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Original Research Article

Comparison of chest X-ray findings in smear-positive and smear-negative patients with pulmonary tuberculosis attending a tertiary care hospital in Bangladesh

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ABSTRACT

Background: Tuberculosis (TB) continues to be a significant public health issue in Bangladesh and a significant number of people with active pulmonary TB (PTB) are sputum smear-negative, making chest radiography an important adjunctive diagnostic tool. The objective of this study was to compare the sociodemographic, clinical and chest radiographic profile of smear-positive and smear-negative PTB patients attending a tertiary care hospital in Bangladesh.
Methods: This descriptive cross-sectional study was conducted at the Department of Medicine in Enam Medical College & Hospital, Dhaka, from January to June 2018 on 100 patients with pulmonary tuberculosis who were equally divided into 50 sputum smear-positive and 50 sputum smear-negative groups according to Ziehl-Neelsen staining. The Chi-square test was used to compare the sociodemographic data, clinical symptoms, erythrocyte sedimentation rate (ESR) and chest radiographic findings between the groups and a p value of less than 0.05 was regarded as statistically significant.
Results: The two groups were mainly male, middle-aged and had no significant sociodemographic differences. Smear-positive patients were significantly more likely to have cough (100.0% vs 72.0%, p=0.001). Smear-positive patients had a higher rate of a raised ESR (>50 mm in the first hour) (50.0% vs 24.0%, p=0.007). Consolidation (56.0% vs 24.0%), inhomogeneous opacity (16.0% vs 4.0%), patchy opacity (32.0% vs 12.0%) and cavitary lesions (54.0% vs 22.0%) were all significantly more common in the smear-positive group ($p<0.05$), whereas nodular opacity, fibrosis, pleural effusion and collapse did not differ significantly between the groups.
Conclusions: Pulmonary tuberculosis with smear positivity was associated with more frequent cough, raised ESR and consolidation and cavitation on chest radiography, suggesting that chest radiography is complementary to sputum microscopy in the diagnostic evaluation of pulmonary tuberculosis.

Keywords: Chest radiography, Cavitary lesion, Pulmonary tuberculosis, Sputum smear microscopy

INTRODUCTION

Tuberculosis (TB) is one of the top causes of death due to a single infectious agent globally, with an estimated 10.8 million new cases of TB and 1.25 million deaths from TB in 2023 alone.[1] The majority of these cases are pulmonary tuberculosis (PTB) which is still largely diagnosed by the demonstration of acid-fast bacilli (AFB) in sputum using the Ziehl–Neelsen (ZN) microscopy, with chest radiography used when bacteriological confirmation is delayed or not available.[2] The sensitivity of ZN staining is moderate and is widely available in resource-limited countries like Bangladesh, but a significant number of patients with true PTB are repeatedly smear-negative despite being actively ill.[3] Molecular assays like GeneXpert MTB/RIF have enhanced the detection of

smear-negative suspects, but are expensive and not widely available at the primary-care level in high-burden, low-resource countries.[4] Therefore, chest radiography remains a recommended adjunctive screening and diagnostic tool, especially in patients with negative sputum smears but clinical suspicion of PTB.[5] The diagnostic value of radiographic interpretation alone, however, is not consistent across settings and is not as useful when not used in conjunction with a rapid molecular test.[6] Bangladesh is one of the high TB burden countries in the world and the COVID-19 pandemic has exacerbated the difference between the estimated and notified cases in the country's national tuberculosis control programme.[7]

In Bangladesh, a significant proportion of presumptive TB cases have been found to be false-positive in community-based surveys of presumptive TB cases, highlighting the need for radiological correlation in this population.[8] This diagnostic gap is exacerbated by health-seeking behaviour and health-system delay, which have been found to be significant among rural Bangladeshi patients with smear-positive disease and are likely to be even higher among smear-negative patients.[9] Smear-positive PTB is classically associated with cavitary and consolidative lesions, which are indicative of a higher bacillary load, while smear-negative disease has been reported to have more heterogeneous and often subtler patterns.[10] Cross-sectional imaging has been demonstrated to be useful in the diagnosis of disease when plain radiography is ambiguous, reinforcing the fact that radiographic pattern recognition has diagnostic value in addition to confirming the already smear-positive cases.[11]

However, there is still a lack of comparative description of the chest radiographic features of smear-positive and smear-negative PTB patients in the context of Bangladesh. This study was therefore conducted to compare the sociodemographic, clinical and chest radiographic profile of smear-positive and smear-negative pulmonary tuberculosis patients attending a tertiary care hospital in Bangladesh to clarify whether the radiographic pattern can meaningfully help to differentiate and assess these two clinically important groups.

METHODS

This descriptive cross-sectional study was conducted at the Department of Medicine in Enam Medical College & Hospital, Dhaka, from January to June 2018, enrolling 100 patients with a diagnosis of pulmonary tuberculosis by purposive sampling and dividing them into two groups of 50 each: sputum smear-positive and sputum smear-negative, based on Ziehl-Neelsen stained sputum microscopy, in the department of radiology and imaging in collaboration with the department of respiratory medicine of a tertiary care hospital in Bangladesh over a period of 12 months. Patients aged over 18 years, both male and female, who presented with symptoms suggestive of pulmonary tuberculosis (cough, fever, haemoptysis, weight loss, night sweats or chest pain) and who had a standard postero-anterior chest radiograph and at least two sputum smear examinations before starting anti-tubercular treatment were included in the study. Patients with extrapulmonary TB alone, patients receiving anti-tubercular therapy for more than 2 weeks, patients with HIV co-infection, pregnant women and patients with other chronic respiratory or cardiac diseases that may affect the chest radiographic appearance were excluded. The clinical symptoms recorded for each participant were fever, night sweats, cough, haemoptysis, weight loss, chest pain, shortness of breath, loss of appetite and malaise, ESR and chest radiographic findings, including the laterality and zonal distribution of lung involvement and specific radiographic patterns, such as consolidation, inhomogeneous opacity, nodular opacities, patchy opacity, pleural effusion, fibrosis, collapse and cavitary lesion. All chest radiographs were reviewed and findings were recorded by the treating clinicians and radiologists.

The data were entered into a Microsoft Excel spreadsheet and analysed using SPSS software. Categorical variables were presented as frequencies and percentages and continuous variables as mean±SD. Categorical variables were compared between the smear-positive and smear-negative groups using the Chi-square test or Fisher's exact test if cell frequencies were small and a p value of <0.05 was considered statistically significant.

RESULTS

The sociodemographic data of the 100 study subjects (50 smear-positive and 50 smear-negative) are shown in Table 1. The mean age of the smear-positive and smear-negative patients was 46.7±10.9 years and 49.1±12.0 years, respectively, with the majority of patients in both groups being aged 41-50 years. The majority of both groups were male (60.0% and 66.0%, respectively) and Muslim, married and in service occupations and from middle-income families. The distribution of clinical symptoms based on the sputum smear status is shown in Table 2. All (100.0%) smear-positive patients had cough, while 72.0% of smear-negative patients had cough (p=0.001). Other symptoms recorded in both groups were fever, night sweats, haemoptysis, weight loss, chest pain, shortness of breath, loss of appetite and malaise, but these differences were not significant.

The ESR is compared in the two groups in able 3.T In smear-positive patients, ESR values were also evenly distributed with 25 (50.0%) patients having ESR ≤50 mm and 25 (50.0%) patients having ESR >50 mm. In smear-negative patients, 38 (76.0%) had ESR ≤50 mm and 12 (24.0%) had ESR >50 mm. This difference in ESR distribution between the groups was statistically significant (p=0.007). The distribution and location of pulmonary involvement on chest X-ray is described in Table 4. In terms of lung involvement, 48.0% of smear-positive and 42.0% of smear-negative patients had involvement of the left lung and 12.0% and 14.0% of the patients had involvement of both lungs, respectively. The

middle zone was the most commonly involved zone in both groups (40.0% and 42.0%), with no significant difference between the groups (p=0.830 and p=0.756). The chest X-ray results are compared between the groups in Table 5. Consolidation (56.0% vs 24.0%, p=0.001), inhomogeneous opacity (16.0% vs 4.0%, p=0.046), patchy opacity (32.0% vs 12.0%, p=0.016) and cavitary lesion (54.0% vs 22.0%, p=0.001) were significantly more frequent among smear-positive patients. Nodular opacities, pleural effusion, fibrosis and collapse were also noted in both groups, but were not significantly different between smear-positive and smear-negative patients.

Table 1: Sociodemographic characteristics of the study participants (n=100).

Variables	Category	Smear positive, (n=50), N (%)	Smear negative, (n=50), N (%)
Age (in years)	≤30	7 (14.0)	3 (6.0)
	31-40	8 (16.0)	11 (22.0)
	41-50	21 (42.0)	17 (34.0)
	51-60	11 (22.0)	12 (24.0)
	>60	3 (6.0)	7 (14.0)
	Mean±SD	46.7±10.9	49.1±12.0
Sex	Male	30 (60.0)	33 (66.0)
	Female	20 (40.0)	17 (34.0)
Religion	Muslim	48 (96.0)	47 (94.0)
	Hindu	2 (4.0)	3 (6.0)
Occupational status	Housewife	16 (32.0)	12 (24.0)
	Service	26 (52.0)	28 (56.0)
	Businessman	8 (16.0)	10 (20.0)
Marital status	Unmarried	5 (10.0)	7 (14.0)
	Married	44 (88.0)	43 (86.0)
	Divorced	1 (2.0)	0 (0.0)
Family income	Lower	11 (22.0)	14 (28.0)
	Middle	31 (62.0)	29 (58.0)
	Upper	8 (16.0)	7 (14.0)

Table 2: Clinical symptoms according to sputum smear status (n=100).

Clinical symptoms	Smear positive, (n=50), N (%)	Smear negative, (n=50), N (%)	P value
Fever	26 (52.0)	21 (42.0)	0.316
Night sweat	15 (30.0)	14 (28.0)	0.826
Cough	50 (100.0)	36 (72.0)	0.001
Haemoptysis	6 (12.0)	2 (4.0)	0.134
Weight loss	33 (66.0)	25 (50.0)	0.105
Chest pain	2 (4.0)	1 (2.0)	0.500
Shortness of breath	2 (4.0)	1 (2.0)	0.500
Loss of appetite	1 (2.0)	0 (0.0)	0.500
Malaise	2 (4.0)	0 (0.0)	0.247

Table 3: ESR according to sputum smear status (n=100).

Variables	Category	Smear positive, (n=50), N (%)	Smear negative, (n=50), N (%)	P value
ESR (mm in 1st hour)	≤50	25 (50.0)	38 (76.0)	0.007
	>50	25 (50.0)	12 (24.0)	

Table 4: Distribution and location of pulmonary involvement on chest X-ray (n=100).

Variables	Category	Smear positive, (n=50), N (%)	Smear negative, (n=50), N (%)	P value
Lung involvement	Right lung	20 (40.0)	22 (44.0)	0.830
	Left lung	24 (48.0)	21 (42.0)	
	Both lungs	6 (12.0)	7 (14.0)	
Zone involvement	Upper	18 (36.0)	20 (40.0)	0.756
	Middle	20 (40.0)	21 (42.0)	
	Lower	12 (24.0)	9 (18.0)	

Table 5: Comparison of chest X-ray findings according to sputum smear status (n=100).

Chest X-ray finding	Smear positive, (n=50), N (%)	Smear negative, (n=50), N (%)	P value
Consolidation	28 (56.0)	12 (24.0)	0.001
Inhomogeneous opacity	8 (16.0)	2 (4.0)	0.046
Nodular opacities	17 (34.0)	21 (42.0)	0.410
Patchy opacity	16 (32.0)	6 (12.0)	0.016
Pleural effusion	6 (12.0)	5 (10.0)	0.749
Fibrosis	16 (32.0)	10 (20.0)	0.171
Collapse	3 (6.0)	1 (2.0)	0.309
Cavitary lesion	27 (54.0)	11 (22.0)	0.001

DISCUSSION

This study compared the sociodemographic, clinical and chest radiographic profile of 50 sputum smear-positive and 50 sputum smear-negative pulmonary tuberculosis (PTB) patients who attended a tertiary care hospital in Bangladesh.

The mean age of smear-positive (46.7±10.9 years) and smear-negative (49.1±12.0 years) patients was similar and both groups were predominantly male, which is broadly consistent with sociodemographic profiles reported from other South Asian settings. A study conducted in a hospital in West Bengal, India, also found that the majority of TB patients were middle-aged, male and of lower and middle socioeconomic status.[12]

Studies conducted in Delhi and central India, which documented the sociodemographic profile of TB patients at DOTS centers, also found a predominance of married, middle-aged adults, with the majority of patients in the 4th and 5th decades of life, similar to the age and marital distribution observed in the present cohort.[13,14] The cough was significantly more frequent in the smear-positive group (100.0% vs 72.0%, p=0.001), but other symptoms, including fever, weight loss and haemoptysis, were more common in the smear-positive group but were not statistically significant.

A similar hospital-based cross-sectional study conducted in Puducherry, India, that compared clinical and radiological features of newly diagnosed smear-positive PTB patients also found that cough was the most consistent symptom and was a good discriminator of bacillary load, not a feature specific to age or region.[15] The higher proportion of raised ESR (>50 mm in the first hour) among smear-positive patients (50.0%) compared with smear-negative patients (24.0%) in this study is consistent with a Pakistani study of haematological manifestations in newly diagnosed PTB patients, which found a raised ESR in the overwhelming majority of patients and identified it as a sensitive, though non-specific, marker of disease activity and bacillary burden.[16]

The radiographic features of this study revealed that consolidation and inhomogeneous opacity were significantly more common in smear-positive patients, while nodular opacities, fibrosis, pleural effusion and collapse were more evenly distributed between the two groups. This is similar to the results of a prospective study in India which compared chest radiographs of new sputum-positive and sputum-negative PTB patients and found that patchy infiltrate and cavitation were significantly more common in sputum-positive patients, whereas cystic lesions, fibrosis, nodules and mediastinal adenopathy were relatively more common in sputum-negative patients.[17]

A similar Indian cohort study of radiological sequelae after treatment for PTB also highlighted that cavitary and consolidative change on baseline radiographs is associated with increased bacillary load at presentation.[18] A cross-sectional study of HRCT in smear-positive and smear-negative PTB in Pakistan also showed that features of active bacillary disease such as consolidation and cavitation were more common and more easily detected in smear-positive patients, whereas smear-negative disease was often not easily diagnosed on HRCT and required cross-sectional imaging for confident radiological categorisation.[19]

In addition to the national tuberculosis prevalence survey in Pakistan, which also identified that there were significant gaps between the radiologically suspected and bacteriologically confirmed TB in high-burden South Asian populations, these regional data reinforce the current finding that smear-negative PTB, although less florid on chest radiograph, is a significant and clinically important proportion of the disease burden that cannot be fully characterized by chest radiograph alone.[20]

The overall agreement with the larger South Asian literature indicates that the pattern of radiographic and haematological findings by bacillary status is a more regional than institution-specific phenomenon and is consistent with the pattern seen in the rest of the world in TB surveillance data that are currently available.[21]

Limitations

The study was conducted in a single center, was cross-sectional and included a relatively small number of patients and radiological findings were obtained from plain chest radiography and not from more sensitive imaging modalities.

CONCLUSION

This study demonstrated that smear-positive pulmonary TB patients were more likely to have cough, elevated ESR and radiographic features like consolidation, patchy opacity and cavitary lesions, while smear-negative patients had comparatively milder clinical and radiological presentations. The two groups were comparable in terms of sociodemographic factors.

The results indicate that chest radiography is not a substitute for bacteriological diagnosis, but characteristic patterns like cavitation and consolidation could assist clinicians in considering the possibility of high bacillary load disease and in adopting a more comprehensive diagnostic strategy for smear-negative pulmonary tuberculosis.

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