doi • 10.5578/tt.2025021014
Tuberk Toraks 2025;73(2):132-143
Received: 26.11.2024 • Accepted: 26.05.2025

RESEARCH ARTICLE

Clinical, radiological and microbiological profile of post-tuberculosis versus non-tuberculosis bronchiectasis patients at a tertiary care centre of Central India: A retrospective study

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Cite this article as: *Arbat A, Gandhasiri D, Chourasia S, Gadge G, Deshpande P, Bakamwar S. Clinical, radiological and microbiological profile of post-tuberculosis versus non-tuberculosis bronchiectasis patients at a tertiary care centre of Central India: A retrospective study. Tuberk Toraks 2025;73(2):132-143.*

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Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

ABSTRACT

Clinical, radiological and microbiological profile of post-tuberculosis versus non-tuberculosis bronchiectasis patients at a tertiary care centre of Central India: A retrospective study

Introduction: *This study aimed to examine and compare the characteristics of post tuberculosis (PTB) and non-tuberculosis (NTB) bronchiectasis patients of Central India retrospectively.*

Materials and Methods: *Bronchiectasis patients who underwent bronchoscopy were diagnosed by high resolution computed tomography (CT) scans, and PTB versus NTB were assessed clinically, radiologically, microbiologically and on the basis of spirometry.*

Results: *Mean age of the total 90 patients was 52.54 ± 16.33 years. Maximum patients were in the age group above 60 years old. Overall major symptoms were cough (n= 78, 86.66%), dyspnea (n= 65, 72.22%) and fever (n= 44, 48.88%). The proportion of the male population was more in the PTB group (n= 26, 59.09% vs. n= 18, 40.91%, p= 0.387). Bilateral and unilateral bronchiectasis were predominantly present in NTB (n= 34, 73.91%) and PTB (n= 18; 40.91%) respectively. The most common radiological variant of bronchiectasis found in all patients was a cystic type (n= 52, 89.66%); however, the presence of varicose was significantly higher in PTB than NTB group (n= 8, 18.18% vs. n= 2, 4.35%, p= 0.037). Body mass index in NTB (21.79 ± 4.93 kg/m^2) was significantly higher than that of PTB group (18.89 ± 3.60 kg/m^2) with p-value of 0.004. The proportion of patients with Pseudomonas aeruginosa infection in bronchoalveolar lavage (BAL) of PTB group (n= 12, 27.27%) was more than the NTB group (n= 10, 21.74%). 22.73% (n= 10) patients had a reactivation of TB in the PTB and 8.70% (n= 04) in NTB group. On spirometry, the proportion of patients with obstructive findings was significantly higher in NTB than PTB group (30.43% vs. 6.82%, p= 0.004).*

Conclusion: *The most prominent underlying cause of bronchiectasis was PTB, with unilateral, varicose subtype being significantly more prevalent on thorax CT. Re-infection was the primary cause of exacerbations in bronchiectasis patients, with Pseudomonas being the most common infectious agent. Our study also contributes to the data pool on bronchiectasis patients in India.*

Key words: *Bronchiectasis; post-tuberculosis sequelae; pseudomonas aeruginosa*

ÖZ

Orta Hindistan'daki üçüncü basamak bir sağlık merkezinde tüberküloz sonrası ve tüberküloz olmayan bronşektazi hastalarının klinik, radyolojik ve mikrobiyolojik profili: Retrospektif bir çalışma

Giriş: *Bu çalışmanın amacı, Orta Hindistan'daki tüberküloz sonrası (PTB) ve tüberküloz dışı (NTB) bronşektazi hastalarının özelliklerini retrospektif olarak incelemek ve karşılaştırmaktır.*

Materyal ve Metod: *Bronkoskopi uygulanan bronşektazi hastalarına yüksek çözünürlüklü bilgisayarlı tomografi (BT) taramaları ile tanı konuldu ve PTB ile NTB klinik, radyolojik, mikrobiyolojik ve spirometri temelinde değerlendirildi.*

Bulgular: *Toplam 90 hastanın ortalama yaşı 52.54 ± 16.33 yıldı. Hastaların çoğu 60 yaş üstü yaş grubundaydı. Genel olarak majör semptomlar öksürük (n= 78, %86.66), dispne (n= 65, %72.22) ve ateş (n= 44, %48.88) idi. Erkek popülasyonun oranı PTB grubunda daha fazlaydı (n= 26, %59.9'a karşı n= 18, %40.91, p= 0.387). İki taraflı ve tek taraflı bronşektazi, sırasıyla NTB'de (n= 34, %73.91) ve PTB'de (n= 18, %40.91) baskındı. Tüm hastalarda bulunan bronşektazinin en sık radyolojik varyantı kistik tipti (n= 52, %89.66), ancak varis varlığı PTB'de NTB grubuna göre anlamlı olarak daha yüksekti (n= 8, %18.18'e karşı n= 2, %4.35, p= 0.037). Tüberküloz olmayan hastalarda vücut kitle indeksi (21.79 ± 4.93 kg/m^2) PTB grubuna göre (18.89 ± 3.60 kg/m^2) anlamlı olarak daha yüksekti (p= 0.004). PTB grubunda (n= 12, %27.27) bronkoalveolar lavajda (BAL) Pseudomonas aeruginosa enfeksiyonu olan hastaların oranı NTB grubundan (n= 10, %21.74) daha fazlaydı. PTB grubunda %22.73 (n= 10) hastada tüberküloz reaktivasyonu ve NTB grubunda %8.70 (n= 04) hastada tüberküloz reaktivasyonu vardı. Spirometride, obstrüktif bulguları olan hastaların oranı NTB grubunda PTB grubundan anlamlı olarak daha yüksekti (%30.43'e karşı %6.82, p= 0.004).*

Sonuç: *Bronşektazinin en belirgin altta yatan nedeni PTB'dir ve tek taraflı varisli alt tip toraks BT'de anlamlı olarak daha yaygındır. Bronşektazi hastalarında alevlenmelerin birincil nedeni re-enfeksiyondur ve Pseudomonas en yaygın enfeksiyöz ajandır. Çalışmamız aynı zamanda Hindistan'daki bronşektazili hastalara ait veri havuzuna da katkıda bulunmaktadır.*

Anahtar kelimeler: *Bronşektazi; tüberküloz sonrası sekel; pseudomonas aeruginosa*

INTRODUCTION

Bronchiectasis has been frequently described as a rare and neglected lung disease, with a growing global prevalence that is a significant public health concern (1). It is a chronic respiratory condition affecting the airways, characterized by abnormal bronchial dilation and impaired mucus clearance, which leads to persistent cough, sputum production, and recurrent respiratory infections that often necessitate frequent healthcare utilization. In India, bronchiectasis is predominantly observed as a sequela of previous tuberculosis (TB), contributing substantially to the disease burden (2). However, in addition to TB, various other etiological factors have been identified in both Indian and global contexts, along with a considerable portion of cases lacking a clear underlying cause (3). Although post-TB (PTB) and non-TB (NTB) bronchiectasis exhibit comparable symptoms, PTB bronchiectasis is frequently linked to an elevated risk of exacerbations, hemoptysis, and distinct lung function abnormalities, distinguishing it from NTB bronchiectasis. Recent advancements in research have generated valuable insights into this disease, and by examining the variations in clinical, radiological, spirometry, and microbiological characteristics, we aim to gain a more comprehensive and nuanced understanding of bronchiectasis. This retrospective study investigates and compares the features of bronchiectasis patients from PTB and NTB groups at our tertiary care centre in Central India.

MATERIALS and METHODS

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the ethics committee (EC outward number: 12/2024). Due to the retrospective nature of the study, requirement for patient's informed consent was waived. This retrospective study was conducted from January 2017 to December 2023. Patients from the Vidarbha region of Maharashtra, as well as parts of Madhya Pradesh and Chhattisgarh, sought consultation and treatment at our centre, which serves the central India region. We first collected the data of patients who underwent bronchoscopy and segregated those with a diagnosis of bronchiectasis based on computed tomograpghy (CT) findings in accordance with the BTS guidelines.

Inclusion and exclusion criteria

- Patients of both sexes >18 years of age who underwent bronchoscopy and showed evidence of bronchiectasis on high resolution computed tomography (HRCT) were included in this study.
- Patients with interstitial lung disease and primary lung malignancy were excluded.

The medical histories of the patients were reviewed, and etiologies were identified as follows: Attention was focused on prior severe lower respiratory tract infections, asthma, TB, pneumonia, smoking status, chronic obstructive pulmonary disease (COPD), gastroesophageal reflux disease (GERD), a history of inflammatory bowel disease, or neurological conditions that predispose to chronic aspiration, as well as signs and symptoms indicative of connective tissue disease. Hence, on the basis of the patient's history and relevant investigations the bronchiectasis cases were categorized into two groups: Those with PTB sequelae and those without NTB as shown in Figure 1.

Etiologic risk factors associated with bronchiectasis were described by PT King, Bajpai et al., and Sharif et al. in their articles (3-5). Accordingly, PTB was assigned based on the history of the patients along with clinical evidence and radiological findings showing cavitation, granuloma and scarring of the upper lobes. Post infectious cases include bronchiectasis attributed to microbial infections other than TB. Patients with bronchiectasis distal to the bronchus obstructed with foreign body or mucus plug was categorised as post obstruction bronchiectasis. Asthma patients with proximal bronchiectasis were subjected to serum immunoglobulin E (IgE), Aspergillus skin test and Aspergillus specific IgE evaluation and were cited to have Allergic Bronchopulmonary Aspergillosis (ABPA) based on International Society for Human and Animal Mycology criteria for the diagnosis of ABPA (6). Patients with COPD were identified collectively based on extensive smoking history and exposure to biomass smoke; having evidence of emphysema and post-bronchodilator obstructive airway impairment through spirometry. Autoimmune

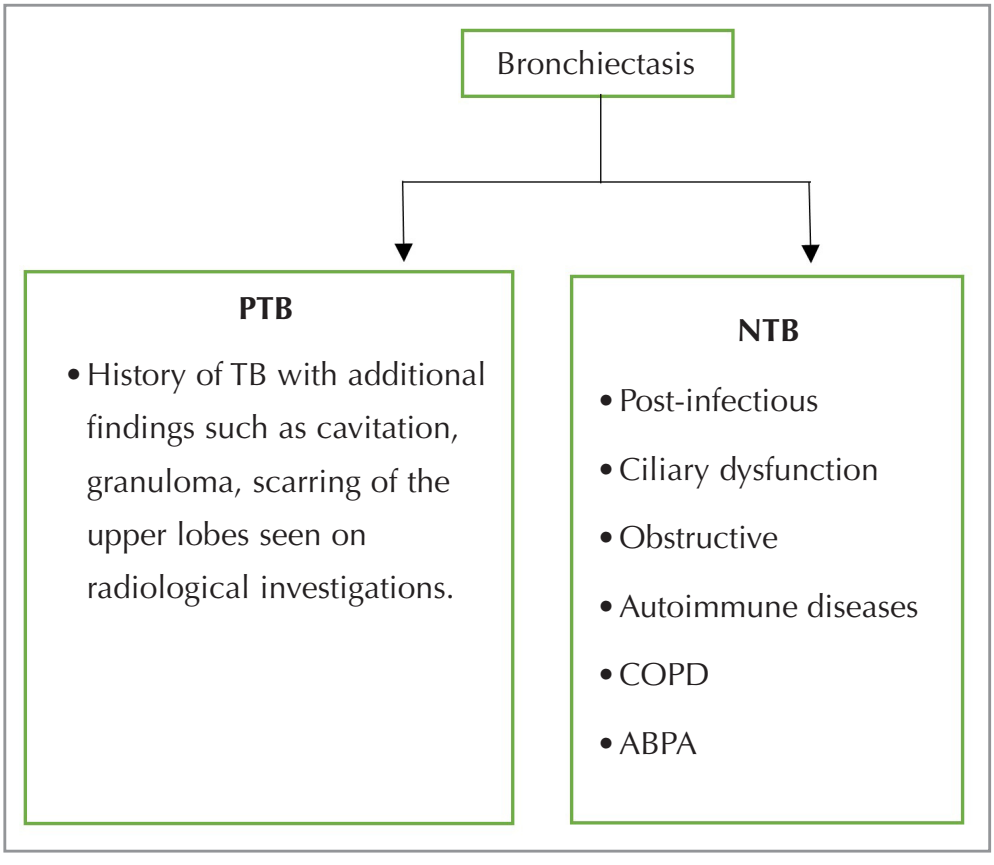

Figure 1. Different etiologies of bronchiectasis patients.

conditions such as arthritis and connective tissue disorder (CTD) were identified on the basis of anti-CCP, rheumatoid factor and antinuclear antibody profile. In case these results were negative but indicative symptoms persisted, an extended CTD panel was performed to confirm the diagnosis. In patients with the classical triad of dextrocardia, situs inversus totalis and chronic sinusitis, we diagnosed Kartagener's syndrome (ciliary dysfunction) and one of the patients' being male was noted to have azoospermia. Nasal ciliary biopsy could not be performed as consent was not given. Idiopathic bronchiectasis was labelled when no specific underlying factor could be identified as the cause of bronchiectasis.

Two groups thus formed were then compared in terms of etiology, clinical features, radiology, microbiology, symptoms, and spirometry findings. Patients were stratified by age group as -≤20, 21-30, 31-40, 41-50, 51-60, 61-70 and ≥70 years. Clinical profiles of the patients were assessed, concentrating on respiratory symptoms such as cough, dyspnea, fever, hemoptysis, weight loss, loss of appetite, and chest pain.

HRCT scans of these patients were analysed to determine the extent of the disease, which was classified as unilateral or bilateral. The radiological extent was further categorized according to the lobes involved, as described by Sharif N et al., and the corresponding details are presented in Table 1. Additionally, the predominant type of bronchiectasis in these patients was identified and recorded (5).

Table 1. Description and statistical analysis of patient characteristics according to NTB and PTB bronchiectasis

Variable	All	PTB	NTB	p
n	90	44	46	
Demographics				
Age, years	50	51.61 ± 15.87	53.43 ± 16.89	0.600[1]
	n (%)	n (%)	n (%)	
Sex				
Male	49 (54.45)	26 (59.09)	23 (50.00)	0.387
Female	41 (45.56)	18 (40.91)	23 (50.00)	
BMI (kg/m^2)		18.89 ± 3.60	21.79 ± 4.93	**0.004**
Smoker	5 (5.55)	3 (6.82)	2 (4.34)	0.609
Non-smoker	85 (94.45)	41 (93.18)	44 (95.65)	
Symptoms				
Cough	78 (86.66)	37 (84.09)	41 (89.13)	0.482
Dry cough	19 (21.11)	10 (22.72)	09 (19.56)	0.602
Cough with expectoration	59 (65.55)	27 (61.36)	32 (69.56)	
Dyspnoea	65 (72.22)	28 (63.64)	37 (80.43)	0.075
Fever	44 (48.88)	22 (50.00)	22 (47.83)	0.837
LOW	31 (34.44)	13 (29.55)	18 (39.13)	0.339
Haemoptysis	23 (25.55)	12 (27.27)	11 (23.91)	0.715
LOA	17 (18.88)	10 (22.73)	7 (15.22)	0.363
Radiological findings				
Unilateral	30 (33.33)	18 (40.91)	12 (26.09)	0.136
Bilateral	60 (66.67)	26 (59.09)	34 (73.91)	0.136
Cystic	52 (89.66)	25 (56.82)	27 (58.7)	0.857
Cylindrical	19 (21.11)	9 (20.45)	10 (21.74)	0.881
Varicose	10 (11.11)	8 (18.18)	2 (4.35)	**0.037**
Traction	13 (14.44)	9 (20.45)	4 (8.7)	0.113

Table 1. Description and statistical analysis of patient characteristics according to NTB and PTB bronchiectasis (continue)

Variable	All	PTB	NTB	p
Lobes involved				
BLL	4 (4.44)	2 (4.55)	2 (4.35)	0.999
BUL	6 (6.67)	3 (6.82)	3 (6.52)	0.999
ML	14 (15.56)	7 (15.91)	7 (15.22)	0.928
DBB	40 (44.44)	16 (36.36)	24 (52.17)	0.131
DUB	6 (6.67)	5 (11.36)	1 (2.17)	0.081
ULL	16 (17.78)	8 (18.18)	8 (17.39)	0.922
UUL	13 (14.44)	8 (18.18)	5 (10.87)	0.324
L	7 (7.78)	5 (11.36)	2 (4.35)	0.214
Microbiology				
GeneXpert	12 (13.33)	8 (18.18)	4 (8.7)	0.186
AFB staining	3 (3.33)	2 (4.55)	1 (2.17)	0.969
AFB culture	3 (3.33)	1 (2.27)	2 (4.35)	0.999
NTM culture	1 (1.11)	0 (0)	1 (2.17)	0.999
Bacterial culture				
P. aeruginosa	22 (24.44)	12 (27.27)	10 (21.74)	0.542
Klebsiella	9 (10)	5 (11.36)	4 (8.7)	0.673
E. coli	5 (5.56)	5 (11.36)	0 (0)	**0.018**
Staphylococcus	4 (4.44)	3 (6.82)	1 (2.17)	0.285
Enterococcus	2 (2.22)	2 (4.55)	0 (0)	0.144
Streptococcus	1 (1.11)	1 (2.27)	0 (0)	0.304
Fungal culture	11 (12.22)	3 (6.82)	8 (17.39)	0.126
Aspergillus	6 (6.67)	2 (4.55)	4 (8.70)	0.714
Candida	4 (4.44)	1 (2.27)	3 (6.52)	0.641
Yeast	1 (1.11)	0 (0)	1 (2.17)	0.999
Diagnosed to have TB by GeneXpert, AFB staining and AFB culture	14 (15.56)	10 (22.73)	4 (8.70)	0.066
Spirometry				
Mixed	18 (20.00)	9 (20.45)	9 (19.57)	0.916
Restrictive	24 (26.67)	14 (31.82)	10 (21.74)	0.279
Obstructive	17 (18.89)	3 (6.82)	14 (30.43)	**0.004**
Normal	5 (5.56)	3 (6.82)	2 (4.35)	0.959
Non-specific	2 (2.22)	1 (2.27)	1 (2.17)	0.999
Bronchodilator reversibility	7 (7.78)	3 (6.82)	4 (8.7)	0.999

Data are n (%) except for age and BMI. These continuous parameters are represented as: Mean ± SD; Percentages are column wise; [1]Obtained using t-test for independent samples; rest of the comparisons are using Pearson's chi-square test; bold p-values indicate statistical significance.
BMI: Body mass index, AFB: Acid-fast *bacilli*, NTM: Non-tuberculosis *Mycobacteria*, TB: Tuberculosis, LOW: Loss of weight, LOA: Loss of appetite, BLL: Bilateral lower lobe, BUL: Bilateral upper lobe, ML: Middle lobe, DBB: Diffused bilateral bronchiectasis, DUB: Diffused unilateral bronchiectasis, ULL: Unilateral lower lobe, UUL: Unilateral upper lobe, L: Lingula, *E. coli*: *Escherichia coli*, NTB: Non-tuberculosis, PTB: Post-tuberculosis, *P. aeruginosa*: *Pseudomonas aeruginosa*.

Bronchoalveolar lavage (BAL) samples were collected and sent for acid-fast bacillus, fungal, and gram staining, as well as acid-fast *bacilli* (AFB), bacterial, and fungal culture, along with GeneXpert testing.

Spirometry data of the patients were collected and categorized into obstructive, restrictive, and normal patterns based on the American Thoracic Society/ European Respiratory Society task force statement on lung function testing standardization (7).

Statistical Methods

Continuous variables were expressed in terms of mean and standard deviation while categorical variables were summarized in terms of frequencies and percentages. The means of continuous variables were compared between the two groups using t-test for independent samples. The distribution of categorical variables between the two groups was compared using Pearson's chi-square test. Statistical significance was tested at 5% level. All the analyses were performed using SPSS version 26.0 (IBM Corp. ARMONK USA) software.

RESULTS

The study population consisted of 90 individuals. Of these, 44 patients were categorised as PTB and the remaining 46 patients were classified into NTB group that comprised of various etiologies as described in methods section (Figure 2).

Our data shows that the highest number of patients, 25.55%, were in the 61-70 years age group, followed closely by in the 51-60 years age group (24.44%), as shown in Figure 3a. The age-wise distribution in PTB and NTB groups is shown in Figure 3b. Mean age of the patients in PTB group was 51.61 ± 15.87 years while that of NTB group was 53.43 ± 16.89, and the difference between the means was statistically not significant. Other patient characteristics like sex and smoking behaviour also showed no statistical differences between the two groups. Body mass index in the NTB group (21.79 ± 4.93 kg/m^2) was significantly higher than that of the PTB group (18.89 ± 3.60 kg/m^2), as indicated by a p-value of 0.004. Key symptoms observed among bronchiectasis patients in the study included cough (86.66%), with a greater prevalence of productive cough over dry cough. Additionally, dyspnea, fever, weight loss, and hemoptysis were reported in 72.22%, 48.88%, 34.44%, and 25.55% of the patients, respectively. Loss of appetite was the least common symptom reported. The presentation of different symptoms showed no statistically significant difference between the two groups. The statistical comparison of clinical characterization of bronchiectasis patients is shown in Table 1.

The NTB group had an equal distribution of male and female patients, whereas the PTB group had a higher proportion of male patients (59.09%) compared to females (40.91%), with a p value of 0.387.

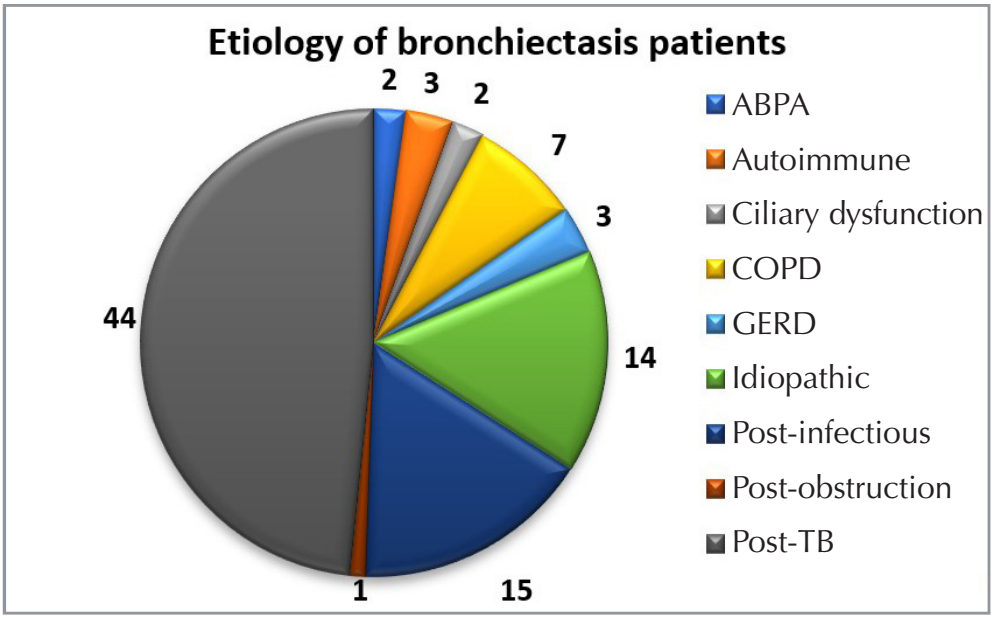

Figure 2. Distribution of bronchiectasis patients on the basis of etiologies.

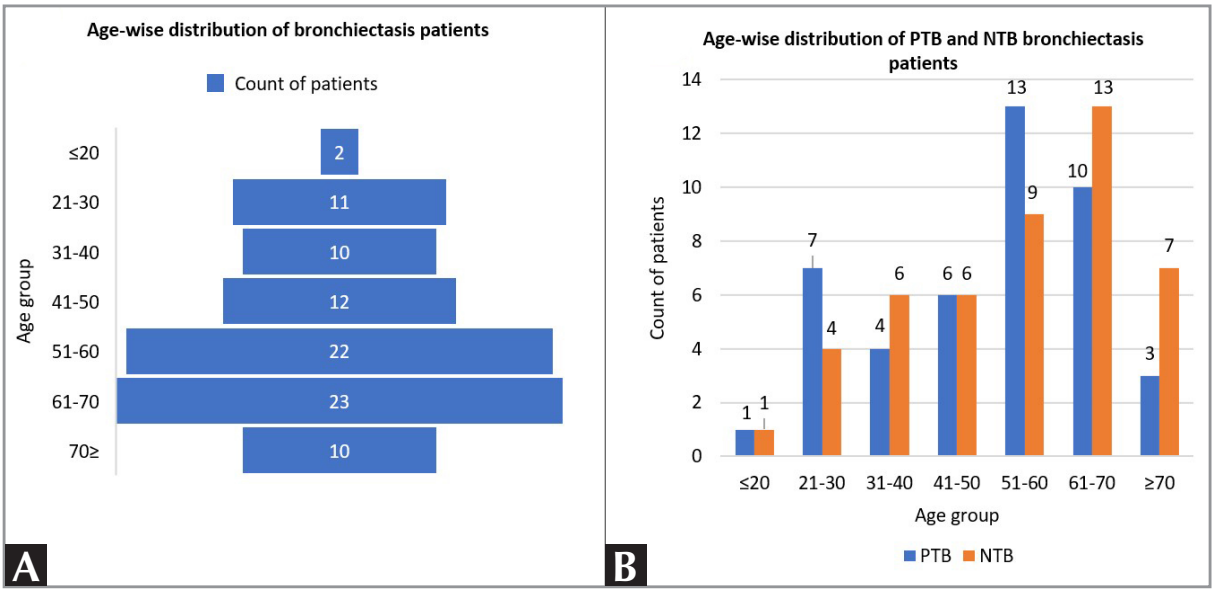

Figure 3. Age-wise distribution of bronchiectasis patients. **A.** Shows the age-wise distribution of total bronchiectasis patients and **B.** Compares the PTB and NTB groups according to different age groups.

Bilateral bronchiectasis was more prominent in the NTB group (73.91%) compared to the PTB group (59.09%) whereas, unilateral bronchiectasis was more common in the PTB group (40.91%) than the NTB group (26.09%). The distribution of bronchiectasis across the affected lung lobes revealed the diffuse bilateral bronchiectasis (DBB) as the most common location (44.44%), followed by unilateral involvement of the lower lobe, middle lobe, and upper lobe. The diffuse unilateral bronchiectasis (11.36%) and unilateral upper lobe (18.18%) were more prevalent in the PTB group than the NTB group. Conversely, DBB was more common in the NTB group (52.17%) compared to the PTB group (36.36%). The difference in lobar distribution between the two groups was not statistically significant. Cystic bronchiectasis (89.66%) was the predominant HRCT pattern observed across the overall patient population. The presence of varicose was significantly higher in PTB group (18.18%) as compared to NTB group (4.35%), as indicated by a p-value of 0.037. The occurrence of other radiological findings was statistically not different between the groups.

The most common organism identified on BAL culture was *Pseudomonas aeruginosa* (24.44%), followed by *Klebsiella*, *Escherichia coli*, *Staphylococcus*, *Enterobacter*, and *Streptococcus* species (Table 1). *P. aeruginosa* was found more prevalent in the PTB group (27.27%) than the NTB group (21.74%); however, it was statistically non-significant. In bacterial culture examination, the proportion of patients with *E. coli* in the PTB group (11.36%) was significantly higher than that of the NTB group (0%), with a p-value of 0.018. Aspergillus species was the commonest fungal strain identified in the fungal culture of the BAL, found in 8.70% of the NTB group compared to 4.55% of the PTB group. The fungal culture findings were statistically not different between two groups. In the PTB group, we saw that 22.73% of patients had a reactivation of TB. In the NTB group, 8.7% of patients were diagnosed to have TB based on BAL GeneXpert and/or AFB culture. About 23% of the 90 patients showed no growth, whether bacterial, fungal and/or tubercular.

Spirometry result showed the proportion of patients with obstructive findings was significantly higher in NTB group (30.43%) as compared to PTB group (6.82%), with a p-value of 0.004. The reverse result was observed in restriction, which was more prevalent in the PTB (31.82%) group than the NTB (21.74%) group. These findings were not significantly different between two groups.

Bronchodilator reversibility was 6.82% in the PTB group and 8.7% in the NTB group, while normal spirometry was observed in 6.82% of the PTB group and 4.35% of the NTB group, which was statistically not significant.

DISCUSSION

Bronchiectasis is a chronic and progressive respiratory condition characterized by permanent dilation of the bronchi, often leading to repeated respiratory infections (8). India, a densely populated country, experiences a high prevalence of TB among its population. Chronic TB infection can lead to the destruction of the bronchial wall's elasticity and muscular components, ultimately resulting in bronchiectasis. The co-existence of bronchiectasis and TB was first discovered in 1819 (9). Bronchiectasis is widespread among the Indian population, but it is often overlooked and considered an orphan disease. However, recent research has shown increased interest in this disease due to its growing public health burden, including higher healthcare costs, hospital admissions, and mortality rates (10,11).

In contrast to the western world, where the etiology of bronchiectasis has revealed causes other than TB, in India, PTB sequelae remain the major cause of both non-cystic and cystic bronchiectasis (12,2). A systematic review conducted in India reported that 40-80% of pulmonary TB cases had associated bronchiectasis (13). Given that India has a high TB burden, the prevalence of PTB bronchiectasis in the country is particularly relevant. A 2017 Indian bronchiectasis registry reported that 35.5% of bronchiectasis cases were caused by PTB sequelae, though our study data indicates an even higher proportion (2). These findings underscore the critical need for early diagnosis and appropriate management of TB to mitigate the long-term respiratory complications, including bronchiectasis, which can have a significant impact on the patient's quality of life and healthcare system. After PTB, post-infectious etiology showed the highest number of cases. When cases from PTB and post-infectious etiology were combined, they accounted for 65.55% of the total, which is even higher than the 58% reported in The European Multicentre Bronchiectasis Audit and Research Collaboration (EMBARC) study (2). This suggests that microbial infection, whether caused by TB or other microorganisms, is a major contributing factor to the development of bronchiectasis. Our study identified an overall 15.55% of idiopathic cases, with several other studies reporting 18-55% of idiopathic cases (14,15,2).

According to Chandrasekaran et al., the aging process plays a pivotal role in the development of bronchiectasis, with a multifactorial impact (12). Consistent with this, the present study found that the number of bronchiectasis patients increased with advancing age, with the majority of patients in the 61-70 years age group, as reported by various national and international studies (3,14,16-18).

Furthermore, the study reported a higher prevalence of bronchiectasis among males in the PTB group compared to females, aligning with the findings of a recent study by Bajpai et al (3). Similarly, Woo et al. have observed a higher prevalence of PTB bronchiectasis in males, attributing it to factors like occupational exposure, smoking, and delayed diagnosis.

Dominant symptoms observed in our study were chronic cough, expectoration, and dyspnea, which align with the available research (2,19-21). While hemoptysis is a serious complication of bronchiectasis reported by other studies, only 25.55% of patients in our study presented with this symptom (3,14). It is important to note that patients affected by PTB sequelae exhibited symptoms not only related to bronchiectasis but also due to other TB-related complications, such as bronchial mutilation, cavitation, fibrosis, and obstructive airway disorders (22). Therefore, the side effects observed in PTB-associated bronchiectasis are not solely attributable to bronchiectasis itself, but also to the additional consequences of TB.

Microbial profiling is crucial to identify the causative organisms and guide appropriate treatment during acute exacerbations of bronchiectasis. Bacteriological examination could isolate microbes in 43.33% of cases. The accumulated secretions in the distorted bronchial architecture provide a suitable environment for infections. *P. aeruginosa* was the most commonly identified pathogen, with a higher prevalence in the PTB group compared to the NTB group. It would be thus beneficial to screen for and treat *Pseudomonas* infections in bronchiectasis patients, as it is associated with later stages of the disease and a worsening clinical course (2,5,14,20,23). In addition to *Pseudomonas*, other microbes that were more commonly isolated from the PTB group were *Klebsiella*, *Staphylococcus* and *Enterococcus*. *E. coli* was found to be exclusively isolated from the PTB group and was statistically significant. Fungal cultures showed Aspergillus, Candida, and yeast strains more frequently in the NTB group, suggesting a higher prevalence of fungal infections in this group. *Haemophilus influenzae* was not identified in the

study samples, which contrasts with the findings in the United States (US) and European populations (24).

Reactivation of TB was observed among PTB (22.73%), and newly diagnosed TB was observed in 8.7% of the NTB group through BAL GeneXpert and/or AFB culture. Overall, 15.56% of cases showed current TB infection. One study from Hoole A et al. has reported a 33.3% TB re-infection rate in PTB bronchiectasis patients (25). In this study, two patients died due to respiratory failure during the treatment regime. One patient was a young extensively drug-resistant TB patient, whereas another was an 83-year-old elderly patient who was suffering from severe COPD with TB reactivation. This showed that TB predominantly infects and re-infects the bronchiectasis patients, hence, diagnosing TB and close monitoring of symptoms with proper follow-up is highly recommended among these patients. Delay in diagnosis and treatment initiation may lead to significant pulmonary complications and even mortality in these patients.

The study found that in 23% of cases, no microbial growth was detected. Recent research has indicated that bronchiectasis patients often experience exacerbations characterized by neutrophilic inflammation, even in the absence of an active infection (26). Emerging therapeutic approaches, such as the use of dipeptidyl peptidase-1 inhibitors, are currently being investigated for the management of these cases (27,28). Accurately identifying and differentiating instances of exacerbation without underlying infection can aid in the development of more targeted and effective treatment strategies for these patients.

Studies have shown that obstruction is the predominant spirometry pattern in bronchiectasis patients because of persistent airway deterioration and distortion brought on by chronic inflammation and abnormal mucociliary clearance (1,3,29). It was observed that obstruction was significantly higher than restriction in the NTB group. While obstruction has been considered the hallmark feature of bronchiectasis, recent studies have shown that the disease can also present with restrictive, mixed, or even normal spirometry patterns (30,31). The overall predominant spirometry pattern was restrictive which was also noted in the PTB group. This restrictive pattern could be due to factors like air trapping or extrapulmonary causes, or it could indicate destruction of lung parenchyma during the infectious phase, particularly in patients with PTB bronchiectasis. Bronchodilator reversibility, observed in 7.78% of our patients, is an important parameter that can guide the use of bronchodilators and inhaled corticosteroids in the management of these patients as shown by other researchers (32,33). Overall, our findings highlight the need to recognize the diverse spirometric presentations of bronchiectasis and tailor treatment approaches accordingly.

Overall, the radiological pattern in our study group showed more bilateral than unilateral lung involvement. When the PTB group was compared to the NTB group, the NTB group exhibited more diffuse bilateral lung involvement. In the PTB bronchiectasis group, a unilateral lung involvement and a predominant upper lobe distribution were commonly observed. Western countries report an upper lobe predominance in cases of bronchiectasis due to cystic fibrosis and allergic bronchopulmonary aspergillosis (34). However, the etiology of bronchiectasis in India is different compared to the USA and Europe, as TB is the major causative factor, as seen in the Indian EMBARC registry (2). Our study found that the PTB group showed a more upper lobe predominance, which corroborates with studies by Dias et al., Wang et al., and Choi et al. (35-37). Sharif N et al. have also stated that upper lobe bronchiectasis is highly suggestive of TB infection, which aligns with our findings (5). Consistent with findings from studies by Lee et al., Methe et al., Sunny S et al., and the EMBARC study, cystic bronchiectasis was observed in the maximum number of cases, followed by the cylindrical type (38,21,16,2). Compared to the NTB group, the PTB group predominantly exhibited varicose and traction types of bronchiectasis, while the cystic and cylindrical types were approximately equally distributed between the two groups. The cystic type is most commonly present in patients with prior TB infection or as a consequence of repeated pulmonary infections, as evident from other published reports (16,39).

During the study, we found some interesting causes of bronchiectasis like ciliary dysfunction, post-obstructive, auto-immune, GERD and ABPA. Identifying the underlying etiology is crucial, even though PTB and post-infectious causes remain the most prevalent. Diligent efforts to diagnose the specific etiology are essential for providing appropriate and targeted management for bronchiectasis patients.

This study had some limitations. It was conducted at a single centre and involved a relatively small number of patients, as bronchoscopies were only performed when absolutely necessary during the coronavirus disease-2019 pandemic years of 2020 and 2021. Additionally, spirometry data was unavailable for over a quarter of the patients (26.66%), which may have impacted the assessment of respiratory function in the study population.

Despite these limitations, the study provides valuable insights into the clinico-radiological and microbiological profiles of PTB versus NTB bronchiectasis patients in an Indian setting. Further large-scale multicentric studies are warranted to better understand the epidemiology, clinical characteristics, and management strategies for these distinct phenotypes of bronchiectasis.

CONCLUSION

Our study examined the characteristics of bronchiectasis patients in Central India, highlighting key differences between PTB and NTB cases. The most common etiology was PTB bronchiectasis. Cough, dyspnea, and cystic radiological patterns were common, with *P. aeruginosa* as the predominant pathogen. PTB patients were more likely to be male with unilateral involvement, and varicose bronchiectasis, with a higher rate of *Pseudomonas* and tubercular infection. One fourth of the patients had no detectable pathogens. Further large-scale studies could provide valuable insights to improve management of these patients. Our study also adds to the Indian repository of Bronchiectasis patients as Madhya Pradesh regions were included in our study which was not part of the EMBARC study.

Acknowledgement

We acknowledge Dr. Dnanajay Raje (Ph.D. Statistics) for conducting the statistical analysis of our data. We also acknowledge Mr. Hemant Balapure for assisting in bronchoscopy procedure and maintaining the images and videos of the patients along with Mr. Sandeep Raut for collecting the patient's data.

Ethical Committee Approval: This study was approved by KRIMS Ethics Committee (Decision no: 12/2024, Date: 18.10.2024).

CONFLICT of INTEREST

The authors declare that they have no conflict of interest.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: All of authors

Analys/Interpretation: AA, DG, SC, GG

Data acqusition: AA, GG, PD, SB

Writing: AA, DG, SC, GG

Clinical Revision: All of authors

Final Approval: All of authors

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