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Original Article

Analysis of Spectrum of Radiographic Findings in Patients with Pulmonary Tuberculosis at a Tertiary Care Hospital

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ABSTRACT

Background: Pulmonary tuberculosis remains a major public health concern, presenting with diverse clinical and radiographic manifestations. Chest radiography plays an important role in identifying pulmonary abnormalities, determining disease distribution, and assessing complications.

Aim: To analyze the spectrum, frequency, and clinical associations of radiographic findings in patients with pulmonary tuberculosis.

Materials and Methods: This hospital-based observational cross-sectional study included 88 adult patients with microbiologically confirmed pulmonary tuberculosis at Index Medical College, Hospital & Research Centre, Indore, Madhya Pradesh, India. Demographic characteristics, clinical symptoms, comorbidities, and microbiological findings were recorded. Digital chest radiographs were systematically evaluated for pulmonary abnormalities, anatomical distribution, cavitary lesions, and extent of involvement. Statistical analysis was performed using IBM SPSS, with $p<0.05$ considered statistically significant.

Results: The highest proportion of patients belonged to the 31–45 years age group (31.82%). Males constituted 63.64%, while 59.09% belonged to rural areas. Cough (85.23%), fever (72.73%), and sputum production (69.32%) were the predominant symptoms. Pulmonary consolidation was the most frequent radiographic finding (60.23%), followed by patchy opacities (50.00%), cavitary lesions (40.91%), and nodular infiltrates (38.64%). Upper lung zone predominance was observed in 57.95%, while bilateral pulmonary involvement occurred in 36.36%. Cavitary lesions demonstrated significant associations with male sex ($p=0.006$), smoking ($p<0.001$), previous tuberculosis ($p=0.026$), AFB smear positivity ($p=0.003$), and upper-zone involvement ($p=0.002$). The association with diabetes mellitus was statistically insignificant ($p=0.133$).

Conclusion: Pulmonary tuberculosis demonstrated considerable radiographic variability, with consolidation and upper-zone involvement being predominant findings. Cavitation showed significant associations with selected clinical and microbiological characteristics. Chest radiography, combined with clinical and microbiological assessment, remained valuable for comprehensive evaluation of pulmonary tuberculosis.

KEYWORDS: Pulmonary Tuberculosis; Chest Radiography; Cavitary Lesions; Pulmonary Consolidation; Lung Zones.

INTRODUCTION

Pulmonary tuberculosis (PTB) remains a major infectious disease and an important cause of morbidity and mortality worldwide, particularly in developing countries. It is caused by Mycobacterium tuberculosis, which primarily affects the lungs through airborne transmission of infectious respiratory droplets. Despite improvements in diagnostic techniques, treatment strategies, and public health programmes, tuberculosis

continues to present significant challenges in early diagnosis and disease control. India bears a substantial burden of tuberculosis because of population density, socioeconomic disparities, malnutrition, overcrowding, and delayed access to healthcare facilities. The disease presents with diverse clinical manifestations, ranging from mild respiratory symptoms to extensive pulmonary destruction. Early recognition and appropriate diagnostic evaluation are essential for initiating treatment and limiting transmission.[1]

Radiological imaging plays an important role in the evaluation of patients with suspected or confirmed pulmonary tuberculosis. Conventional chest radiography remains one of the most widely available, economical, and frequently performed imaging investigations in clinical practice. It provides valuable information regarding the location, distribution, morphology, and extent of pulmonary abnormalities. Chest radiographs may demonstrate consolidation, nodular infiltrates, cavitary lesions, fibrotic opacities, pleural effusion, lymphadenopathy, and diffuse pulmonary involvement. The radiographic appearance varies according to the stage of infection, immune status, previous tuberculosis exposure, and associated medical conditions. Familiarity with these abnormalities assists radiologists and clinicians in recognizing pulmonary involvement, identifying complications, and determining the need for additional investigations.[2]

The radiographic manifestations of pulmonary tuberculosis are heterogeneous and may differ considerably among individual patients. Classical post-primary pulmonary tuberculosis commonly involves the apical and posterior segments of the upper lobes, with heterogeneous opacities, consolidation, and cavitation. However, atypical presentations may include lower lung zone infiltrates, mediastinal or hilar lymphadenopathy, pleural abnormalities, and diffuse pulmonary lesions. The distinction between primary and post-primary tuberculosis based exclusively on radiographic appearances is not always reliable. Host immune responses, underlying comorbidities, and the extent of pulmonary infection influence the observed radiological patterns. Consequently, systematic interpretation of chest radiographs is necessary to recognize both typical and uncommon manifestations of pulmonary tuberculosis.[3]

The spectrum of pulmonary tuberculosis also includes parenchymal, airway, pleural, and residual structural abnormalities. Consolidation represents inflammatory involvement of pulmonary airspaces, whereas cavitary lesions develop following tissue necrosis and communication with the bronchial tree. Nodular and reticulonodular abnormalities may indicate bronchogenic or disseminated pulmonary involvement. Fibrosis, calcification, bronchiectasis, and volume loss may persist after previous infection and can complicate the interpretation of current radiographs. Computed tomography provides additional anatomical detail and may identify subtle cavitation, small nodules, lymphadenopathy, and endobronchial spread that are less clearly demonstrated on conventional radiography. Nevertheless, chest radiography remains the practical initial imaging modality in many healthcare settings.[4] Although chest radiography is useful for detecting pulmonary abnormalities, its diagnostic interpretation has certain limitations. Several radiographic manifestations of tuberculosis overlap with bacterial pneumonia, fungal infections, lung malignancies, and other chronic inflammatory pulmonary disorders. Furthermore, previously healed lesions may resemble abnormalities associated with ongoing infection. Radiographic appearances alone cannot reliably establish microbiological activity or differentiate all active lesions from inactive pulmonary changes. Interpretation may also be influenced by image quality, patient positioning, overlapping anatomical structures, and observer variability. Therefore, radiographic evaluation should be integrated with clinical history, physical examination, and appropriate laboratory investigations to improve diagnostic accuracy and avoid unnecessary treatment or delayed identification of tuberculosis.[5]

Microbiological confirmation remains essential for establishing the diagnosis of pulmonary tuberculosis. Conventional diagnostic methods include sputum acid-fast bacilli smear microscopy and mycobacterial culture, while molecular techniques such as cartridge-based nucleic acid amplification testing provide rapid identification of Mycobacterium tuberculosis and associated drug resistance. Radiographic examinations complement these investigations by identifying pulmonary abnormalities, assessing anatomical distribution, and detecting complications. The relationship between imaging findings and microbiological characteristics is particularly relevant in patients with cavitary disease, extensive pulmonary involvement, or previous tuberculosis. Combining radiographic and microbiological assessments provides a more comprehensive understanding of disease presentation and helps guide clinical decisions regarding additional investigations and management.[6]

MATERIALS & METHODS

The present study was designed as a hospital-based, observational cross-sectional study conducted in the Department of Radiodiagnosis, Index Medical College, Hospital & Research Centre, Indore, Madhya Pradesh, India. The study was undertaken to analyze the spectrum, frequency, and clinical associations of radiographic findings in patients with pulmonary tuberculosis (PTB).

Particular emphasis was placed on identifying common and atypical radiological manifestations, the anatomical distribution of pulmonary lesions, and their association

with demographic and clinical characteristics. A total of 88 patients diagnosed with pulmonary tuberculosis were included in the study. Patients were selected through consecutive sampling from those attending the outpatient department or admitted to the hospital. Adult patients aged 18 years and above, irrespective of sex, who fulfilled the eligibility criteria and underwent chest radiographic examination were enrolled. Relevant demographic, clinical, microbiological, and radiological information was collected using a structured data collection proforma.

Inclusion Criteria

Patients aged 18 years or above with microbiologically confirmed pulmonary tuberculosis, based on sputum acid-fast bacilli (AFB) smear microscopy, cartridge-based nucleic acid amplification testing (CBNAAT), or mycobacterial culture, were eligible for inclusion. Both newly diagnosed and previously treated patients were considered. Patients with technically adequate chest radiographs obtained during their initial clinical evaluation and those willing to provide informed consent were included.

Exclusion Criteria

Patients with exclusively extrapulmonary tuberculosis without pulmonary involvement were excluded. Patients with inadequate or technically unsatisfactory chest radiographs, those with established alternative pulmonary diseases likely to substantially interfere with radiographic interpretation, and those unwilling to participate were excluded. Patients with incomplete essential clinical or diagnostic records were also excluded from the final analysis.

Methodology

Detailed demographic and clinical information was recorded for all patients, including age, sex, residence, occupation, smoking status, and relevant medical history. Clinical parameters included cough, fever, sputum production, haemoptysis, chest pain, dyspnoea, night sweats, loss of appetite, and weight loss. Associated conditions such as diabetes mellitus, HIV infection, previous tuberculosis, immunosuppressive conditions, and history of antitubercular treatment were documented wherever applicable. Patients were categorized according to age groups, sex, previous tuberculosis treatment history, and microbiological findings to assess possible associations with radiographic manifestations.

Radiographic Examination and Assessment

All 88 patients underwent chest radiographic evaluation using standard digital radiography. Posteroanterior (PA) chest radiographs were obtained in ambulatory patients, whereas anteroposterior (AP) projections were used when patients were unable to stand. Additional projections were obtained when clinically indicated. Radiographs were systematically assessed for parenchymal, pleural, and mediastinal abnormalities. The predominant radiographic findings evaluated included pulmonary consolidation, patchy or heterogeneous opacities, nodular infiltrates, cavitary lesions, fibrotic changes, calcified lesions, bronchiectatic changes, miliary mottling, pleural effusion, hilar or mediastinal lymphadenopathy, atelectasis, and pneumothorax. The presence of multiple simultaneous abnormalities was also documented.

Anatomical Distribution and Radiographic Patterns

Pulmonary abnormalities were evaluated according to their anatomical location and extent. Each lung was divided into upper, middle, and lower radiographic zones, and lesions were classified as unilateral or bilateral. The predominant involvement of upper, middle, or lower lung zones was recorded. Radiographic manifestations were further categorized into cavitary, consolidative, nodular, miliary, fibrotic, and mixed patterns. Cavitary lesions were assessed according to their number, location, and approximate size. Consolidative lesions were evaluated for focal, multifocal, or diffuse involvement. Pleural abnormalities, volume loss, calcification, and associated lymphadenopathy were documented separately. The number of affected lung zones was recorded as an indicator of radiographic disease extent.

Radiographic Interpretation and Quality Control

Chest radiographs were evaluated by qualified radiologist using a standardized reporting format. Radiologist assessed the distribution, morphology, and extent of pulmonary lesions. Disagreements regarding radiographic findings were resolved through joint review and consensus. Radiological observations were correlated with available clinical history and microbiological investigations after the initial image assessment. Chest computed tomography findings, when obtained for clinical indications, were documented separately and were not considered part of the routine radiographic assessment.

Outcome Parameters

The primary outcome was the frequency and distribution of different radiographic manifestations of pulmonary tuberculosis. Secondary outcomes included the anatomical distribution of lesions, frequency of unilateral and bilateral involvement, occurrence of cavitary and non-cavitary disease patterns, extent of lung involvement, and association of radiographic findings with age, sex, smoking status, diabetes mellitus, previous tuberculosis treatment, and sputum microbiological findings.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using IBM SPSS. Categorical variables were expressed as frequencies and percentages, whereas continuous variables were presented as mean ± standard

deviation or median with interquartile range, depending on data distribution. The Shapiro–Wilk test was used to assess normality where appropriate. Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test, as applicable. Comparisons of continuous variables were performed using the independent-samples t-test or Mann–Whitney U test, depending on the distribution of data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 presents the demographic, clinical, and microbiological characteristics of the 88 patients diagnosed with pulmonary tuberculosis. The highest proportion of patients belonged to the 31–45 years age group (31.82%), followed by 46–60 years (30.68%), above 60 years (19.32%), and 18–30 years (18.18%). Males constituted 63.64% of the study population, whereas females accounted for 36.36%. A greater proportion of patients belonged to rural areas (59.09%) compared with urban areas (40.91%). Regarding smoking status, 35.23% were smokers, while 64.77% were non-smokers. Diabetes mellitus was present in 25.00% of patients, and 21.59% reported a previous history of tuberculosis. HIV positivity was recorded in 4.55% of patients. Regarding the primary method of microbiological confirmation, CBNAAT was the most frequently recorded method (70.45%), followed by AFB smear microscopy (19.32%) and mycobacterial culture (10.23%).

Table 2 illustrates the distribution of clinical symptoms among the 88 patients with pulmonary tuberculosis at the time of presentation. Cough was the most frequently reported symptom, affecting 75 patients (85.23%), followed by fever in 64 patients (72.73%) and sputum production in 61 patients (69.32%). Weight loss was observed in 53 patients (60.23%), while loss of appetite was reported by 48 patients (54.55%). Night sweats were present in 41 patients (46.59%). Respiratory symptoms such as dyspnoea and chest pain were documented in 27 (30.68%) and 26 (29.55%) patients, respectively. Haemoptysis was the least frequently reported symptom, occurring in 23 patients (26.14%). Multiple clinical symptoms were recorded in individual patients, resulting in overlapping frequencies across the different symptom categories.

Table 3 demonstrates the spectrum and frequency of chest radiographic abnormalities identified among the 88 patients with pulmonary tuberculosis. Pulmonary consolidation was the most common radiographic finding, observed in 53 patients (60.23%), followed by patchy or heterogeneous opacities in 44 patients (50.00%). Cavitary lesions were identified in 36 patients (40.91%), while nodular infiltrates were present in 34 patients (38.64%). Fibrotic changes were observed in 24 patients (27.27%), whereas pleural effusion was documented in 13 patients (14.77%). Bronchiectatic changes and calcified lesions were identified in 11 (12.50%) and 10 (11.36%) patients, respectively. Hilar or mediastinal lymphadenopathy was observed in 9 patients (10.23%), followed by atelectasis in 8 patients (9.09%) and miliary mottling in 6 patients (6.82%). Pneumothorax was the least common radiographic abnormality, identified in only 2 patients (2.27%). Several patients demonstrated more than one radiographic abnormality.

Table 4 presents the anatomical distribution, extent of pulmonary involvement, and predominant radiographic patterns among the 88 patients. Right-sided pulmonary involvement was recorded in 34 patients (38.64%), left-sided involvement in 22 patients (25.00%), and bilateral involvement in 32 patients (36.36%). Regarding anatomical distribution, upper lung zone predominance was observed in 51 patients (57.95%), followed by lower lung zones in 15 patients (17.05%) and middle lung zones in 12 patients (13.64%), while 10 patients (11.36%) demonstrated diffuse involvement without a single predominant zone. Assessment of disease extent revealed involvement of a single lung zone in 35 patients (39.77%), two lung zones in 33 patients (37.50%), and three or more zones in 20 patients (22.73%). Regarding predominant radiographic patterns, the consolidative pattern was most frequent, occurring in 30 patients (34.09%), followed by the cavitary pattern in 26 patients (29.55%). Nodular and fibrotic patterns were recorded in 14 (15.91%) and 12 (13.64%) patients, respectively, whereas the miliary pattern was observed in 6 patients (6.82%).

Table 5 presents the association of selected demographic, clinical, microbiological, and radiographic parameters with the presence of cavitary lesions among the 88 patients. Cavitary lesions were identified in 36 patients (40.91%), whereas 52 patients (59.09%) had no cavitary lesions. Cavitation was significantly more frequent among males (51.79%) than females (21.88%), with a p-value of 0.006. Similarly, smokers demonstrated a significantly higher frequency of cavitary lesions (67.74%) compared with non-smokers (26.32%; $p<0.001$). Among patients with diabetes mellitus, 54.55% had cavitary lesions compared with 36.36% of non-diabetic patients; however, this difference was not statistically significant ($p=0.133$). Patients with a previous history of tuberculosis showed a significantly higher frequency of cavitation (63.16%) compared with those without such a history (34.78%; $p=0.026$). Cavitary lesions were also significantly more common among AFB smear-positive patients (55.32%) than smear-negative patients (24.39%; $p=0.003$). Furthermore, patients with predominant upper-zone involvement demonstrated a significantly higher frequency of cavitation (54.90%) compared with those without upper-zone predominance (21.62%; $p=0.002$).

Table 1: Distribution According to Demographic, Clinical and Microbiological Characteristics (N = 88)

Parameters	Categories	Frequency (n)	Percentage (%)
Age (years)	18–30	16	18.18
	31–45	28	31.82
	46–60	27	30.68
	>60	17	19.32
Sex	Male	56	63.64
	Female	32	36.36
Residence	Rural	52	59.09
	Urban	36	40.91
Smoking status	Smoker	31	35.23
	Non-smoker	57	64.77
Diabetes mellitus	Present	22	25.00
	Absent	66	75.00
Previous tuberculosis	Present	19	21.59
history	Absent	69	78.41
HIV status	Positive	4	4.55
	Negative	84	95.45
Primary	CBNAAT	62	70.45
microbiological	AFB smear microscopy	17	19.32
confirmation	Mycobacterial culture	9	10.23

Table 2: Distribution According to Clinical Symptoms at Presentation (N = 88)

Clinical symptoms	Frequency (n)	Percentage (%)
Cough	75	85.23
Fever	64	72.73
Sputum production	61	69.32
Weight loss	53	60.23
Loss of appetite	48	54.55
Night sweats	41	46.59
Dyspnoea	27	30.68
Chest pain	26	29.55
Haemoptysis	23	26.14

Table 3: Spectrum of Chest Radiographic Findings Among Pulmonary Tuberculosis Patients (N = 88)

Radiographic findings	Frequency (n)	Percentage (%)
Pulmonary consolidation	53	60.23
Patchy/heterogeneous opacities	44	50.00
Cavitary lesions	36	40.91
Nodular infiltrates	34	38.64
Fibrotic changes	24	27.27
Pleural effusion	13	14.77
Bronchiectatic changes	11	12.50
Calcified lesions	10	11.36
Hilar/mediastinal lymphadenopathy	9	10.23
Atelectasis	8	9.09
Miliary mottling	6	6.82
Pneumothorax	2	2.27

Table 4: Anatomical Distribution, Extent of Lung Involvement & Predominant Radiographic Patterns (N = 88)

Parameters	Categories	Frequency (n)	Percentage (%)
Laterality of involvement	Right lung only	34	38.64
	Left lung only	22	25.00
	Bilateral lungs	32	36.36
Predominant anatomical distribution	Upper lung zones	51	57.95
	Middle lung zones	12	13.64
	Lower lung zones	15	17.05
	Diffuse/no single predominant zone	10	11.36
Extent of lung involvement	Single lung zone	35	39.77
	Two lung zones	33	37.50
	Three or more lung zones	20	22.73
Predominant radiographic pattern	Consolidative	30	34.09
	Cavitary	26	29.55
	Nodular	14	15.91
	Fibrotic	12	13.64
	Miliary	6	6.82

Table 5: Association of Selected Clinical and Radiographic Parameters with Cavitary Lesions (N = 88)

Parameters	Categories	Cavitary lesions present (n=36)	Cavitary lesions absent (n=52)	p-value
Sex	Male	29 (51.79%)	27 (48.21%)	0.006
	Female	7 (21.88%)	25 (78.12%)	
Smoking status	Smoker	21 (67.74%)	10 (32.26%)	<0.001
	Non-smoker	15 (26.32%)	42 (73.68%)	
Diabetes mellitus	Present	12 (54.55%)	10 (45.45%)	0.133
	Absent	24 (36.36%)	42 (63.64%)	
Previous tuberculosis	Present	12 (63.16%)	7 (36.84%)	0.026
	Absent	24 (34.78%)	45 (65.22%)	
AFB smear status	Positive	26 (55.32%)	21 (44.68%)	0.003
	Negative	10 (24.39%)	31 (75.61%)	
Predominant upper-zone involvement	Present	28 (54.90%)	23 (45.10%)	0.002
	Absent	8 (21.62%)	29 (78.38%)	

DISCUSSION

The present study included 88 patients diagnosed with pulmonary tuberculosis, with the highest proportion belonging to the 31–45 years age group (31.82%), followed by 46–60 years (30.68%). Male patients constituted 63.64%, while females accounted for 36.36%. Rural residents represented 59.09% of the population, and 35.23% of patients were smokers. A previous history of tuberculosis was reported in 21.59%, while diabetes mellitus was present in 25.00% of patients. Chiang et al. (2014) conducted a multicentre study involving 1,209 patients with culture-positive pulmonary tuberculosis in Taiwan and reported that 74.00% were males, 44.30% were ever-smokers, and 86.90% were newly diagnosed cases.[7]

The male predominance observed in the present study was comparable to their findings, although the proportion of males was relatively lower. Smoking was also less frequent in the present study, although the definitions of smoking exposure differed. These variations may reflect differences in demographic characteristics, patient selection, and the distribution of tuberculosis-related risk factors across populations.

In the present study, cough was the most frequently reported clinical manifestation, affecting 85.23% of patients, followed by fever (72.73%), sputum production (69.32%), weight loss (60.23%), and loss of appetite (54.55%). Night sweats were reported in 46.59%, while haemoptysis was observed in 26.14% of patients. Singh et al. (2013), in their prospective study conducted among pulmonary tuberculosis index cases and household contacts in South Delhi, reported that among 432 index patients, cough was present in 94.70%, fever in 91.00%, weight loss in 63.20%, and anorexia in 69.00%.[8]

The findings of the present study were broadly comparable, particularly regarding the predominance of cough and constitutional symptoms. However, the frequencies of cough, fever, and anorexia were relatively lower than those observed by Singh and colleagues. The similarity in symptom distribution supports the importance of respiratory and constitutional manifestations in the clinical presentation of pulmonary tuberculosis, while differences in frequency may be related to disease severity and healthcare-seeking patterns. The radiographic assessment in the present study demonstrated pulmonary consolidation as the most frequent abnormality, occurring in 60.23% of patients, followed by patchy or heterogeneous opacities (50.00%), cavitary lesions (40.91%), and nodular infiltrates (38.64%). Fibrotic changes were identified in 27.27%, while pleural effusion was observed in 14.77% of patients.

Eini et al. (2013) evaluated chest radiographic findings among 325 patients with sputum smear-positive pulmonary tuberculosis and reported bronchopneumonia in 74.40%, patchy consolidation in 30.40%, cavitary lesions in 20.90%, and pleural effusion in 10.70%.[9] Compared with their study, the present study demonstrated a higher frequency of cavitary lesions (40.91% versus 20.90%) and pleural effusion (14.77% versus 10.70%). Consolidation was also prominent in both studies, although the reported consolidation categories were not identical. These differences may be attributed to variations in radiographic classification, previous tuberculosis history, and the clinical characteristics of the selected patients. Regarding the predominant radiographic patterns, the present study demonstrated a consolidative pattern in 34.09% of patients, followed by cavitary (29.55%), nodular (15.91%), fibrotic (13.64%), and miliary (6.82%) patterns. Upper lung zone predominance was identified in 57.95% of patients, whereas lower and middle lung zone predominance occurred in 17.05% and 13.64%, respectively.

Shumy et al. (2013) conducted a cross-sectional radiographic evaluation of 100 patients with post-primary pulmonary tuberculosis and observed upper-zone involvement in 45.00% of cases, while consolidation was the predominant opacity in 25.00%. Furthermore, 44.00% of their patients were sputum AFB-positive, among whom cavitation was the dominant lesion.[10]

The present study demonstrated a higher proportion of upper-zone predominance (57.95% versus 45.00%) and consolidative patterns (34.09% versus 25.00%). Nevertheless, both studies identified upper-zone involvement and consolidation as important radiographic manifestations of pulmonary tuberculosis. These findings demonstrate the predominance of upper pulmonary zones in the radiographic distribution of disease. The anatomical distribution of pulmonary lesions in the present study revealed right-sided involvement in 38.64% of patients, left-sided involvement in 25.00%, and bilateral pulmonary abnormalities in 36.36%. Upper-zone predominance was observed in 57.95%, whereas 22.73% of patients demonstrated involvement of three or more lung zones. Koh et al. (2010) investigated chest radiographic findings in 58 adolescents with primary pulmonary tuberculosis, of whom 55 demonstrated abnormal radiographs. Among these 55 patients, upper-zone predominance was observed in 49.00%, lower-zone predominance in 33.00%, and combined upper- and lower-zone involvement in 18.00%. Bilateral pulmonary involvement was documented in 24.00%, while cavitary lesions were identified in 45.00%.[11]

Compared with their findings, the present study demonstrated greater upper-zone predominance (57.95% versus 49.00%) and bilateral involvement (36.36% versus 24.00%), whereas the frequency of cavitary lesions was relatively similar (40.91% versus 45.00%). The differences in anatomical distribution may be influenced by the inclusion of adults with previously treated disease in the present study compared with adolescents with primary tuberculosis in the earlier investigation. The association between clinical characteristics and cavitary lesions demonstrated that cavitation was significantly more frequent among males (51.79%) than females (21.88%; $p=0.006$). Similarly, smokers exhibited a higher frequency of cavitary lesions (67.74%) compared with non-smokers (26.32%; $p<0.001$). Patients with a previous history of tuberculosis also demonstrated significantly greater cavitary involvement (63.16%) than those without such a history (34.78%; $p=0.026$).

Dholakia et al. (2012) investigated chest radiographic findings and associated clinical parameters among pulmonary tuberculosis patients enrolled in the National Tuberculosis Programme in Mumbai. Their study demonstrated a significant association between smoking and cavitary lesions among newly diagnosed patients ($p=0.0238$). Bilateral cavitary disease was also significantly associated with male sex ($p=0.01$), while cavitation was associated with multidrug-resistant tuberculosis ($p=0.048$).[12] These observations were consistent with the significant associations of smoking and male sex with cavitary pulmonary disease in the present study. The findings suggest that patient-related characteristics may be associated with the morphological presentation and extent of pulmonary tuberculosis, although the cross-sectional design cannot establish causality. In the present study, diabetes mellitus was identified in 25.00% of patients. Cavitary lesions were observed in 54.55% of diabetic patients compared with 36.36% of non-diabetic patients. Although the frequency of cavitation was higher among individuals with diabetes

mellitus, the difference was not statistically significant (p=0.133). Alavi et al. (2014) conducted a comparative study involving 148 hospitalized patients with pulmonary tuberculosis, including 36 diabetic and 112 non-diabetic individuals. They reported cavitary lesions in 55.50% of diabetic patients compared with 31.20% of non-diabetic patients, demonstrating a statistically significant association (p=0.008). Reticulonodular radiographic abnormalities were also significantly more common among diabetic patients (22.20% versus 8.00%; p=0.020).[13]

The frequency of cavitary disease among diabetic patients in the present study (54.55%) was almost identical to that reported by Alavi and colleagues (55.50%). However, the absence of statistical significance in the present study may be related to its smaller sample size and the comparatively limited number of diabetic patients. These findings indicate a possible association between diabetes mellitus and cavitary pulmonary tuberculosis that requires confirmation in a larger population. The present study demonstrated a significant association between cavitary lesions and sputum AFB smear positivity. Cavitation was identified in 55.32% of smear-positive patients compared with 24.39% of smear-negative patients (p=0.003). Furthermore, patients with predominant upper-zone involvement demonstrated significantly greater cavitary involvement (54.90%) than those without upper-zone predominance (21.62%; p=0.002). Palaci et al. (2007) evaluated the association between cavitary pulmonary tuberculosis and quantitative sputum bacillary load in 244 patients, including 100 patients with cavitary disease and 144 without cavitation. They reported that 85.00% of patients with cavitary disease demonstrated high-grade sputum smear positivity (3+), compared with 38.00% of patients without cavitary lesions (p<0.0001). Conversely, smear negativity was observed in only 3.00% of cavitary cases compared with 38.00% of non-cavitary cases.[14]

CONCLUSION

The present study concluded that pulmonary tuberculosis demonstrated a wide spectrum of radiographic abnormalities, with pulmonary consolidation, patchy opacities, cavitary lesions, and nodular infiltrates being the predominant findings. Upper lung zone involvement was most frequent, with considerable variation in the anatomical distribution and extent of pulmonary lesions. Cavitary lesions showed significant associations with male sex, smoking, previous tuberculosis history, sputum AFB positivity, and upper-zone involvement. Chest radiography remained a valuable initial imaging modality for assessing pulmonary involvement and identifying complications. Integration of radiographic findings with clinical and microbiological investigations was essential for comprehensive evaluation and appropriate management of pulmonary tuberculosis.

REFERENCES

1. Zumla A, Raviglione M, Hafner R, von Reyn CF. Tuberculosis. N Engl J Med. 2013;368(8):745-755. doi:10.1056/NEJMra1200894.

2. Bhalla AS, Goyal A, Guleria R, Gupta AK. Chest tuberculosis: radiological review and imaging recommendations. Indian J Radiol Imaging. 2015;25(3):213-225. doi:10.4103/0971-3026.161431.

3. Rozenshtein A, Hao F, Starc MT, Pearson GDN. Radiographic appearance of pulmonary tuberculosis: dogma disproved. AJR Am J Roentgenol. 2015;204(5):974-978. doi:10.2214/AJR.14.13483.

4. Skoura E, Zumla A, Bomanji J. Imaging in tuberculosis. Int J Infect Dis. 2015;32:87-93. doi:10.1016/j.ijid.2014.12.007.

5. Piccazzo R, Paparo F, Garlaschi G. Diagnostic accuracy of chest radiography for the diagnosis of tuberculosis (TB) and its role in the detection of latent TB infection: a systematic review. J Rheumatol Suppl. 2014;91:32-40. doi:10.3899/jrheum.140100.

6. Boehme CC, Nabeta P, Hillemann D, Nicol MP, Shenai S, Krapp F, et al. Rapid molecular detection of tuberculosis and rifampin resistance. N Engl J Med. 2010;363(11):1005-1015. doi:10.1056/NEJMoa0907847.

7. Chiang CY, Lee JJ, Chien ST, Enarson DA, Chang YC, Chen YT, et al. Glycemic control and radiographic manifestations of tuberculosis in diabetic patients. PLoS One. 2014;9(4):e93397. doi:10.1371/journal.pone.0093397.

8. Singh J, Sankar MM, Kumar S, Gopinath K, Singh N, Mani K, et al. Incidence and prevalence of tuberculosis among household contacts of pulmonary tuberculosis patients in a peri-urban population of South Delhi, India. PLoS One. 2013;8(7):e69730. doi:10.1371/journal.pone.0069730.

9. Eini P, Osquee HO, Nasab MS, Khiyabani FN, Rahighi AH. Chest radiological features among patients with smear positive pulmonary tuberculosis. Caspian J Intern Med. 2013;4(4):777-780. PMID: 24294473.

10. Shumy F, Faiz MA, Anam AM. Predilection of zonal involvement and pattern of opacities in chest X-ray in post primary pulmonary tuberculosis. Mymensingh Med J. 2013;22(4):721-726. PMID: 24292303.

11. Koh WJ, Jeong YJ, Kwon OJ, Kim HJ, Cho EH, Lew WJ, et al. Chest radiographic findings in primary pulmonary tuberculosis: observations from high school outbreaks. Korean J Radiol. 2010;11(6):612-617. doi:10.3348/kjr.2010.11.6.612.

12. Dholakia YN, D'souza DTB, Tolani MP, Chatterjee A, Mistry NF. Chest X-rays and associated clinical parameters in pulmonary tuberculosis cases from the

National Tuberculosis Programme, Mumbai. Infect Dis Rep. 2012;4(1):e10. doi:10.4081/idr.2012.e10.
13. Alavi SM, Khoshkho MM, Salmanzadeh S, Eghtesad M. Comparison of epidemiological, clinical, laboratory and radiological features of hospitalized diabetic and non-diabetic patients with pulmonary tuberculosis at Razi Hospital in Ahvaz. Jundishapur J Microbiol. 2014;7(9):e12447. doi:10.5812/jjm.12447.
14. Palaci M, Dietze R, Hadad DJ, Ribeiro FKC, Peres RL, Vinhas SA, et al. Cavitary disease and quantitative sputum bacillary load in cases of pulmonary tuberculosis. J Clin Microbiol. 2007;45(12):4064-4066. doi:10.1128/JCM.01780-07.

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