Original Article

Relationship between Sputum Bacilloscopy and Radiological Lesions in Pulmonary Tuberculosis

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ABSTRACT

Background

Pulmonary tuberculosis (PTB) is still a major public health concern worldwide, especially in developing countries. The detection of acid-fast bacilli (AFB) through sputum bacilloscopy in respiratory specimens is the cornerstone for diagnosing active PTB. This study aims to evaluate the relationship between sputum bacilloscopy results and radiological lesions in patients with pulmonary tuberculosis.

Methods

This observational study was carried out in the Department of Internal Medicine, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from 1st January 2015 to 31st January 2016. Seventy (70) newly diagnosed PTB patients attending the inpatient and outpatient departments were recruited prior to initiation of anti-TB chemotherapy. The Data were manually processed and analyzed using the Statistical Package for the Social Sciences version 21.

Result

The average age of 70 pulmonary tuberculosis patients was 34.3 years with male is slightly higher than female (55.7%). Most had normal BMI, though low BMI was more frequent among PTB cases. Cough (92.5%), fever (68.5%), and weight loss (60%) were the most common clinical symptoms. Hematological analysis revealed mild anemia and elevated ESR. Sputum AFB was positive in 45.7% and GeneXpert in 75.7%. Chest X-rays showed consolidation in 50% and cavitation developed in 40% of patients. There was a significant association of AFB positivity with consolidation and cavitary lesions ($p < 0.05$).

Conclusion

This study demonstrates a definite association between sputum bacilloscopic and radiological lesion in pulmonary tuberculosis. Consolidation and cavitary lesions were significantly more frequent among smear-positive patients, reflecting a higher bacillary load and more extensive pulmonary involvement.

Keywords

Sputum Bacilloscopy; Radiological Lesions; Pulmonary Tuberculosis; HRCT

INTRODUCTION

Pulmonary tuberculosis (PTB) remains a major global health challenge, particularly in low and middle-income regions bearing the greatest burden. Two of the most vital diagnostic and monitoring tools are sputum bacilloscopy (AFB microscopy) and chest radiological imaging, including chest X-ray (CXR) and high-resolution computed tomography (HRCT). Sputum smear microscopy provides rapid insight into contagiousness and treatment response can be monitored, imaging assesses the extent of lesion, cavitation, and dissemination.

The crucial diagnostic and prognostic value of understanding how smear status correlates with radiographic findings is enormous. Smear-positive PTB is frequently associated with characteristic radiologic patterns on CXR. In a cohort of 325 smear-positive patients, the upper lung zones including left upper lobes were predominantly affected in 53.8%, and right upper lobes in 41.2%, bronchopneumonia occurred in 74.4%, patchy consolidation was found in 30.4%, and cavitary lesions was seen

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among 20.9% syndromes[1]. Another investigation highlighted that typical adult-type smear-positive PTB cases exhibits upper-zone predilection, cavitation, volume loss, and poorly defined acinar shadows with readers demonstrating excellent inter-reader agreement with regard to cavitation and distribution [2]. Higher sputum AFB burden correlates with greater radiological involvement. A validated CXR scoring system found that the proportion of lung fields affected and the presence of cavitation were significantly associated with higher smear grades, as well as predictive of persistent smear positivity at two months of treatment[3]. In this way, radiological severity parallels microbiological burden and reflects patterns of disease transmissibility and treatment responsiveness. HRCT provides a higher resolution, especially in smear-negative cases or early-stage disease. In one study from Pakistan, HRCT demonstrated high sensitivity and specificity for PTB in both smear-positive and smear-negative cases, it enabled identification of nodules, cavities, consolidation, and lymphadenopathy[4]. In another detailed HRCT analysis of smear-negative cases, centrilobular nodules and tree-in-bud patterns were frequently observed in culture-proven active PTB, suggesting bronchogenic dissemination and these features offer critical diagnostic clues when smear microscopy fails to detect AFB[5]. Smear-negative PTB poses a diagnostic dilemma as imaging appearances are not sufficiently specific although suggestive lesions can be identified[6]. These findings underscore the need for integrating radiological patterns with culture or clinical follow-up for definitive diagnosis. Beyond diagnosis, imaging findings reflect prognosis and feasibility of residual disease. Extensive disease or cavitation at baseline predicts delayed smear conversion and long-term complications including fibrosis and bronchiectasis [3]. Moreover, miliary dissemination, manifesting as numerous 1–3 mm nodules can be radiographically occult in up to 25–40% of cases on CXR but is revealed by HRCT early in disease progression [7]. Radiographic features including pleural effusion, lymphadenopathy and bronchial extension also reflect disease burden and complications[7]. Although radiological findings offer useful insights, they are not definitively diagnostic on their own. A typical and even normal radiographs, despite the diagnosis of positive cultures may be present in some patients, particularly those with immunosuppression[8]. Accordingly, integrating imaging findings with microbiological data, clinical presentation, and epidemiologic setting becomes crucial for accurate diagnosis and treatment. The objectives of the study were to identify the current radiological pattern of pulmonary tuberculosis and compare it with national and international patterns from other studies.

METHODS

This observational study was carried out in the Department of Internal Medicine, Bangladesh Medical University (BMU), Dhaka, Bangladesh, from 1st January 2015 to 31st January 2016. Seventy (70) newly

Table 1: Demographic Characteristics of the Study Subjects (N = 70)

Parameter	Case (N = 70)	P value
Age (years)	34.3 ± 15.3	0.5
18–29	32 (45.7%)	
30–44	23 (32.8%)	
45–60	15 (21.4%)	
Gender		
Male	39 (55.7%)	0.3
Female	31 (44.3%)	
Smoking	21 (30%)	0.22
BMI	20.8 ± 3.3	0.03
Low	11 (15.7%)	
Normal	56 (80%)	
High	3 (4.3%)	
BCG scar	42 (60%)	0.22

The age of the subjects ranged from 18 to 60 years, with a mean age of 34.3 ± 15.3 years. Males constituted 55.7% of the study population, indicating a slight male predominance. Most participants (80%) had a normal BMI, though 15.7% were underweight, indicating a trend toward lower BMI in PTB patients. Smoking was more common among males (30%), and a BCG vaccination scar was observed in 60% of cases. There were no statistically significant differences observed across gender, age groups, or smoking status, except for BMI, that was statistically lower in PTB patients (p = 0.03).

diagnosed PTB patients from inpatient and outpatient department, before starting anti-TB chemotherapy, were enrolled. Study participants were recruited on a convenience basis across genders, racial groups and areas of residence with an age distribution from 18 to 60 years. Exclusion criteria included: Prior anti-TB chemotherapy and pregnancy. Data were collected by using a pre-designed data sheet prepared for the study with face-to-face interviews, relevant clinical examinations, and investigations. The diagnosis of PTB was made through relevant history (fever, cough for 3 weeks or more, and weight loss), examination, and bacteriological confirmation by sputum for acid-fast bacilli (AFB) and/or sputum for Xpert MTB/RIF (GeneXpert). To be considered as a case of PTB, an individual had to have at least one or more of the following: i) positive sputum smear, ii) positive GeneXpert's-morbid conditions were excluded by self-reporting. This study was performed in accordance with the approval of the the Institutional Review Board of Bangladesh Medical University (BMU), Dhaka, Bangladesh. The data were processed manually and analyzed using Statistic Package for Social Science version 26. Mean and standard deviation (SD) were used for reporting. P values < 0.05 were considered as statistically significant.

RESULTS

Table 2: Clinical Presentation of the Study Subjects (N = 70)

Parameter	Case (N = 70) (%)
Fever	48 (68.5%)
Cough (≥2 weeks)	65 (92.5%)
Weight loss	42 (60%)
TB contact	5 (7%)

Among the study population, the most frequently reported symptoms were cough for more than two weeks (92.5%), fever (68.5%), and weight loss (60%). A minority (7%) reported a history of contact with known TB cases. These clinical features align with classical PTB symptomatology, with prolonged cough being the most consistent complaint.

Table 3: Investigation Profiles of the Study Subjects (N = 70)

Variables	Case (N = 70)
Full Blood Count	
Hemoglobin (g/dL)	10.75 ± 1.6
White Blood Cells (10^9/L)	8.5 ± 1.8
Neutrophils (%)	61.0 ± 9.20
Lymphocytes (%)	36.3 ± 4.70
ESR (mm in 1st hour)	61.51 ± 29.30
MT (mm)	9.3 ± 4.1
Bacteriology	
Sputum for AFB positive	32 (45.7%)
Sputum for GeneXpert positive	53 (75.7%)
AFB + GeneXpert both positive	15 (21.4%)

The mean hemoglobin value for the PTB cases determined by hematologic evaluation was 10.75 g/dL, suggesting mild anemia. The ESR was markedly elevated (mean 61.51 mm in the first hour), consistent with inflammatory activity. Lymphocytosis was recorded (36.3%), and the Mantoux test showed a mean induration of 9.3 mm. Bacteriological testing revealed that 45.7% of them were positive for AFB, whereas GeneXpert detected PTB in 75.7% of cases, highlighting superior sensitivity. Concurrence for AFB and GeneXpert positivity was noted in 21.4% of patients.

Table 4: Pulmonary Manifestations on Chest X-Ray (N = 70)

Parameter	Number (%)
Consolidation	35 (50%)
Cavity	28 (40%)
ARDS	2 (2.8%)
Miliary Shadow	1 (1.4%)
Others	4 (5.7%)

Consolidation (50%) and cavitation (40%), radiological signs marking active PTB, were found frequently in

chest radiographs of PTB patients. Acute respiratory distress syndrome (ARDS) and miliary patterns were less commonly seen in 2.8% and 1.4%, respectively. There was 5.7% of a minority with non-specific changes.

Table 5: Correlation between Sputum Bacilloscopy and Radiological Findings in PTB Patients (N = 70)

Radiological Finding	AFB Positive (n = 32)	AFB Negative (n = 38)	p-value
Consolidation	21 (65.6%)	14 (36.8%)	0.013*
Cavity	18 (56.3%)	10 (26.3%)	0.007*
Miliary Shadow	1 (3.1%)	0 (0%)	0.273
ARDS	1 (3.1%)	1 (2.6%)	0.911
Other Findings	2 (6.3%)	2 (5.3%)	0.888

*Statistically significant at $p < 0.05$

This table presents a significant association between AFB smear positivity and two key radiological findings: consolidation and cavitary lesions, both more prevalent among smear-positive patients. Consolidation ($p = 0.013$) and cavitation ($p = 0.007$) are both statistically significant based on p-values. Other findings such as ARDS, miliary shadow, and non-specific changes were not significantly related to the status of sputum smear. (Figure-1)

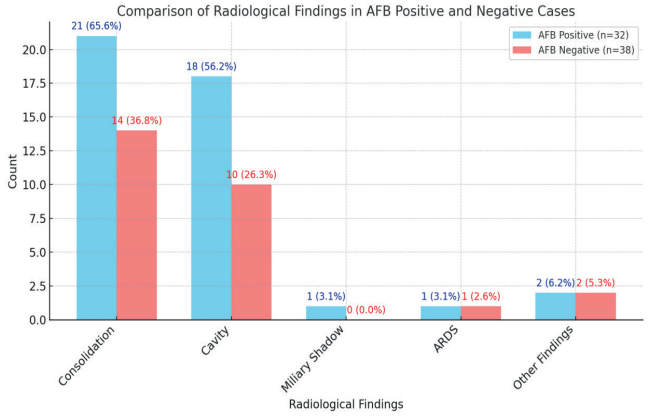

Figure-1: Comparison of Radiological Findings in AFB Positive and Negative Cases

DISCUSSION

The current study, association of sputum AFB positivity with radiological abnormalities like consolidation and cavitatory lesions was strong. In AFB-positive patients consolidation and cavitation were present in 65.6% and 56.3%, also significantly more often than in AFB-negative patients (36.8% vs42; 26.3%, respectively). Our findings are also in concordance with several other studies that have found a more frequent occurrence of these radiological findings among smear-positive pulmonary tuberculosis patients. For example, a research in India showed that consolidation and cavity were detected, respectively, in 78.9% and 36.8% of smear-positive individuals, whereas they affected 49.5% and 15.6%.of smear-negative patients with statistically significant relationship between bacillary load and the amount of pulmonary injury [9]. Likewise, in a Chinese series based on CT findings consolidation and cavitation was seen respectively in 77.7% and 55.3% of smear positives compared with 53.8% and 34.6% of smear negatives further supporting the fact that radiographic severity does correlate with sputum load [10]. An additional study that applied a chest X-ray severity scoring system revealed a close relationship between higher sputum smear grades and more extensive radiological lesions, particularly cavities, and also showed that patients with the most advanced radiographic findings experienced delayed sputum conversion as well as increased risk of post-treatment sequelae [3]. The association was further supported by high-resolution CT studies, which revealed a strong relationship ($r = 0.63$, $p< 0.001$) between radiologic disease burden, in particular nodules cavities and tree-in-bud appearance—and smear positivity[11]. Although other radiological findings, including miliary shadows, ARDS, and non-specific infiltrates were observed in lower numbers of patients in the present study, their distribution did not correlate with AFB smear results. This is consistent with other studies that demonstrated these findings to be less predictive of bacillary load and more common in immunocompromised or disseminated TB[12,13]. The incidence of miliary shadow found in our study was low (only 1.4%) and about half that reported in other reports, where it ranged from 2 to 4% depending on criteria used[13]. The increased rate of cavitation in AFB-positive patients observed in our study (56.3%) compared to several previous publications could possibly reflect an earlier stage of disease at

presentation or local epidemiology factors, such as late health-seeking behavior and high prevalence virulent TB strains[9]. These results have diagnostic and public health implications in that the presence of cavitation or large areas of consolidation on imaging may not only be used to suspect high bacillary load and infectiousness, but already before bacteriological confirmation. This is especially useful in smear-poor environments or where diagnostic delay might elevate the risk of transmission.

Limitations of The Study

The small sample size and the single hospitals makes this a limited study. So the findings might not be representative of the broader community.

CONCLUSION

This research shows the direct relationship between sputum bacilloscopy and the radiological lesions in pulmonary tuberculosis. Consolidation and cavitary lesions were markedly more frequent in positive smear cases indicating greater bacillary burden and severe pulmonary disease.

Recommendation

It is recommended that clinicians should pay careful attention to chest radiographic findings, in particular with regard to consolidation and cavitation for suspected cases of pulmonary tuberculosis because these were closely related to positive sputum smear. In places where bacteriological confirmation is delayed or unavailable, coupling radiological abnormalities and clinical surveillance can be helpful in early diagnosis and commencement of appropriate treatment to limit further transmission and improve patient outcomes.

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Authors' Contribution

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REFERENCES

1. Eini P, Osquee HO, Nasab MS, Khiyabani FN, Rahighi AH. Chest radiological features among patients with smear-positive pulmonary tuberculosis. *Caspian journal of internal medicine*. 2013;**4**(4):777.
2. Lau A, Barrie J, Winter C, Elamy AH, Tyrrell G, Long R. Chest radiographic patterns and the transmission of tuberculosis: implications for automated systems. *PLoS One*. 2016 Apr 22;**11**(4):e0154032.
3. Ralph AP, Ardian M, Wiguna A, Maguire GP, Becker NG, Drogumuller G, Wilks MJ, Waramori G, Tjitra E, Kenagalem E, Pontororing GJ. A simple, valid, numerical score for grading chest x-ray severity in adult smear-positive pulmonary tuberculosis. *Thorax*. 2010 Oct 1;**65**(10):863-9.
4. Rasheed W, Qureshi R, Jabeen N, Shah HA, Khan RN. Diagnostic accuracy of high-resolution computed tomography of the chest in diagnosing sputum smear-positive and sputum smear-negative pulmonary tuberculosis. *Cureus*. 2020 Jun 5;**12**(6):.
5. Caliskan T, Ozkisa T, Aribal S, Kaya H, Incedayi M, Ulcay A, Ciftci F. High-resolution computed tomography findings in smear-negative pulmonary tuberculosis patients according to their culture status. *Journal of Thoracic Disease.* 2014 Jun;**6**(6):706.
6. Ray S, Talukdar A, Kundu S, Khanra D, Sonthalia N. Diagnosis and management of miliary tuberculosis: current state and future perspectives. *Therapeutics and clinical risk management*. 2013 Jan ;**8**:9-26.
7. Bhalla AS, Goyal A, Guleria R, Gupta AK. Chest tuberculosis: Radiological review and imaging recommendations. *Indian Journal of Radiology and Imaging*. 2015 Jul;**25**(03):213-25.
8. Escuissato DL, Warszawiak D. Chest imaging in immunosuppressed patients. Imaging. 2014;**23**(1):20120001.
9. CH MF. Study on Pattern of Chest Radiographic Abnormalities and Co-Morbidities in Newly Detected Sputum Positive Pulmonary Tuberculosis Cases (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India).
10. Wang Y, Shang X, Wang L, Fan J, Tian F, Wang X, Kong W, Wang J, Wang Y, Ma X. Clinical characteristics and chest computed tomography findings related to the infectivity of pulmonary tuberculosis. *BMC Infectious Diseases*. 2021 Nov 27;**21**(1):1197.
11. Ors F, Deniz O, Bozlar U, Gumus S, Tasar M, Tozkoparan E, Tayfun C, Bilgic H, Grant BJ. High-resolution CT findings in patients with pulmonary tuberculosis: correlation with the degree of smear positivity. *Journal of thoracic imaging*. 2007 May 1;**22**(2):154-9.
12. Raghuvanshi V, Sood RG, Jhobta A, Sarkar M, Tomar A, Khanna S. Use of high-resolution computed tomography (HRCT) in diagnosis of sputum negative pulmonary tuberculosis. *Turkish thoracic journal*. 2016 Apr 1;**17**(2):59.
13. Kanaya AM, Glidden DV, Chambers HF. Identifying pulmonary tuberculosis in patients with negative sputum smear results. *Chest*. 2001 Aug 1;**120**(2):349-55.