Original Article

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High-Resolution Computed Tomographic Evaluation of Pulmonary Diseases in Human Immunodeficiency Virus Positive Patients: A Study of 30 Cases

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Abstract

Background: The association between tuberculosis (TB) and human immunodeficiency virus (HIV) presents an immediate and grave public health and socio-economic threat, particularly in the developing world.

Purpose: The aim of given study was to utilize high resolution computed tomography (HRCT) for the detection of pulmonary disease in HIV patients coming with suspected pulmonary complications, and then to arrive at a conclusive or differential diagnosis on the basis of HRCT finding.

Materials and Methods: The cases were selected based on all patients referred to the Department of Radiology, Gauhati Medical College with proven HIV/acquired immunodeficiency syndrome (AIDS) infection which was clinically suspected of pulmonary infections. HRCT was done.

Results: Total 30 cases of HIV/AIDS with suspected pulmonary disease were studied. Out of which 21 were male and 9 were female. Out of which 60% of patients were diagnosed as having pulmonary TB, followed by bacterial infection in 16.6% cases and *Pneumocystis carinii* pneumonia in 10% patients, while 13.3% of our study did not reveal any significant abnormality. Nodular opacities in HRCT were the most common findings in patients with pulmonary TB (77.7%).

Conclusion: Various findings such as pulmonary TB being the most common infection and most common HRCT finding in pulmonary TB were nodular opacity can be obtained from the present study. HRCT is a highly sensitive tool for detecting parenchymal abnormalities and allows better characterization of the lesions, with better reproducibility and less interobserver difference.

Key words: Bronchiectasis, Enzyme-linked immunosorbent assay, Miliary tuberculosis, Mortality, Pulmonary tuberculosis

INTRODUCTION

Human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) is a major world health concern and is a major cause of morbidity and mortality.[1]

It is a serious disorder of the immune system in which the body's normal defenses against infection breakdown, leaving it vulnerable to a host of life-threatening infections/conditions including unusual malignancies. The persons with severe opportunistic infections (OIs) and unusual malignancies are at the one end of the spectrum of disease, while healthy seropositive (for HIV) individuals are at the other end.[2]

The association between tuberculosis (TB) and HIV presents a major public health and socio-economic threat, particularly in the developing world including India.[3]

The estimated adult HIV prevalence in India is to be 0.27% according to National AIDS Control Organization's (NACO) 2013 report which is the third highest burden in the world. India is the highest TB burden country in the world with an estimated 2.2 million new TB cases

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occurring annually. While TB is commonest OIs in HIV-infected individuals, HIV infection is an important risk factor for acquiring TB infection and its progression to active TB. HIV/TB together is a fatal combination with extremely high death rates (15-18%) reported among HIV-infected TB cases notified under Revised National TB Control Program. Overall, TB is estimated to cause about 25% of all deaths among HIV infected cases in India. Early detection of HIV/TB cases and timely administration of anti-retroviral treatment (ART) and anti-TB treatment are key interventions to reduce mortality rates significantly.[4]

Imaging plays a vital role in the diagnosis and management of lung of complications associated with HIV. Accurate diagnosis is based on an understanding of the pathogenesis of the processes involved and their imaging findings.[1]

High-resolution computed tomography (HRCT) combines the use of thinly collimated CT slices that are 1-1.5 to 2 mm in thickness, with a high spatial frequency algorithm that enhances edge detection. Thin collimation decreases partial volume averaging and improves the ability of the CT to demonstrate small pulmonary lesions. HRCT allows delineation of the lung parenchyma down to the level of the secondary pulmonary lobule. Advantage of HRCT over radiograph is that it there is better delineation and characterization of the lesion and less observer variance. HRCT helps in revealing pulmonary parenchymal changes before they are evident on chest radiograph and also helps in better characterization of the lesions and thus helps in differential diagnosis of pulmonary complications seen in these patients.[1]

Empowered with an advanced modality like the HRCT, it was deemed essential to undertake a study on the HRCT evaluation of the pulmonary diseases in HIV/AIDS patients with the following aims and objectives in view:

1. To utilize HRCT for the evaluation of pulmonary parenchyma in HIV patients coming with suspected pulmonary complications.
2. To detect and categorize the pattern of involvement of the pulmonary parenchyma with the help of HRCT findings and then to arrive at a conclusive or differential diagnosis on the basis of HRCT findings.
3. Post-treatment follows up of HIV/AIDS patients.

MATERIALS AND METHODS

The present study was carried out in the Department of Radiology, Gauhati Medical College and Hospital, Guwahati from May 2013 to April 2014.

The cases were selected from ART center of Gauhati Medical College and Hospital based on their HIV-positive status and suspicion of pulmonary disease. The cases were evaluated by using the HRCT.

The age group the patients ranged from 8 to 52 years. Both sexes had their share of cases.

The primary clinical features were of weight loss, fever, and cough both productive and non-productive, and dyspnea.

Methods

A thorough clinical history of all the HIV positive patients presenting with suspicion of pulmonary disease was taken. The history mainly comprised of cough whether productive or non-productive, fever whether low grade or high grade, weight loss, and dyspnea duration of symptoms was also recorded. Then, a meticulous record of all the available laboratory investigations including HIV status, CD4 counts, routine blood examination, sputum examinations, pleural fluid analysis, fine needle aspiration cytology, and other available investigations was kept. Then, chest X-rays of the patients were studies for the presence of any abnormality.

General and systemic examinations of all the patients were done. HRCT scan of the thorax was done in all the cases taken up in the study.

Preparation of the Patient

The procedure and objectives of performing the high-resolution scans were explained to the patients and written consent of the patient or the attendant were taken. The patient was explained and demonstrated the procedure of breath holding during the acquisition of HRCT scans.

CT Protocol

The machine used is PHILIPS MX16 (16 SLICE CT) scanner. CT scan was performed using the following protocols:

1. Positioning: Patients were scanned in the supine position with their arms above their heads. Scans were performed in the axial axis from cephalic to caudal levels.
2. Scanning: After positioning the patient, the topogram or scanogram was taken. Spiral scanning were done with following protocols:
   - Collimation = 1 mm
   - Feed = 10 mm
   - Scan time = 1 sec
   - KVp = 120-140
   - mA = 240
   - Matrix size = 512 × 512

RESULTS AND OBSERVATIONS

Age and Sex Distribution

In the present study of 30 patients with HIV/AIDS with suspected pulmonary disease, 21 patients were male and 9 patients were female. So, males accounted for 70% and females accounted for 30% of cases.

In the present study, a maximum number of cases are seen between 31 and 40 years age group (46.6%), followed by 9 cases in 21-30 years (30%) (Table 1).

So, the most common pulmonary disease in the present study is pulmonary TB (60%) followed by bacterial infection (16.6%) (Table 2).

So, the most common presenting symptom in our present study is weight loss seen in 80% of cases followed by cough with expectoration seen in 70% of cases (Table 3).

So, the most common mode of HIV transmission in the present study is sexual (90%) (Table 4).

Pathological Investigations

1. Enzyme-linked immunosorbent assay (ELISA): All patients had undergone 2 or more ELISA tests and are found to be positive.
2. CD4 counts: Are available in all the patients. The range of CD4 counts varied from 21 to 382 with a mean count of 159.8 cells/cumm.

Table 1: Age distribution

Age	No. of patients	Percentage
<10	1	3
11-20	0	0
21-30	9	30
31-40	14	46.66
41-50	5	16.66
>50	1	3

Table 2: Different pulmonary disease noted

Pulmonary disease	Number of patient	Percentage
Pulmonary tuberculosis	18	60
Bacterial infection	5	16.6
Pneumocystis carinii	3	10
No abnormality	4	13.3

Table 3: Clinical findings

Clinical findings	Number of patients	Percentage
Weight loss	24	80
Cough with expectoration	21	70
Non-productive cough	5	16.6
Low grade fever	20	66.6
High grade fever	6	20
Dyspnea	4	13.3

Pulmonary TB

A total of 18 patients in the preset study are diagnosed to be suffering from pulmonary TB.

So, the most common clinical symptom in patient with pulmonary TB were cough with expectoration (88.9%) followed by weight loss (83.3%) (Table 5).

CD4 Counts in Patient with Pulmonary TB

The CD4 count in these patients varied from 21 to 382 cells/cumm, with a mean count of 170.6 cells/cumm. Six patients had CD4 count >200 cells/cumm, while 12 patients had CD4 counts < 200 cells/cumm (Table 6).

So, sputum positive cases in the present study are 33.3% (Table 7).

Other Investigations

All 18 patients have high ESR counts (counts >20 acid fast bacilli [AFB]), a total of 7 patients has pleural effusion, and in six of these patients pleural analysis reveal findings suggestive of pulmonary TB.

Table 4: Mode of HIV transmission

Mode of transmission	Number of patient	Percentage
Sexual (heterosexual)	27	90
IV drug users	2	6.6
Vertical infection (mother to child)	1	3.3

IV: Intravenous

Table 5: Clinical symptoms in patients with pulmonary tuberculosis

Clinical symptoms	No. of patients	Percentage
Cough with expectoration	16	88.9
Dry cough	1	5.5
Fever low grade	14	77.7
Fever high grade	1	5.5
Weight loss	15	83.3
Dyspnea	1	5.5

Table 6: CD4 counts

CD4 count (cells/cumm)	No. of patients	Percentage
>500	0	0
200-500	6	33.3
<200	12	66.7

Table 7: Patient with sputum positive for AFB

Sputum for AFB	No. of patients	Percentage
Positive	6	33.3
Negative	12	66.7

AFB: Acid fast bacilli

Imaging Findings

Chest radiographs are done in all 18 patients. All patients have some radiograph abnormality detectable in the radiograph. HRCT are done in all the cases (Table 8).

So, the most common HRCT finding in pulmonary TB in present study is nodular opacities seen in 77.7% cases followed by consolidation seen in 50% cases, bronchiectasis in 44.4% cases, pleural effusion in 38.8% cases, lymphadenopathy in 33.3% cases, Cavitations seen in 22.2% cases and miliary TB in 16.6% cases (Figures 1-6).

So, centrilobular nodules are seen in maximum cases (Table 9).

Bacterial Infections

A total of 5 patients in the present study are diagnosed to be suffering from bacterial infections.

Table 8: HRCT findings in pulmonary tuberculosis

HRCT findings	No. of patients	Percentage
Nodular opacities	14	77.7
Consolidation	9	50
Pleural effusion	7	38.8
Lymphadenopathy	6	33.3
Cavitation	4	22.2
Miliary tuberculosis	3	16.6
Bronchiectasis	8	44.4
Septal thickening		
Interlobular	6	33.3
Intralobular	3	16.6
Pleural thickening	5	27.7

HRCT: High-resolution computed tomography

Table 9: Classification of nodules in pulmonary tuberculosis

Nodules (distribution)	No. of patients
Centrilobular	9
Tree in bud	6
In clusters	4
Random	5

So, the most common clinical manifestation in the present study is high grade fever and cough with expectoration both in 80% cases (Table 10).

CD4 Counts in Patient with Bacterial Infections

The CD4 count in these patients varied from 121 to 366 cells/cumm with a mean count of 189.4 cells/cumm.

Other Investigations

Sputum culture is done in one patient and it reveals presence of pneumococcus.

None of the patients has AFB in their sputum.

Imaging Findings

Chest radiographs are done in all 5 patients. Four patients have some radiograph abnormality detectable in the radiograph.

So, the most common HRCT finding in bacterial infection is lobar consolidation seen in 60 % cases (Table 11 and Figure 7).

Pneumocystis carinii Pneumonia (PCP)

A total of 3 patients in present study are diagnosed to be suffering from PCP.

So, the most common clinical symptoms in patients with PCP are dry cough, weight loss and dyspnea in 100% cases (Table 12).

CD4 Counts in Patients with PCP

The CD4 count in these patients varied from 24 to 47 cells/cumm, with a mean count of 32.7 cells/cumm, i.e., all these patients are severely immunocompromised (Table 13).

Imaging Findings

Chest radiographs are done in all 3 patients. All patients have some radiograph abnormality detectable in the radiographs.

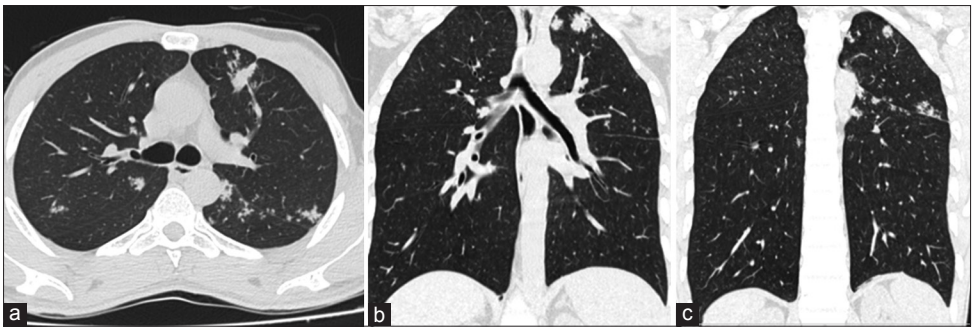

Figure 1: Case of tuberculosis - human immunodeficiency virus (a) Axial, (b and c) coronal HRCT images reveal multiple nodules some are conforming to tree-in-bud nodules

So, the most common HRCT finding in patients with PCP are diffuse ground glass opacities in mosaic pattern of distribution noted in 100% cases, followed by crazy paving noted in 66.6% cases (Table 14 and Figure 6a).

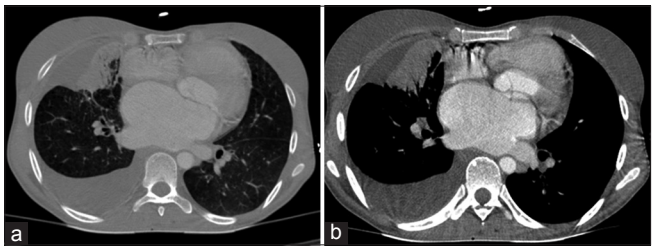

Figure 2: (a) Axial HRCT and (b) Corresponding mediastinal window showing consolidation in the right middle lobe with pleural effusion and in a case of pulmonary tuberculosis

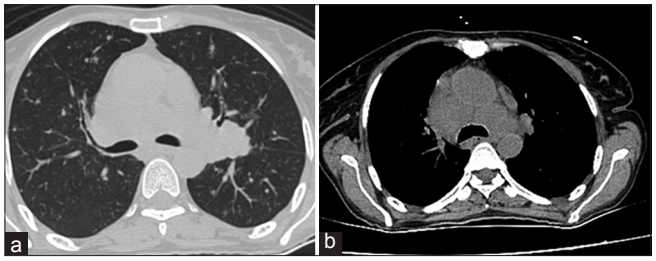

Figure 3: (a) Axial HRCT images reveal multiple discrete nodules in bilateral lung fields. (b) Mediastinal window showing mediastinal lymphadenopathy

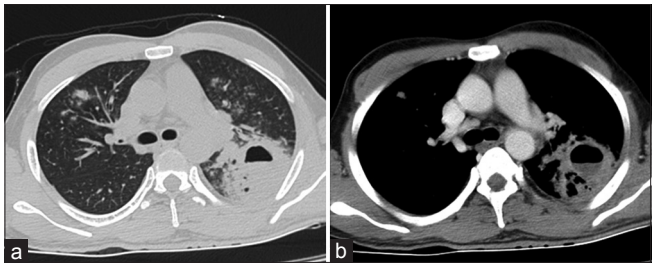

Figure 4: (a) Axial HRCT and (b) corresponding mediastinal window showing cavitary lesion with air fluid level and multiple nodules in a patient with pulmonary tuberculosis

Follow up

Two out of three patients with PCP are followed up after treatment, one patient shows complete resolution of abnormalities, while in another patient radiological resolution lagged behind clinical resolution.

Table 10: Clinical symptoms in patients with bacterial infections

Clinical symptoms	No. of patients	Percentage
Cough with expectoration	4	80
Dry cough	0	0
Fever low grade	1	20
Fever high grade	4	80
Weight loss	3	60
Dyspnea	0	0

Table 11: HRCT findings in bacterial infections

HRCT findings	No. of patients	Percentage
Lobar consolidation	3	60
Bronchiectasis	1	20
Nodules	1	20

HRCT: High-resolution computed tomography

Table 12: Clinical symptoms in patients with PCP

Clinical symptoms	No. of patients	Percentage
Cough with expectoration	0	0
Dry cough	3	100
Fever low grade	2	66.7
Fever high grade	1	33.3
Weight loss	3	100
Dyspnea	3	100

PCP: *Pneumocystis carinii* pneumonia

Table 13: CD4 counts

CD4 counts	No. of patients	Percentage
<200 cells/cumm	3	100
>200 cells/cumm	0	0

Figure 5: (a) Sagittal, (b) axial and (c) coronal HRCT images reveal cavitary lesion and tree in bud nodules in a case of pulmonary tuberculosis

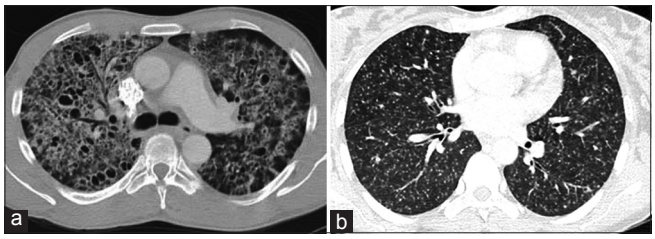

Figure 6: (a) Axial HRCT image reveals ground glass attenuation with crazy paving pattern and multiple cysts in bilateral lung fields which is classic of *Pneumocystis carinii* pneumonia. (b) HRCT image reveals miliary tuberculosis in bilateral lung fields in a different case

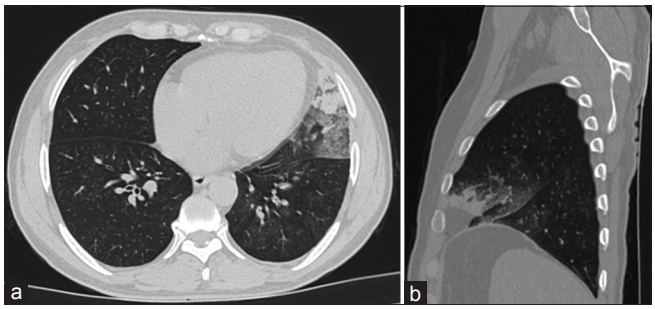

Figure 7: (a) Axial and (b) Sagittal HRCT images showing consolidation in the left lingular segment in case of bacterial infection

Table 14: HRCT findings of PCP

HRCT findings	No. of patients	Percentage
Diffuse ground glass opacity	3	100
Mosaic attenuation	3	100
Crazy-paving	2	66.6
Consolidation	1	33.3

HRCT: High-resolution computed tomography, PCP: *Pneumocystis carinii* pneumonia

DISCUSSION

In present study, maximum number of cases was seen between 31 and 40 years age group numbering 14 cases, followed by 9 cases in 21-30 years of age group. Hence, a maximum number of cases in the present study are also noted in the age group 21-40 years comprising about 76.7% of cases. This correlates well with study by Sharma *et al.*[5] who reported that most of the HIV-positive patients were in the age group 21-40 years.

In the present study, out of 30 patients, 21 patients are male and 9 patients are female. So males accounted for 70% and females accounted for 30% of cases. In a nation-level statistics of the HIV/AIDS cases reported to the NACO,[4] 74% were males. Kumarasamy *et al.*[6] reported a male preponderance with 72.9% cases being males.

In the present study, most common presenting symptom was weight loss seen in 80% of cases, fever (low grade) seen in 66.6% of cases and high grade fever in 20% of cases; cough with expectoration seen in 80% of cases. The cumulative data published by NACO[4] in 5204 AIDS patients indicates that 89% patient had weight loss, 88% had fever and cough was seen only in 68%.

As per NACO[4] recommendation HIV infection is diagnosed on the basis of 3 ELISA/rapid single blood tests using different antigen preparations. AIDS is diagnosed on the basis of 2 ELISA/rapid tests and presence of AIDS-related OI. All patients have undergone 2 or more ELISA tests and are found to be positive. Hence, all patients in the present study matched the NACO[4] recommendation.

The range of CD4 counts varied from 21 to 382 with a mean count of 159.8 cells/cumm. Hence, maximum numbers of patients are in advanced stage of immunosuppression in the present study.

In present study of 30 patients, 18 patients are diagnosed as having pulmonary TB accounting for 60% of cases, 5 patients are diagnosed as having bacterial infection accounting for 16.6% of cases and 3 patients are diagnosed as having PCP (10%).

An analysis of various OIs reported to NACO[4] from different parts of the country shows that about 64% of the AIDS cases were found to be suffering from pulmonary TB, bacterial infection in 7.6% cases, and PCP in 3% cases. Lanjewar and Duggal.[7] in an autopsy study to evaluate pulmonary pathology in patients with AIDS identified the cause of be TB in 59% cases, bacterial pneumonia in 18% cases, and PCP in 5% cases. Hence, the present study fairly correlates with the above-mentioned studies.

Pulmonary TB

A total of 18 patients in the present study are diagnosed to be suffering from pulmonary TB and are the most common disease noted. Worldwide, TB is the most common OI affecting HIV-seropositive individuals and it remains the most common cause of death in patients with AIDS.[8] Mohar *et al.*[9] stated that it is also possible that TB masked the recognition of other OIs.

Kumar *et al.*[10] reported cough and expectoration in 97.6% patients, while 90.4% of the patients had a low- grade fever, and significant weight loss was observed in 78.6% of the patients. In the present study, most common clinical manifestation is cough with expectoration (89%), followed by weight loss (83%), and low-grade fever (78% cases). Slight variation in present study could be attributed to small sample size.

The CD4 count in these patients varied from 21 to 382 cells/cumm with a mean count of 170.6 cells/cumm.

6 patients has CD4 count >200 cells/cumm, while 12 patients has CD4 count <200 cells/cumm.

Kumar *et al.*[10] reported that direct smear examination for AFB in sputum specimens was positive in 21.4% patients. In the present study, 33.3% has AFB in their sputum.

The most common HRCT finding in pulmonary TB are nodular opacities seen in 77.7% cases, followed by consolidation in 50%, pleural effusion in 38.8%, lymphadenopathy in 33.3%, and cavitation in 22.2% cases. Laissy *et al.*[11] also noted that nodular opacities, mainly centrilobular in distribution were the most common finding seen in 72% cases.

In present study 50% patients with pulmonary TB has consolidation visible on HRCT scans and it most commonly involved the right middle lobe and right lower lobe which correlated with study by Leung *et al.*[12] who noted consolidation in 43% cases and it was predominantly right sided.

In present study ground glass opacity are noted in 22% of patients which correlated well with study by Hartman *et al.*[13] who noted presence of ground glass opacity in 19% of cases.

Leung *et al.*[12] detected cavitation in 19% of patients with pulmonary TB. In present study, cavities are seen in 22% patients. Laissy *et al.*[11] noted that 24% patients with pulmonary TB demonstrated presence of cavitation. Furthermore, cavitation are more common in patients who had CD4 counts >200 cells/cumm. The mean CD4 count in these 24% patients is 254.2 cells/cumm.

Hartman *et al.*[13] noted pleural effusions in 38% patients with pulmonary TB. Relkin *et al.*[14] reported an increased prevalence of pleural effusion in AIDS - related TB compared with the TB in HIV - negative patients. In present study, pleural effusions are seen in 38.8% patients with pulmonary TB.

Kumar *et al.*[10] observed lymphadenopathy in 16.8% cases with pulmonary TB. In present study, lymphadenopathy is noted in 33.3% patients with pulmonary TB.

Leung *et al.*[12] noted that miliary disease was more frequent in HIV seropositive patients with 17% their cases showing miliary pattern. In present study, miliary patterns are noted in 16.7% patients. Mcguinness *et al.*[15] mentioned that bronchiectasis and bronchial wall thickening is common in HIV patients occurring in both primary and reactivation disease. In present study, bronchiectasis is noted in 44.4% patients.

Bacterial Infections

A total of 5 patients in present study are diagnosed to be suffering from bacterial infections.

Brecher *et al.*[16] noted that patients with bacterial infection typically present with a relatively rapid onset of clinical symptoms such as a productive cough, fever, shaking chills, pleuritic chest pain, and dyspnea. The most common clinical manifestation in present study is high grade fever (80%) and cough with expectoration (80%).

Hirschtick *et al.*[17] observed that although bacterial pneumonia often occurs in the early stages of HIV infection, the risk of bacterial infection increases steadily with declining CD4 lymphocyte counts. In present study, the CD4 counts varied from 121 to 366 cells/cumm with a mean count of 189.4 cells/cumm.

Boiselle *et al.*[18] and Magnenat *et al.*[19] reported that focal consolidation was observed in approximately 45-60% of patients with pyogenic infection. In present study, lobar consolidations are seen in 60% cases with bacterial infection.

Boiselle *et al.*[18] noted that bacterial infections may also present as solitary or multiple lung nodules. In present study, nodules were noted in 20% patients. The nodules are randomly distributed; some are associated with cavitation.

McGuinness *et al.*[15] noted that HIV-infected patients are at increased risk for developing infectious airways disease, with bronchiectasis being noted to develop in a relatively short time after an episode of pulmonary pyogenic infection. In present study, bronchiectasis is noted in one out of five patients with bacterial infections and it is associated with presence of air fluid level.

PCP

A total of 3 patients in present study are diagnosed to be suffering from PCP.

Thomas and Limper[20] mentioned that common symptoms of PCP include the subtle onset of progressive dyspnea, non-productive cough, and low-grade fever. In present study, most common clinical manifestation are dyspnea (100%), and then cough without expectoration (66.6%), low grade fever (66.6%), and high grade fever (33.3%).

Phair *et al.*[21] noted that PCP occurs more frequently when the CD4 count level falls below 200 cells/cumm. In present study, CD4 counts in all patients with PCP are <200 cells/cumm, with a mean count of 32.7 cells/cumm.

Hartman *et al.*[13] noted ground glass opacities in 92% of patients with PCP. Kuhlman *et al.*[22] noted that PCP

classically results in a ground-glass infiltrate, often in a geographical distribution. In present study, ground glass opacity is noted in 100% patients with PCP. Here the ground glass opacities extended from the apical to basal regions bilaterally. In addition to diffuse disease, a distinct mosaic pattern can be identified in all three patients.

Bergin *et al.*[23] noted crazy-paving pattern in 50% of patients with PCP. In present study, 66.7% patients demonstrated crazy-paving pattern. Slight variation in present study could be attributed to small sample size.

Hartman *et al.*[13] noted consolidation in 38% patients with PCP. In the present study, consolidation is seen in 33.3% cases.

CONCLUSION

From our present study of 30 HIV-positive patients coming with suspected pulmonary disease the following conclusions can be drawn:

The most common HRCT finding in pulmonary TB were nodular opacity, lobar consolidation in bacterial infection and diffuse ground glass opacities in mosaic pattern of distribution in PCP.

The diagnosis of HIV/AIDS patients presenting with pulmonary disease remains a challenge as the signs and symptoms are non-specific and tend to be atypical.

HRCT is a highly sensitive modality for detecting parenchymal abnormalities, and it allows better delineation and characterization of the lesions. Hence, HRCT should be incorporated into the management protocols of HIV/AIDS patients coming with suspected pulmonary complications.

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