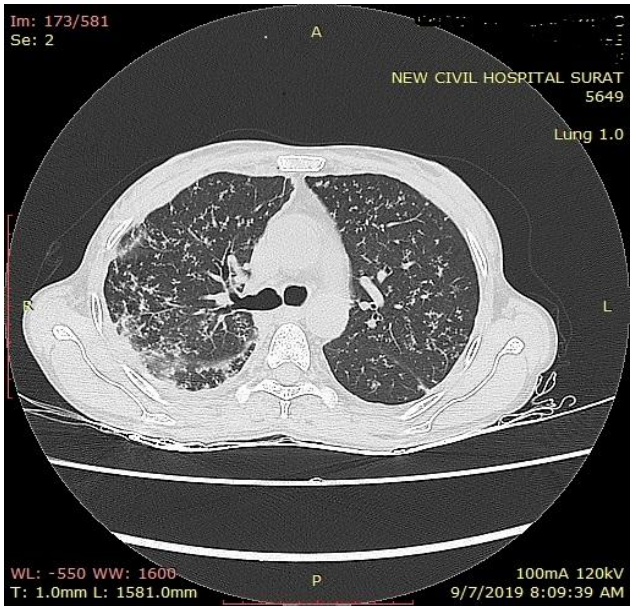
CHEST X RAY –

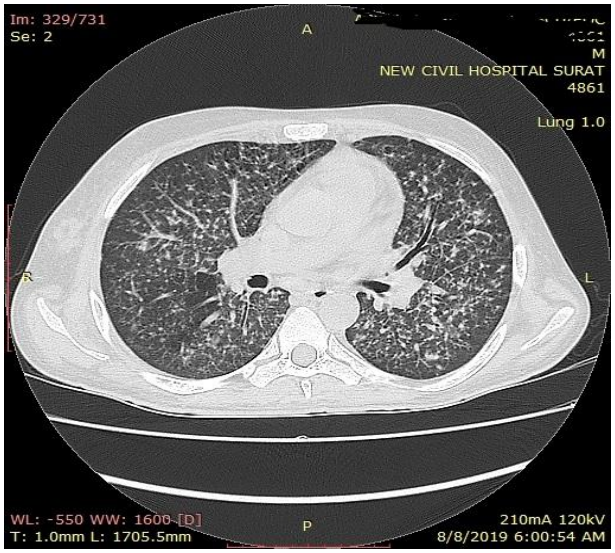
- Normal radiograph
- Consolidation
- Cavitation
- Segmental or lobar atelectasis
- Pleural effusion
- Hilar and mediastinal lymphadenopathy more in children
- Miliary disease



HRCT

- Dense homogenous consolidation in middle and lower lobes
- Lympadenopathy
- Pleural effusion
- Miliary disease



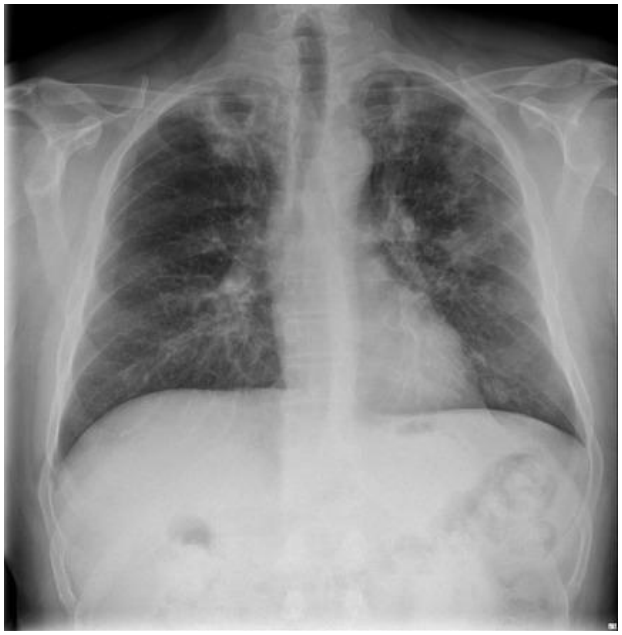


Miliary TB

b) Post-primary TB

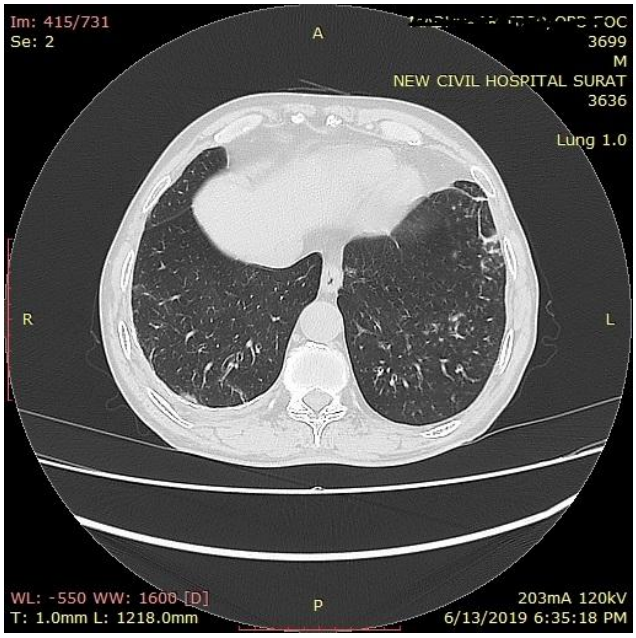
Chest X-ray

- Upper lobe predominance
- Patchy consolidation
- Streak opacities
- Ill-defined nodules between 5-10mm size
- Pleural effusion and pleural thickening
- Fibrosis



HRCT

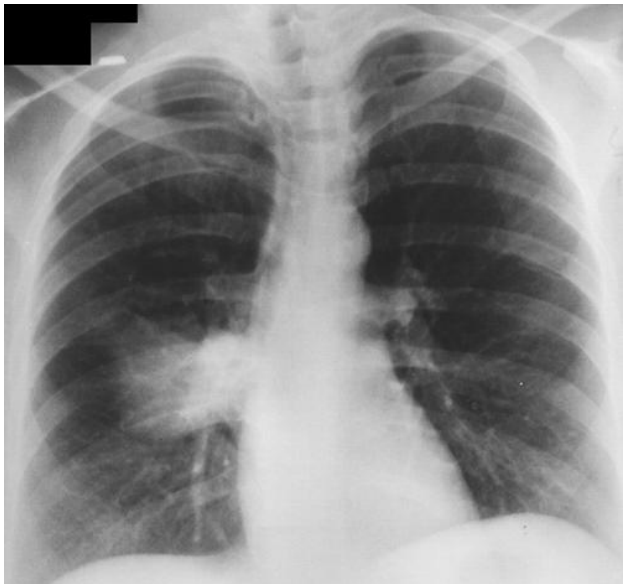
- Patchy peribronchial consolidation
- Cavitation
- Tree in bud appearance
- Miliary disease
- Pleural effusion and empyema
- Brancho-pleural fistula
- Hilar and mediastinal lymphadenopathy
- Reversed halo sign



2. Bacterial Pneumonia

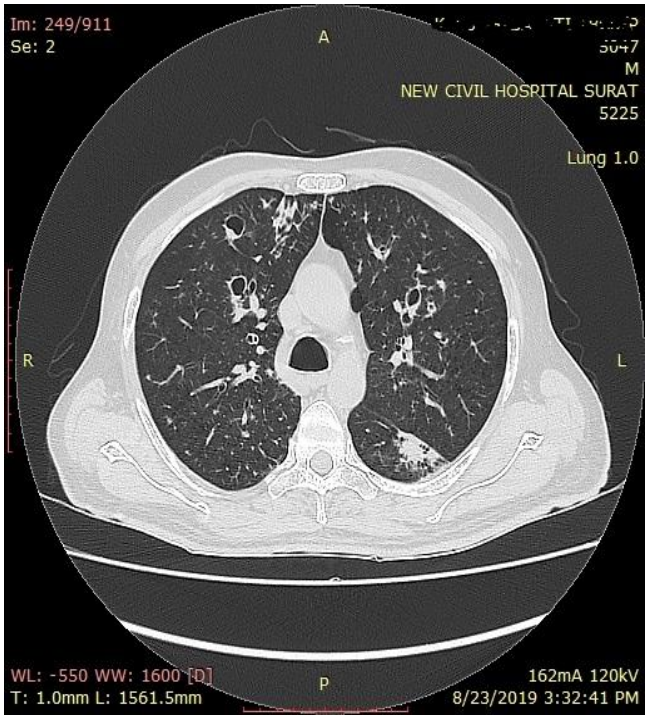
Chest X Ray:

- Focal consolidation, segmental or lobar distribution.
- Parapneumonic effusions and empyema.
- Cavitation



HRCT:

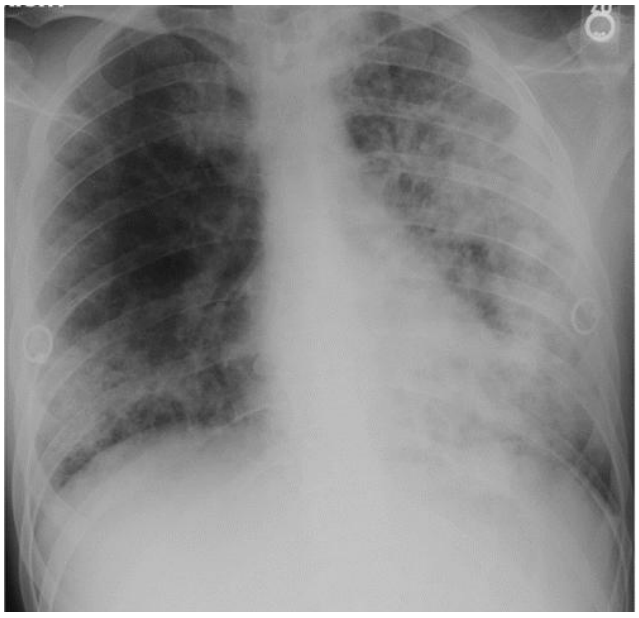
- Nodules, cavities, and pleural fluid collections
- Empyema and abscesses



3. Pneumocystis Carinii Pneumonia

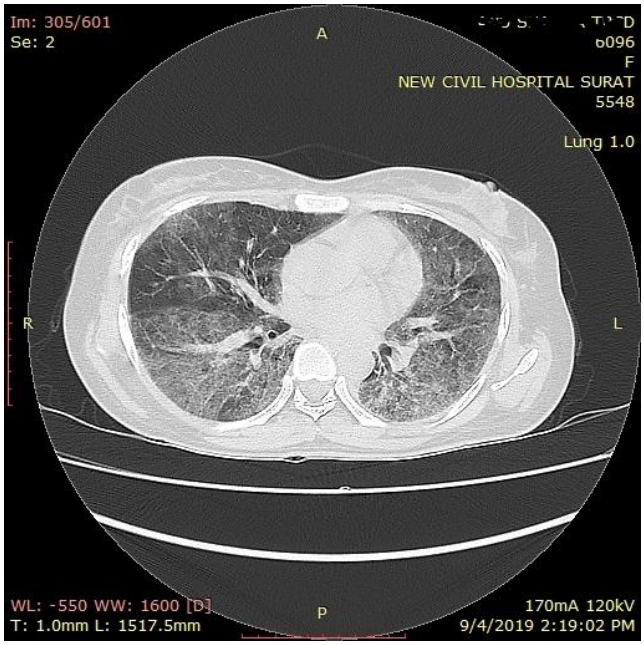
CHEST X-RAY

- Bilateral symmetric perihilar or diffuse interstitial opacification.
- Fine reticular or nodular opacities
- Consolidation
- Coarse reticular opacification and fibrosis (atypical).



HRCT

- Patchy or diffuse bilateral ground-glass opacity (hallmark)
- Central, peri-hilar or upper lobe predominance
- Thin walled, irregular, septated cavities; thin walled cysts
- Spontaneous pneumothorax
- Bronchiectasis and bronchiolectasis
- Consolidation
- Reticulation and septal thickening (resolving disease)
- Large nodules or masses (rare)



4. Fungal Infections

Aspergillosis is a mycotic disease caused by Aspergillus species, usually A. fumigatus. It causes a broad spectrum of pulmonary diseases and is frequently seen in immunocompromised patients.

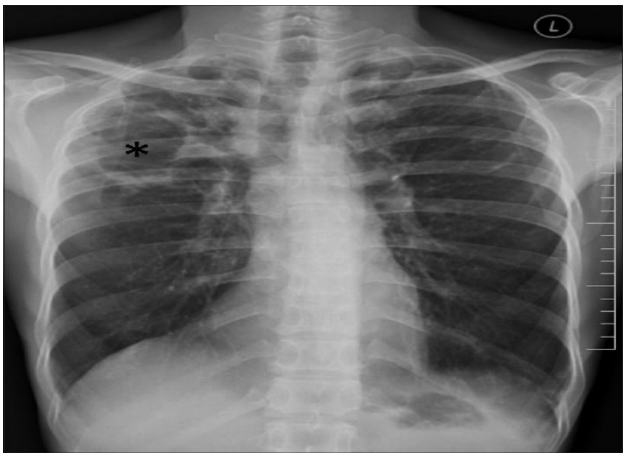
Pulmonary aspergillosis can be subdivided into five categories:

a) saprophytic aspergillosis (aspergilloma) – most common form
b) hypersensitivity reaction (allergic bronchopulmonary aspergillosis),
c) semi-invasive (chronic necrotizing) aspergillosis,
d) airway-invasive aspergillosis (acute tracheobronchitis, bronchiolitis, bronchopneumonia, obstructing bronchopulmonary aspergillosis),
e) angioinvasive aspergillosis.

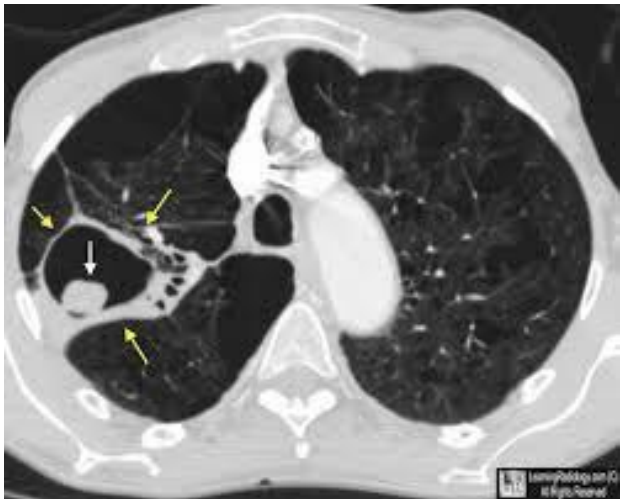
a) Aspergilloma

Chest X-ray

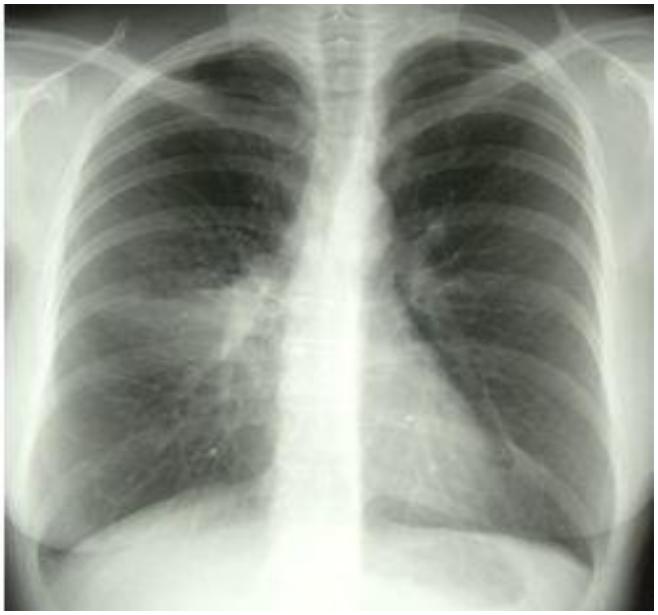
- Well defined, homogenous, nodular opacity within a lung cavity
- Air crescent sign



HRCT
- Central, rounded, soft tissue attenuating mass
- Surrounded by a crescent of air – Monod sign
- Mobile on positioning the patient
- Thickened adjacent pleura
- Markedly enlarged bronchial arteries

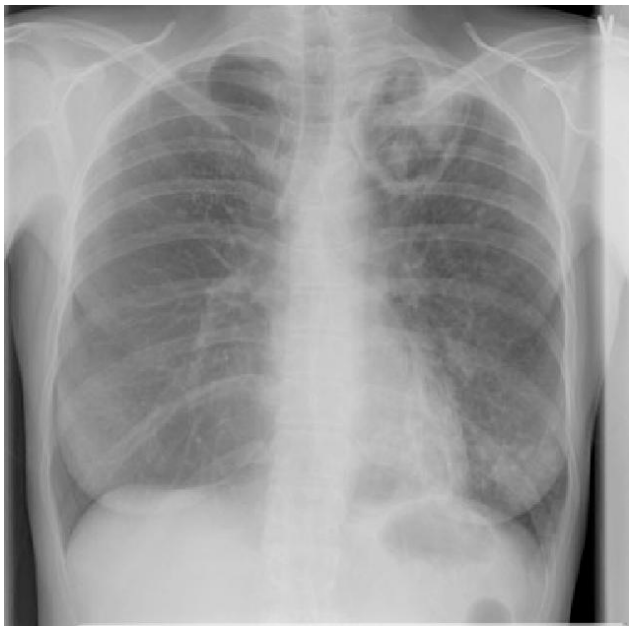


b) Allergic bronchopulmonary aspergillosis
Chest X-ray
- Normal (early)
- Transient patchy areas of consolidation
- Bronchiectasis.
- Finger in glove sign
- Pulmonary collapse

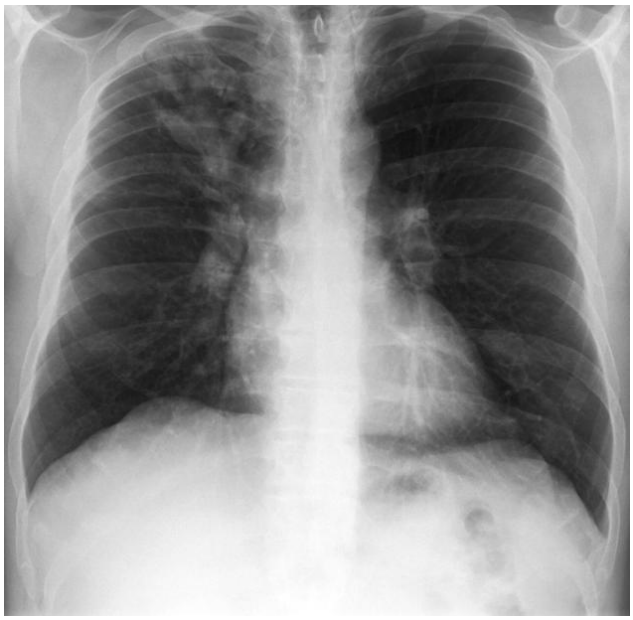


HRCT
- Fleeting pulmonary alveolar opacities: common
- Centrilobular nodules
- Bronchiectasis
- Bronchocoele, the finger in glove sign
- Bronchial wall thickening: common
- pulmonary fibrosis, predominantly in the upper lobe
- cavitation: 10%

c) Chronic necrotizing (semi invasive) aspergillosis
- Upper lobe consolidation
- Multiple thick walled nodules larger than 1cm size
- Cavitation
- Pleural thickening



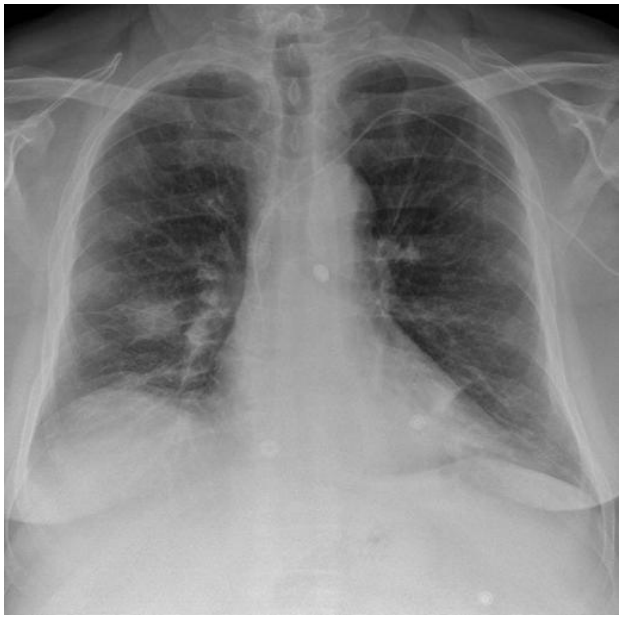
d) Airway invasive aspergillosis
Chest X-ray
- Areas of consolidation
- Nodules



HRCT
- Patchy bilateral peribronchial consolidation
- Centrilobular nodules smaller than 5mm
- Tree in bud appearance
- Lobar consolidation

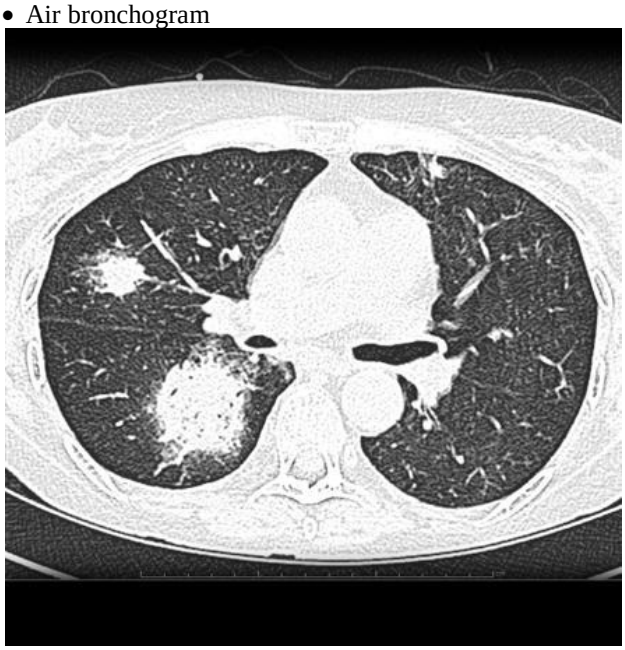
e) Angioinvasive aspergillosis
Chest X-ray
- Solitary or multiple ill-defined nodules

- Focal areas of consolidation with halo sign
- Cavitatory nodules with air crescent.



HRCT

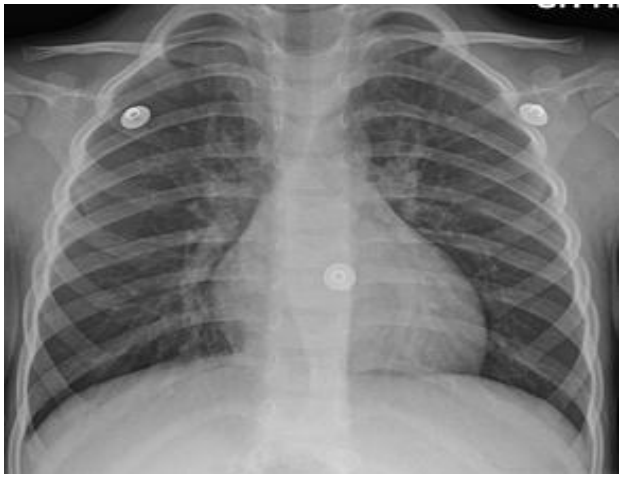
- Halo of ground glass opacity surrounding parenchymal nodules (CT Halo sign)
- Nodules greater than 1cm in diameter
- Cavitation
- Air bronchogram



5. Bacterial bronchiolitis:

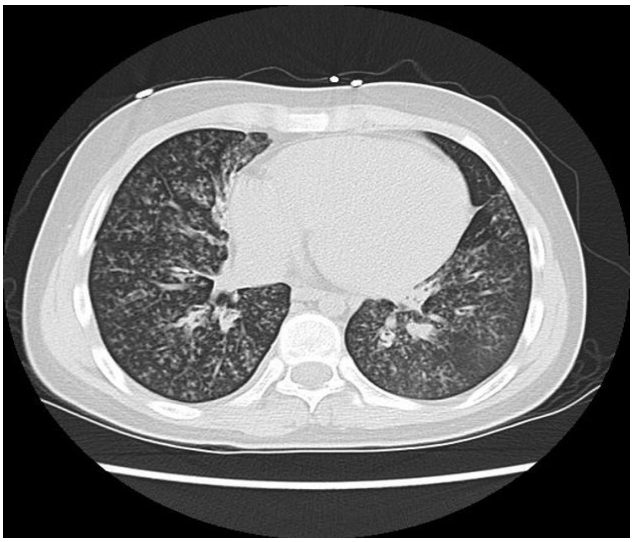
X-ray

- Normal
- Ill-defined hazy nodules
- Hyperlucency



HRCT:

- Bronchiectasis
- Ill-defined centrilobular micronodularity
- Tree-in-bud appearance
- Mosaic attenuation.



3. Methods and Materials

1) Source of data:

All the PLHIV patients with clinical suspected for parenchymal lung disease and coming for their routine check-up in the OPD of pulmonary medicine and HIV center and who are referred to the department of radio diagnosis, government medical college, Surat for diagnosis and evaluation were subjected to both conventional chest radiograph and HRCT thorax.

2) Method of collection of data:

A retrospective study was performed. All ages and both sex with some exclusion as mentioned below were included in the study. It was a duration-based study.47 patients were included in the study who are come during the study period.

3) Inclusion criteria:

PLHIV who have been referred from department of pulmonary medicine for chest X-ray and HRCT thorax for suspected lung pathology with following inclusion criteria:

a) Aged less than 65 years
b) Both male & female patients
c) Patients having reports of previous chest X ray for the same suspected pathology.
d) Patients who are ready to give written informed consent

4) Exclusion criteria:
a) Any participant not having the required chest X Ray and HRCT
b) Patients refusing to participate/ give consent for the study.

5) Duration of the study:
The study was conducted for a period of one year.

Scanning Parameters:
Position: Supine
Scanner Settings: kV (p)-120, mAs (effective)-100-200 or dynamic
Collimation: 2mm
Scan Time: 1 to 2 sec
Matrix Size: 512x 512
Superior Extent: lung apices
Inferior Extent: domes of diaphragm
Reconstruction Algorithm: high frequency spatial bone algorithm
Windows: 100/900 HU or 50/1000 HU.

TECHNIQUE: Written consent was taken and procedure was properly explained to patient.

Patient was placed on gantry table in the supine position with both arms raised above the heads. He/she was taught prior to procedure to hold breaths in deep inspiration and expiration wherever required.

A digital AP scanogram was obtained in suspended full inspiration.

Axial scans were obtained at 10 mm intervals from lung apices to domes of diaphragm.

Modification in the above technique were done if indicated.

Prone scans were taken to determine whether opacities in the dependent lung are abnormal or not. Scans were also taken at the end of deep expiration to detect air trapping.

Technical Aspect of High Resolution CT
The purpose of HRCT is to improve spatial resolution. Several factors affect this resolution. Some of them are CT scanner specific and cannot be changed such a focal spot size, geometry and array of detector, and frequency of data sampling.

There are number of controllable factors such as:
1) **Scan Collimation:** Narrow collimation (1-2 mm) leads to smaller voxel size, less volume averaging and a greater spatial resolution. Studies have shown that collimation greater than 3 does not improve spatial resolution over that obtained from conventional CT collimation and collimation less than 1 mm increases noise from quantum mottle, thereby failing to improve spatial resolution.
2) **Reconstruction Algorithm**: A "high spatial frequency reconstruction" or "bone algorithm" sharpens images of the lung and increases spatial resolution. Although this results in increased noise, this is not problematic because of the inherent high contrast of lungs.
3) **Field of view (FOV) and Targeted Imaging:** The FOV should be adjusted to the size, reduces volume averaging and increase spatial resolution. Targeting a single lung is superior to magnification which merely increases the size and not the spatial resolution.
4) **Kilovolts (Peak) and Milliamperes:** Increasing the mA or kVp can help reduce image noise, and in general 120 to 140 kVp and 200 to 300 mAs produce quality images.
5) **Scan Time:** Should be kept as low as possible (less than 2seconds) to reduce motion artefacts.
6) **Window Level and Width:** A window level-600 to-70 HU and width 1000 to 1500 HU are appropriate. However, they can differ with user preference and machines.

Artifacts Inherent to HRCT:

A. Patient related:-
1) **Motion Artifact:** Respiratory and cardiac motion may cause appearance on HRCT, such as double images of vessels, fissures and bronchial walls, blurring of images, ground glass opacity and linear streaks or "star Page 14 artefacts" from edges of vessels, which become potential pitfall in interpretation.
2) **Large Patient size**: Results in grainy image due to more quantum noise.
3) **Beam Hardening Artifacts:** Preferential absorption of low energy photons by high density structure such as the vertebral body results in decrease attenuation of the surrounding structure by the remaining high energy photons. This results in fine net like or coarse streak like artifacts radiating from high contrast interfaces like bronchial wall, vessels, ribs or vertebral bodies seen commonly over the posterior part of the lungs.

B. Technical Source Related:-
1) Low tube current and kVp results in more quantum noise.
2) Decreasing window level or increasing window width can cause normal lung tissue to have ground glass appearance, and magnification of bronchial wall thickness and vessel size.
3) With thin collimation, vessels can mimic small nodules.

4. Result and Analysis

The study was carried out at the department of Radiology, government medical college and new civil hospital, Surat. A total of 47 patients were selected for the study for one year time period.

The 47 patients were subjected to both conventional chest radiograph and HRCT scan thorax and a detailed work up of these patients was performed by department of respiratory medicine.

Distribution of diseases in the patient included in our study are:
Active Koch's: 42 %
Old Koch's: 20 %
PCP: 8%
Miliary TB: 6%
Bacterial pneumonia: 16%
Fungal: 2 %
Nonspecific finding: 6%

Table 1: Distribution of 47 Cases on Chest Radiograph and HRCT

Modality	Positive Findings	Normal	Total
X-Ray	37	10	47 (78.7%)
HRCT	44	3	47 (93.6%)

Total cases in study were 47. HRCT was positive for detection of parenchymal lung pathologies in (93.6) % of cases as in contrast to chest x-ray (78.7%)

Table 2: X- Ray Findings and Patterns. (Total Patients: 47)

	Pattern	Number	Percentage
1	Nodularity	16	34%
2	Consolidation	17	36.1%
3	Cavitation	10	21.2%
4	Fibrosis	5	10.6%
5	Pleural Effusion	8	17%
6	Lymphadenopathy	2	4.2%
7	Normal	10	21.2%

Table 3: Pathology and Age-Wise Distribution of 47 Cases on HRCT

S. No	Diagnosis	5-19	20-29	30-39	40-49	50-59	60-65	Total
1	Active Koch's	3	2	3	3	5	4	20
2	Old Koch's	1	1	1	3	2	1	9
3	PCP	-	2	1	1	-	-	5
4	Milliary TB	-	-	1	1	-	1	3
5	Fungal	-	-	1	-	-	-	1
6	Paracytic	-	-	-	-	-	-	-
7	Bacterial Pneumonia	-	1	2	1	1	1	6
8	Normal	1	1	-	1	-	-	3

Infections were seen affecting in all age groups in our study.

Table 4: Distribution Parenchymal Lung Disease

S. No	Diagnosis	No. of Cases	Percentage
1	Active Koch's	20	42%
2	Old Koch's	9	20%
3	PCP	5	8%
4	Milliary TB	3	6%
5	Fungal	1	2%
6	Bacterial Pneumonia	6	16%
7	Other	3	6%

Table 5: Pattern Wise Distribtuion of Various Lung Pathologies

Pattern	Interstitial Thickening	Ground Glass	Nodularity	Architectural Ditortion	Consolidation	Cyst/Cystic Space	Fibrosis	Pleural Thickening	Lymphedenopathy	Pleural Effusion	Bronchiectasis	Emphysema	Cavitation	Emphysema
Active Koch's	7	-	14	4	11	-	1	-	6	4	-	-	10	
Old Koch's	4	-	6	5	-	-	3	2	-	-	5	4	-	4
PCP	4	4	2	-	2	3	1	-	1	1	-	-	-	
Milliary TB	-	1	3	1	1	-	-	-	3	2	-	-	-	
Fungal	-	-	1	-	1	-	-	-	-	-	-	-	1	
Paracytic	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bacterial Pneumonia	5	-	-	-	6	-	-	-	-	5	-	-	-	
Lung Pathology (Total Cases)	20	5	26	10	21	3	5	2	10	12	5	4	11	

Table 6: Active Koch

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	7	34%
2	Ground Glass	-	-
3	Nodularity	14	71%
4	Architectural Distortion	4	18%
5	Consolidation	11	55%
6	Cyst/Cystic Space	-	-
7	Fibrosis	-	-
8	Pleural Thickening	-	-
9	Pleural Effusion	4	17%
10	Lymphedenopathy	6	31%
11	Bronchiectasis	-	-
12	Emphysema	-	-
11	Cavitation	10	50%

Table 7: Old Koch's

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	4	50%
2	Ground Glass	-	-
3	Nodularity	6	70%
4	Architectural Ditortion	5	58%
5	Consolidation	-	-
6	Cyst/Cystic Space	-	-
7	Fibrosis	3	33%
8	Pleural Thickening	2	22%
9	Lymphedenopathy	-	-
10	Pleural effusion	-	-
11	Bronchiectasis	5	58%
12	Emphysema	4	50%
13	Cavitation	-	-

In our study patients with active Koch predominantly demonstrated nodularity, consolidation and cavitation.

In our study patients with old Koch predominantly demonstrated patterns of nodularity, architectural distortion, interstitial thickening and bronchiectasis.

Table 8: PCP

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	4	80%
2	Ground Glass	4	80%
3	Nodularity	2	40%
4	Architectural Ditortion	-	-
5	Consolidation	2	40%
6	Cyst/Cystic Space	3	60%
7	Fibrosis	1	20%
8	Pleural Thickening	-	-
9	Lymphedenopathy	1	20%
10	Pleural effusion	1	20%
11	Bronchiectasis	-	-
12	Emphysema	-	-
13	Cavitation	-	-

In our study patients with PCP predominantly demonstrated patterns of ground glass opacity, interstitial thickening and consolidation.

Table 9: Miliary TB:

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	-	-
2	Ground Glass	1	33%
3	Nodularity	3	100%
4	Architectural Distortion	1	33%
5	Consolidation	1	33%
6	Cyst/Cystic Space	-	-
7	Fibrosis	-	-
8	Pleural Thickening	-	-
9	Lymphedenopathy	3	100%
10	Pleural Effusion	2	67%
11	Bronchiectasis	-	-
12	Emphysema	-	-
13	Cavitation	-	-

In our study patients with military Koch predominantly demonstrated patterns of nodularity and lymphadenopathy.

Table 10: Fungal Infection (ABPA)

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	-	-
2	Ground Glass	-	-
3	Nodularity	1	100%
4	Architectural Ditortion	-	-
5	Consolidation	1	100%
6	Cyst/Cystic Space	-	-
7	Fibrosis	-	-
8	Pleural Thickening	-	-
9	Lymphedenopathy	-	-
10	Pleural Efffusion	-	-
11	Bronchiectasis	-	-
12	Emphysema	-	-
13	Cavitation	1	100%

In our study patients with fungal infection predominantly demonstrated patterns of consolidation, cavitation and nodularity.

Table 11: Bacterial Pneumonia

S. No.	Finding	Number	Percentage
1	Interstitial Thickening	5	83%
2	Ground Glass	-	-
3	Nodularity	-	-
4	Architectural Distortion	-	-
5	Consolidation	6	100%
6	Cyst/Cystic Space	-	-
7	Fibrosis	-	-
8	Pleural Thickening	-	-
9	Lymphedenopathy	-	-
10	Pleural Effusion	5	83%
11	Bronchiectasis	-	-
12	Emphysema	-	-
13	Cavitation	-	-

In our study patients with bacterial pneumonia predominantly demonstrated patterns of consolidation, interstitial thickening and pleural effusion.

5. Discussion

The final results of our study were evaluated by using proportions and chi square test. The level of significance was taken as 0.05.

Decision Criterion: we are comparing the P Value with the level of significance. If P<0.05, we reject the null hypothesis as there is significant deference between the two parameter and accept the alternate hypothesis. If >0.05, we accept the null hypothesis and there is no significant difference between two modality.

Computation: the tables below give us the various computations and the P-value.

Nodular opacity

Nodular opacity	HRCT Number	Chest X-ray Number	Total	X2	P value
Present	26	16	42	4.3	0.03802
Absent	21	31	52		
Total	47	47	94		

As we found that higher no of samples with nodular opacity were detected in HRCT method compared to conventional chest x-ray method and this difference between the two methods was found to be statistically significant as the P value is less than <0.05

Consolidation

Consolidation	HRCT Number	Chest X-ray Number	Total	X2	P value
Present	21	17	38	0.7	0.4005
Absent	26	30	56		
Total	47	47	94		

As we found that higher no of samples with consolidation were detected in HRCT method compared to conventional chest x-ray method however the difference between the two methods was found to be statistically significant as the P value is more than 0.05

Pleural effusion

leural effusion	HRCT Number	Chest X-ray Number	Total	X2	P value
Present	12	8	20	1.01	0.03
Absent	35	39	74		
Total	47	47	94		

As we found that higher no of samples with pleural effusion were detected in HRCT method compared to conventional chest x-ray method and this difference between the two methods was found to be statistically significant as the P value is less than <0.05

Lymphadenopathy

Lymphadenopathy	HRCT Number	Chest X-ray Number	Total	X2	P value
Present	10	2	12	6.11	0.01341
Absent	37	45	82		
Total	47	47	94		

As we found that higher no of samples with lymphadenopathy were detected in HRCT method compared to conventional chest x-ray method and this difference between the two methods was found to be statistically significant as the P value is less than 0.05

Comparison between finding of Xray and HRCT thorax

	Pattern	NUMBER of patient	
		On Xray	HRCT
1	Nodularity	16	26
2	Consolidation	17	21
3	Fibrosis	5	5
4	Pleural Effusion	8	12
5	Lymphadenopathy	2	10
6	Normal	10	3

So mentioning above all the observation in our study it was found that more number of samples with findings were detected by HRCT as compared to conventional radiography. Even when both modalities were able to detect the findings, HRCT could characterise the abnormality and specify its location much more accurately. By early diagnosis of lung infection by HRCT, it helps a lot in reduction of morbidity and mortality of the patient.

The chest radiograms can appear completely normal in patients having parenchymal lung disease indicating lack of sensitivity of conventional chest radiography in the diagnosis of the conditions. In our study, 10 out of 47 patients (22%) had no abnormalities in their chest radiographs. However HRCT was able to show nodular, fibrotic etc. changes in these patients.

Nodular opacities are another very common manifestation of parenchymal lung diseases. In our study, 34% had nodular opacities in their chest radiographs. While HRCT showed evidence of nodular opacity in 55% of cases. The appearance of the nodules themselves can be an indicator as to whether they are interstitial or air space nodules. Interstitial nodules tend to be sharply marginated while air space nodules poorly defined. The distinction of nodules is much better appreciated on HRCT scans than on chest radiograms.

Tuberculosis

32 cases of tuberculosis were diagnosed of which 20 were new cases and 9 were old cases.

For New case of TB

Pattern	Our study	Im et al[69]
Nodule	71%	69%
Consolidation	55%	52%
Interstitial Thickening	34%	34%
Mediastinal Lymphadenopathy	31%	31%
Architectural distortion	18%	17%
Fibrotic band	0%	17%

For old case of TB showing reactivation

Pattern	Our study	Im et al[69]
Interstitial Thickening	50%	34%
Mediastinal Lymphadenopathy	0%	17%
Architectural distortion	58%	58%
Fibrotic band	33%	50%

Our findings correspond to those of Im et al in newly diagnosed cases and in cases showing reactivation. Im et al stressed the high frequency of endobronchial spread of infection (97%) in their patients with newly diagnosed active TB or recent reactivation of disease.

For PCP

Pattern	Our study	Hartman et al [131]
Ground glass opacity	80%	92%
Consolidation	40%	38%
Nodules	40%	25%
Lymphedenopathy	20%	25%
Pleural effusion	20%	17%
Interstutial thickening	80%	17%

Also demonstrated was interstitial thickening interspersed in areas of ground glass opacity which was similar to findings of Hartmann et al [131]. Histologically it represents organization of intra-alveolar exudates with resultant thickening of the pulmonary interstitium.

6. Summary

The study included 47 patients of different ages and both sexes with suspected parenchymal lung diseases.

Parenchymal lung diseases include various diseases in which the main part of the lung involvement is the lung parenchyma Most of these patients typically present with symptoms related to the respiratory system and if the chest x-ray taken the finding are suggestive of parenchymal involvement but many of these patient have normal chest radiograms. In these condition patients have benefit of an HRCT examination which invariably detects the abnormality. However even HRCT has it limitation. This particular study attempted to compare between conventional radiography and HRCT in the diagnosis of parenchymal lung disease.

All the patients having respiratory complain were subjected to both conventional radiography and HRCT examinations and the images were viewed and finding of these radiograph and HRCT were analysed. The two modalities were

compared with regard to their ability to detect findings like nodular opacities, consolidation, cavitation, lymphadenopathy, emphysema, bronchiectasis etc. The results were statistically analysed using chi square test.

After analysing the finding of chest X-ray and HRCT thorax, it was found that higher number of patient with findings was detected by HRCT rather than conventional radiography.

In the detection of nodular opacity pleural effusion and lymphadenopathy, the p value was less than 0.05 indicating the significant statistical difference was there between two modalities for detection of it. . Of the 47 patients, 10 patients had normal chest radiograms while HRCT was able to detect abnormal pattern in these patients. In current study HRCT was positive in 93% of cases, in contrast to chest x-ray which was positive in only 78% cases i. e. was able to detect

Pulmonary abnormalities in patients with suspected parenchymal lung diseases or disease processes much earlier in their evolution. On chest radiograph study nodular pattern was the pre-dominant pattern correlating with parenchymal lung diseases.

Of all parenchymal lung diseases studied tuberculosis including active as well as reactivated TB constituted more than half (68%) of the cases, followed by bacterial pneumonia being second most common parenchymal lung disease. Nodularity was present in most of new active cases and reactivation of tuberculosis suggesting presence of disease activity; differentiating reactivation from dormant state of disease by architectural distortion which is well depicted on HRCT.

So, HRCT seems to be investigation of choice in evaluating patients of parenchymal lung disease. Chest radiography is relatively insensitive and all patients with a clinical suspicion of parenchymal lung disease should benefit from an HRCT examination of the chest.

7. Conclusion

In most of the patient with respiratory complain, detection of the parenchymal lung disease if missed due to ignorance as well as false diagnosis with some interstitial lung disease due to lack of clinical history. PLHIV patient with respiratory complain requires require help of pulmonologist, and many of these cases can be diagnosed in the early stages with the help of HRCT and in these cases which are diagnosed early in the course of disease are helpful in improving morbidity and mortality by early therapeutic management.

HRCT can detect parenchymal lung abnormalities in patients in early stage when even when the chest radiograph appears completely normal.

There were some limitation to the pattern wise identification of disease as few non-specific pattern like ground-glass attenuation which was a prominent finding in early phase of many disease like NSIP, early infective stage; with diseases like tuberculosis having varied pattern depending on their stage of activity or remission, treatment status and association with other lung diseases.

For detection of early or mild parenchymal lung diseases, HRCT is clearly more sensitive than the chest radiograph.

Ultimately all the patients should benefit from an HRCT scan of thorax. High resolution computed tomography (HRCT) chest scans are essential to the diagnostic work up since parenchymal lung disease show specific pattern of abnormalities and a confident diagnosis can often be arrived at by HRCT alone or in correlation with the clinical symptoms.

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