A Study of Various Chest Radiological Manifestations of Pulmonary Tuberculosis in both Human Immunodeficiency Virus-positive and Human Immunodeficiency Virus-negative Patients in a South Indian Population

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ABSTRACT

Context: The chest radiography is an essential diagnostic tool in assessing the pattern and progression of pulmonary tuberculosis (PTB), which helps in taking suitable clinical decisions. **Aims:** The aim of this study is to bring out any specific radiologic pattern in PTB among human immunodeficiency virus (HIV) infected and noninfected and make an attempt to systemize reporting and recording radiographic findings. **Settings and Design:** Patients of all age groups with sputum positivity were included in the study and divided into groups based on gender, age and HIV-infected and noninfected patients. Chest radiographs were taken and assessed for findings. **Materials and Methods:** Data for the study were taken from sputum acid-fast bacilli positive patient's referred to the Department of Radiodiagnosis for chest X-ray and were evaluated with standard posterior-anterior chest radiograph. **Statistical Analysis Used:** Documented observations were compiled using SPSS-16.5 software (IBM). Univariate analysis was carried out for data interpretation. **Findings/Results:** Chest radiographic pattern change between HIV and noninfected cases. Lymphadenopathy was more common in patients with low CD4 count, predominantly involving the right hilar and mediastinal nodes. Large opacities with mid zone predilection, smaller opacities involving both upper zones, and bilateral lung involvement in patients with HIV coinfection was indicative of low CD4 count. **Conclusions:** In the present study, it was observed that major chest radiographic pattern change between patients with HIV and noninfected cases were increase in large opacities, decrease in cavity formation, increase in pleural effusion, no apical cap, and no volume loss. Lymphadenopathy was more common in patients with low CD4+ count (<200 cells/dl).

Key words: CD4 counts; chest radiograph; human immunodeficiency virus; pulmonary tuberculosis

Introduction

Pulmonary tuberculosis (PTB) is a common worldwide infection and a medical and social problem causing high mortality and morbidity. While TB never disappeared from the developing world, it re-emerged globally with a vengeance with the emergence of global pandemic of human immunodeficiency virus (HIV) infection in the resistant form.[1,2] In India, TB scourge creates more orphans than any other infectious disease.[3]

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PTB is a chronic infectious disease caused by *Mycobacterium tuberculosis*.[4] PTB can be considered two broad headings as follows: (1) Primary TB, and (2) postprimary TB. Though radiographically primary and postprimary TB are different in the nature of the lesion, site of involvement, lymphadenopathy, and pleural involvement, often, there is a considerable overlap in the findings observed in both the forms.[5] Primary disease now accounts for 23–24% of all adult cases of TB.[6] Where chest radiographs may be normal in up to 15%. Majority of postprimary TB occurs as a result of reactivation of a focus of infection acquired in earlier life. Serial imaging helps determine the stability or activity of PTB.[7]

The chest radiograph is one of the essential diagnostic tools where the pattern of abnormality and its rate of progression help in taking suitable clinical decision and treatment.[4] Use of microscopy in diagnosis of TB is of paramount importance as culture takes a long time. Stained smears are examined directly from the sputum and after concentration.[8] Even though bacteriological confirmation is the gold standard for diagnosing TB, it is not always possible to gather sputum specimens from all that patients. A large number of pediatric patients are asymptomatic at presentation and even in symptomatic patients, early diagnosis by bacteriology is hampered by the difficulty in obtaining suitable sputum samples.[9]

The aims of the study are

- To emphasize the role of conventional chest radiograph and to find out the various chest radiographic pattern in sputum positive PTB patients among varied groups
- To find out relation between chest radiographic pattern with regard to age and HIV seropositive among smear positive PTB patients.

Materials and Methods

Source of data

Data for the study were collected from the sputum acid-fast bacilli positive patients referred to the Department of Radiodiagnosis for chest X-ray to the teaching hospitals attached to Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India, viz., Victoria Hospital, Bowring and Lady Curzon Hospital and antiretroviral therapy (ART) centre located at Bowring and Lady Curzon Hospital.

The prospective study was conducted over a period of 1½ year (December 2011–March 2013) on 100 sputum positive patients. They were evaluated with standard posterior-anterior chest radiograph, HIV status with CD4 cell count where ever applicable. The observation was documented as various variables such as parenchymal abnormalities, pleural abnormalities, central abnormalities, and other abnormalities. Further parenchyma abnormalities were grouped as opacities and cavities, and subgroups according to the size, extent, zone, and CD4 counts. The descriptive observations analyzed forming three groups such as PTB with no HIV, PTB with HIV, and pediatric group.

Inclusion criterion

Patients of all age groups with sputum positivity were included in the study.

Exclusion criterion

Sputum positive pregnant females were excluded from the study.

Chest radiographs were taken with high output generator with X-ray tube capable of 125 kV or more and a focal spot size of 0.6–1.5 mm and a medium speed cassette screen combination. Collimation was used to ensure that the whole thorax and surrounding chest wall and soft tissues are included in the film.

To ensure optimal radiographic quality, the following were checked: Correctness of labelling by identity number and left or right indicators, positioning with nonrotation, adequacy of the inspiration, and correctness of exposure. A radiograph was considered suboptimal if the above criterion were not fulfilled.

Radiographs were interpreted as follows

Parenchymal abnormalities

Parenchyma is defined as the area involving the lung fields including the airway and vascular structures, which were classified into - large opacities (>1 cm), small opacities (<1 cm), cavities [Figures 1-7].

Pleural abnormalities

This includes the abnormalities of pleura over the convexities of the lungs, diaphragmatic, and mediastinal surfaces [Figure 8].

Central abnormalities

The central abnormalities include the trachea, mediastinum, and the left and right hila; and involve tracheal deviation, mediastinal shift, hilar elevation, and lymphadenopathy [Figures 9 and 10].

Other abnormalities

Other abnormalities rely upon pattern of both anatomical structures and common pathologies. They can be surgical, cardiac, skeletal, and lung abnormalities. The presence of any other abnormality is detected.

Results

The results of the present study are as listed in tables below. The results can be summarized as follows. In this study out of 100 cases, the maximum percentage of patients was in the age group of 31–40 years, and there was a male preponderance (62%) when compared to female (38%).

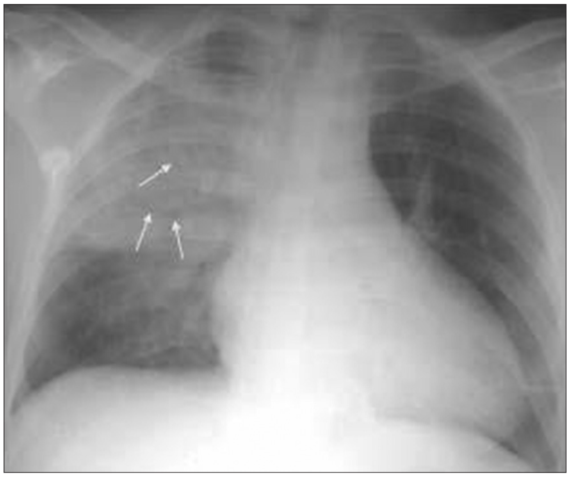

Figure 1: Chest posterior-anterior radiograph showing upper lobe opacity, with air bronchogram (white arrows), in a sputum acid-fast bacilli positive patient

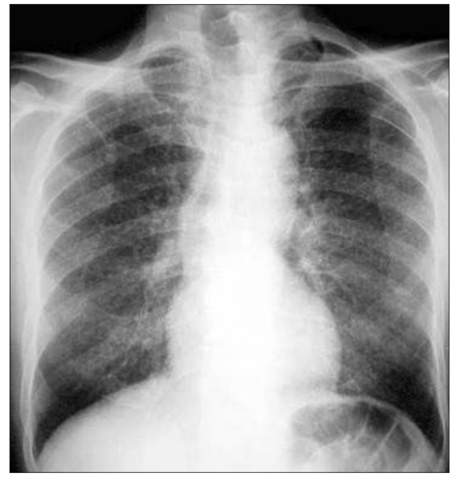

Figure 2: Chest posterior-anterior radiograph showing small opacities, size <1.5 mm, in all the lung zones in a sputum acid-fast bacilli positive patient (miliary form)

Figure 3: Chest posterior-anterior radiograph showing small opacities and cavity formation in a patient with human immunodeficiency virus and sputum acid-fast bacilli positivity

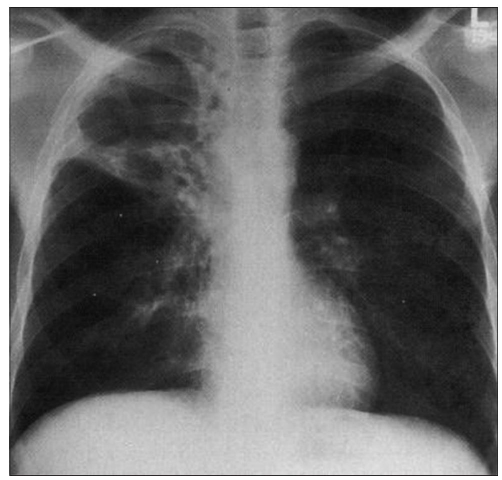

Figure 4: Chest posterior-anterior radiograph showing typical pattern with CD4 count >200 cells/dl. A cavitory right upper lobe opacity is seen, typical of reactivation tuberculosis

Figure 5: Chest posterior-anterior radiograph shows multiple disseminated nodules with random distribution in both lungs

Figure 6: Chest posterior-anterior radiograph in a human immunodeficiency virus patient with counts <200 cells/dl showing right paratracheal lymph node enlargement with upper lobe opacities

Figure 7: Chest posterior-anterior radiograph shows two cavities in right upper and mid zone, size 1–5 cm. Small opacities are also present in both upper and left mid zone

Figure 8: Chest posterior-anterior radiograph shows left apical cap formation, associated left tracheal deviation also noted

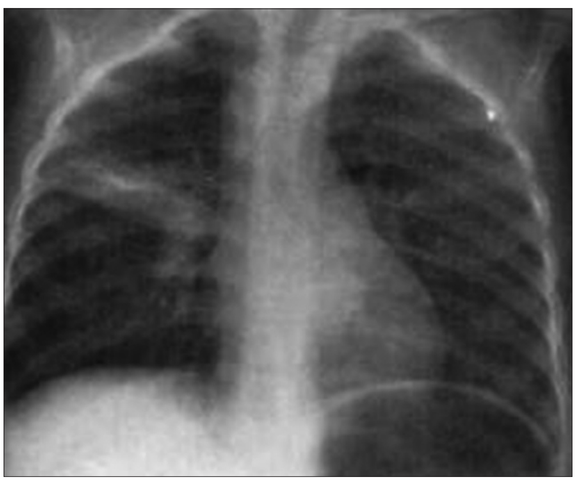

Figure 9: Chest posterior-anterior radiograph shows enlargement of right hilar nodes, paratracheal and left hilar lymphadenopathy right upper lobe opacities

Figure 10: Chest posterior-anterior radiograph shows large opacities in right upper lobe, with associated right paratracheal lymph node enlargement

Patients with HIV infection (n = 22) also showed male preponderance (71.5%) and female (28.5%).

In the present study, out of total 100 patients, large opacities were found in 48%, small opacities in 35%, cavity in 25%, lymphadenopathy in 19%, pleural effusion in 22%, and mediastinal shift in 3% patients.

In patients with non-HIV status, large opacities seen in 43.05%, small opacities in 34.72%, cavity in 29.16%, lymphadenopathy in 20.83%, pleural effusion in 19.44%, apical cap in 11.11%, tracheal deviation in 13.8%, mediastina shift in 2.7%, volume loss in 11.11%, granuloma in 5.55%, and hilar elevation in 4.16% [Tables 1 and 2].

In patients with HIV-positive status, large opacities seen in 60.71%, small opacities in 35.71%, cavity in 14.25%, lymphadenopathy in 14.28%, pleural effusion in 28.57%, tracheal deviation in 7.14%, mediastinal shift in 2.7%, and no apical opacity [Tables 1-3].

Discussion/Conclusion

The present study found that large opacities were the predominant lesion in both non-HIV status (40%) and HIV-infected patients (60%). In the present study, large opacity characteristics in noninfected HIV patients were predominantly single both round and irregular whereas small opacities were predominantly round and in right upper lobe. While in patients with HIV-positive status, large opacities predominated in middle lobes which were rounded.

In this study, it was observed that the major chest radiographic pattern change between patients with HIV and noninfected cases were increase in large opacities (30% vs. 14%), decrease in cavity formation (30% vs. 14%), increase in pleural effusion (28% vs. 19.4%), no apical cap (none vs. 11%), and

Table 1: Definable features of large opacities

Large opacities	Variables	*n*=48 Normal population	*n*=17 Human immunodeficiency virus infected	*P*
Type	Round	21	5	0.02
	Irregular	27	12	0.04
Size (cm)	1-5	19	8	0.03
	>5	14	4	0.04
	>Upper lobe size	15	5	0.05
Extent	Single	37	15	0.03
	Few	11	2	0.02
Zones: Right (*n*=34)	Upper	16	4	0.04
	Middle	21	8	0.02
	Lower	9	2	0.01
	Upper + middle	6	1	0.13
	Middle + lower	2	1	0.23
	Upper + middle + lower	2	0	0.45
Zones: Left (*n*=14)	Upper	7	1	0.65
	Middle	8	5	0.36
	Lower	3	2	0.44
	Upper + middle	1	0	0.58
	Middle + lower	1	1	0.77
	Upper + middle + lower	0	0	0.00
Both	Right + left	3	0	0.00

Table 2: Definable features of small opacities

Smaller opacities	Variables	*n*=35 Normal	*n*=10 Human immunodeficiency virus infected	*P*
Type	Round	26	10	0.04
	Irregular	9	0	0.48
Size (mm)	<1.5	7	0	0.65
	1.5-3.0	22	0	0.74
	3.5×10	6	0	0.60
Profusion	3+	12	4	0.03
	2+	12	4	0.03
	1+	11	2	0.02
	Zone: Right	23	8	0.03
	Zone: Left	22	8	0.03
	Both	12	6	0.04
Zone: Right	Upper	15	5	0.03
	Middle	14	7	0.03
	Lower	9	5	0.04
	Upper + middle	8	7	0.01
	Middle + lower	9	8	0.01
	Upper + middle + lower	7	4	0.03
Zone: Left	Upper	14	5	0.03
	Middle	13	5	0.02
	Lower	10	6	0.04
	Upper + middle	9	4	0.03
	Middle + lower	7	0	0.62
	Upper + middle + lower	7	4	0.04

Table 3: Definable features of other abnormalities

Characteristic radiologic features	Variables	Normal population	Human immunodeficiency virus infected	*P*
Mycetoma	Right	1	0	0.49
Granuloma (*n*=4)	Right	2	0	0.59
	Left	2	0	0.67
Pleural fluid/fibrosis		*n*=22	*n*=8	
	Right	15	6	0.04
	Left	7	2	0.03
Extent	<1/4	11	5	0.03
	1/4-1/2	7	1	0.01
	>1/2	4	2	0.51
Apical cap		*n*=8	*n*=0	
	Right	6	0	0.61
	Left	2	0	0.55
Calcification (*n*=1)	Right	0		
	Left	1	>1/2 extent	
Tracheal deviation		*n*=12	*n*=2	
	Right	8	1	0.68
	Left	4	1	0.56
Mediastinal shift		*n*=3	*n*=1	
	Right	2	0	0.70
	Left	1	1	0.43
Lymphadenopathy	*n*=18	*n*=14	*n*=4	
Hilar	Right	15	4	0.51
	Left	4	2	0.03
	Both	3	2	0.64
Mediastinal	Right	10	3	0.03
	Left	1	0	0.65
	Both	1	1	0.55
Hilar elevation	Right	2	0	0.62
	Left	1	0	0.55
Volume loss *n*=8		*n*=8		
	Right	5	0	0.65
	Upper	3	0	0.45
	Middle	2	0	0.15
	Lower	0	0	
	Left	*n*=3		
	Upper	1	0	0.10
	Middle	0	0	
	Lower	2	0	0.15

no volume loss (none vs. 11%). Lymphadenopathy was more common in patients with low CD4 count (<200 cells/dl), predominantly involving the right hilar and mediastinal nodes. In the present study, large opacities (1–5 cm) with mid zone predilection, smaller opacities (1.5–3 mm) involving both the upper zones, and bilateral lung involvement in patients with HIV coinfection was indicative of low CD4 count (<200 cells/dl) [Tables 1 and 2].

In the present study, irregular, single lesion predominance was seen in middle zones in both lungs in patients with CD4 count <200 cells/dl.

Various similar studies were conducted, viz., Koh *et al*.[10] in their study of high school students (*n* = 55) found large opacities in 51%, small opacities 96%, cavity 45%, lymphadenopathy 2%, pleural effusion was not seen. Tshibwabwa-Tumba *et al*.[11] in their study of radiological pattern of TB without HIV (*n* = 1000) reported large opacities in 33%, small opacities 12%, cavity 7.8%, lymphadenopathy 13%, pleural effusion 6.8%, and volume loss 24% patients. Banafsheh *et al*.[12] in their study of TB without HIV (*n* = 196) observed large opacities in 12%, focal opacities in 51%, miliary pattern in 4.7%, lymphadenopathy in 7.4%, pleural effusion in 23.5%, cavitation in 20.1%.

The present study correlates well with other studies except for small opacities is more frequent in the Korean study by Koh *et al*. This may be due to their definition of small opacities <10 mm in diameter; however, in our study, small opacities were considered when the diameter was <15 mm. The present study correlates well with other studies except for parameters such as volume loss - in none of the cases and air trapping observed only in 3.8% patients.

This study was conducted on sputum positive patients, but few of the patients may have sputum negativity or may not be able to produce sputum as in pleural or extra PTB. Such patients pose a limitation to this study as they were not included. Furthermore, the study size was 100, which may be less to draw broad conclusions, especially when the geographic and cultural differences of the population are taken into consideration. The radiographic pattern is often confusing and equivocal and varies depending on various parameters; hence, proper image processing and interpretation is paramount.

Multiple profound variables in similar studies[10,13-16] are more than the variable observed in other similar studies. As a result, the present study helps in predicting with less error HIV coinfected group so that early inception of highly active ART before the CD4 positive counts are available.

This study can help treating clinicians, researchers, and policy makers for effective implementation of new program for PTB with HIV coinfection.

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Conflicts of interest

There are no conflicts of interest.

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