Original Research

A CROSS-SECTIONAL DESCRIPTIVE STUDY TO ASSESS THE CLINICAL RADIOLOGICAL MICROBIOLOGICAL AND FUNCTIONAL CORRELATION OF BRONCHIECTASIS

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ABSTRACT

Background: Bronchiectasis is a chronic suppurative lung disease characterized by irreversible bronchial dilatation resulting from recurrent infection and inflammation. The disease exhibits marked heterogeneity in clinical presentation, radiological patterns, microbiological colonization, and functional impairment. An integrated evaluation of these parameters is essential for understanding disease severity, predicting outcomes, and optimizing patient management in clinical practice.

Aim: To evaluate clinical, radiological, microbiological and lung function profiles of bronchiectasis, and assess disease severity using FACED and Bronchiectasis Severity Index scores.

Materials and Methods: This cross-sectional descriptive study was conducted over 18 months at a tertiary care hospital in South India. A total of 60 adult inpatients and outpatients diagnosed with bronchiectasis were included. Detailed demographic data, clinical symptoms, duration of illness, comorbidities, exposure history, and examination findings were recorded. Radiological evaluation included chest X-ray and HRCT assessment for lobar involvement and morphological type. Sputum samples were analyzed for microbiological pathogens. Pulmonary function testing was performed using spirometry, and dyspnoea was graded using the modified Medical Research Council scale. Disease severity was assessed using FACED and BSI scores. Statistical analysis was carried out using appropriate descriptive and inferential methods, with significance set at $p < 0.05$.

Results: Pulmonary tuberculosis sequelae was the most common aetiology, observed in 40 (66.7%) patients. Cough (58, 96.7%) and dyspnoea (56, 93.3%) were the predominant symptoms. Sputum culture was positive in 36 (60%) patients, with Pseudomonas aeruginosa being the most common isolate (17, 28.3%). HRCT revealed predominant lower lobe involvement, and cystic bronchiectasis was the most frequent morphological pattern (40, 66.7%). Spirometry showed mixed ventilatory defects in 19 (31.7%) patients. FACED scoring classified 39 (65.0%) patients as having mild disease, whereas BSI scoring identified 33 (55.0%) patients as having severe bronchiectasis. Exacerbation frequency showed a significant correlation with BSI scores.

Conclusion: Bronchiectasis in this study was predominantly post-tuberculous, with significant clinical symptoms, structural lung damage, chronic bacterial colonization, and functional impairment. Pseudomonas aeruginosa infection was associated with higher disease severity. The Bronchiectasis Severity Index demonstrated better correlation with exacerbations and may be more useful for risk stratification and long-term management.

Keywords: Bronchiectasis, Bronchiectasis Severity Index, FACED Score, High-Resolution Computed Tomography, Pseudomonas Aeruginosa, Pulmonary Function Test.

INTRODUCTION

Bronchiectasis is a chronic, progressive respiratory disorder characterized by permanent and irreversible dilatation of the bronchi, resulting from recurrent infection and inflammation that lead to structural damage of the bronchial wall.[1] Once considered a declining disease, bronchiectasis has re-emerged as an important cause of respiratory morbidity and mortality, particularly in developing countries.[2] The condition is clinically heterogeneous, with wide variations in aetiology,

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severity, disease progression, and outcomes, making its diagnosis and management challenging.[3] Patients with bronchiectasis typically present with chronic cough, sputum production, recurrent lower respiratory tract infections, haemoptysis, and progressive breathlessness. Repeated infective exacerbations contribute to a vicious cycle of airway inflammation, impaired mucociliary clearance, and bacterial colonization, resulting in gradual deterioration of lung function.[4] Over time, this may lead to complications such as respiratory failure, pulmonary hypertension, and cor pulmonale, significantly affecting quality of life and survival. Despite advances in respiratory medicine, bronchiectasis remains underdiagnosed and undertreated, often due to lack of clinical suspicion and limited awareness.[5]

High-resolution computed tomography (HRCT) of the chest is the gold standard for diagnosing bronchiectasis and provides detailed information regarding the extent, distribution, and morphological patterns of airway dilatation.[6] Radiological features not only confirm the diagnosis but also correlate with disease severity, frequency of exacerbations, and prognosis. However, radiological findings alone do not fully reflect the clinical and functional impact of the disease, highlighting the need for a comprehensive approach to assessment.[7,8]

Microbiological evaluation plays a crucial role in the management of bronchiectasis, as chronic colonization of the airways by potentially pathogenic microorganisms is common.[9] Persistent bacterial colonization, particularly by organisms such as Pseudomonas aeruginosa, is associated with more severe disease, frequent exacerbations, accelerated decline in lung function, and increased mortality.[10] Sputum microscopy and culture remain practical, cost-effective, and widely available tools for identifying airway pathogens, although contamination with oropharyngeal flora is a recognized limitation.[11]

Pulmonary function testing provides objective assessment of functional impairment in bronchiectasis. Most patients exhibit an obstructive ventilatory defect, though mixed or restrictive patterns may also be observed in advanced disease. Decline in lung function correlates with disease severity and long-term outcomes and serves as an important marker for monitoring disease progression and response to therapy.[12]

The severity of bronchiectasis is commonly assessed using validated scoring systems such as the Bronchiectasis Severity Index (BSI) and the FACED score.[13] The BSI incorporates multiple clinical variables to predict mortality, exacerbation frequency, hospital admissions, and quality of life, whereas the FACED score places greater emphasis on age and may be less accurate in predicting these outcomes. Both scoring systems are useful in identifying high-risk patients who require closer monitoring and targeted management.[14,15]

Given the complex interplay between clinical features, radiological extent, microbiological profile, and functional impairment in bronchiectasis, an integrated assessment is essential for optimal patient management. This cross-sectional descriptive study aims to evaluate and correlate the clinical, radiological, microbiological, and functional parameters of bronchiectasis in patients attending a tertiary care centre, thereby providing a comprehensive understanding of disease characteristics and aiding in improved risk stratification and individualized management strategies.

Aims and Objectives

- To evaluate clinical, radiological, microbiological and lung function profiles of bronchiectasis, and assess disease severity using FACED and Bronchiectasis Severity Index scores.

MATERIALS AND METHODS

This cross-sectional descriptive study was conducted among inpatients and outpatients diagnosed with bronchiectasis attending the Department of Respiratory Medicine at Shri Sathya Sai Medical College and Research Institute, a tertiary care hospital located at Ammapettai in South India. The study was carried out over a period of 18 months. Ethical approval was obtained from the Institutional Ethical Committee prior to initiation of the study. Adult patients aged more than 18 years with bronchiectasis confirmed on high-resolution computed tomography (HRCT) of the chest were included. Both clinically stable patients and those presenting with acute exacerbations were enrolled, irrespective of smoking status.

Patients with poor general condition contraindicating pulmonary function testing, those with HRCT findings negative for bronchiectasis, patients with active pulmonary tuberculosis confirmed clinically, radiologically, or microbiologically, and antenatal cases were excluded from the study.

The sample size was calculated based on a previous study by Katerina Dimakou et al., considering a prevalence of obstructive ventilatory pattern of 43%, with a precision of 13% and a 95% confidence interval. Using the standard formula for prevalence studies, the minimum required sample size was estimated as 56. During the study period, 60 eligible patients were identified and included, and hence the final sample size was rounded off to 60. Patients fulfilling the inclusion criteria were

consecutively recruited after obtaining informed written consent. Baseline demographic and clinical data were collected using a pre-structured proforma. Detailed clinical history including duration of illness, symptoms, smoking status, biomass fuel exposure, and comorbid conditions was recorded, followed by thorough physical examination. Patients with clinical suspicion and chest radiograph findings suggestive of bronchiectasis underwent HRCT of the chest for diagnostic confirmation and assessment of radiological extent and type of bronchiectasis.

After confirmation of diagnosis, sputum samples were collected for microbiological evaluation, including Gram staining and acid-fast bacilli staining, to identify airway pathogens and exclude active tuberculosis. Pulmonary function testing was performed using spirometry to assess ventilatory patterns and functional impairment. Disease severity was assessed using validated scoring systems, namely the FACED score and the Bronchiectasis Severity Index (BSI), to correlate clinical, radiological, microbiological, and functional parameters.

Data were entered into Microsoft Excel and analysed using SPSS software version 16. Continuous variables such as age, duration of illness, number of exacerbations, haemoglobin levels, total leukocyte count, and erythrocyte sedimentation rate were expressed as mean, median, and standard deviation. Categorical variables including gender, aetiology, comorbidities, exposure history, clinical features, sputum culture results, radiological findings, pulmonary function patterns, mMRC grading, FACED score, and BSI score were presented as frequencies and percentages. Correlation between variables was analysed using appropriate parametric or non-parametric tests after testing for normality, and a p-value of less than 0.05 was considered statistically significant.

OBSERVATION AND RESULTS

A total of 60 patients with bronchiectasis were included in the study. The mean age of the study population was 53.7 ± 14.4 years (range: 20–85 years), with a slight male predominance (53.3%).

Table 1: Mean Age and Gender Distribution

Variable	Value
Mean age (years)	53.66 ± 14.44
Male	32 (53.3%)
Female	28 (46.7%)

Pulmonary tuberculosis sequelae was the most common aetiology, accounting for 66.7% of cases, followed by post-infective causes and idiopathic bronchiectasis (11.6% each).

Table 2: Aetiology of Bronchiectasis in the Study Population

	Frequency	Percent
PTB Sequelae	40	66.7%
Post Infective	7	11.6
Sequestration	1	1.7%
ABPA	4	6.7%
Rheumatoid Arthritis	1	1.7%
Unknown etiology	7	11.6

Most patients (75%) had no associated comorbidities; pulmonary hypertension (10%) was the most frequent comorbidity. Biomass fuel exposure was present in 28.3% of patients. The majority were non-smokers (78.4%) and did not consume alcohol (78.3%). The mean duration of illness was 9.0 ± 8.0 years. More than half of the patients (53%) required hospitalization during the study period. The mean number of exacerbations was 2.23 ± 1.42. Cough (96.7%) and dyspnoea (93.3%) were the most common presenting symptoms, followed by fever (36.7%), wheeze (30%), clubbing (36.6%), and haemoptysis (13.4%). Most patients with clubbing had Grade I or II changes. The mean haemoglobin level was 11.3 ± 1.76 g/dL, mean total leukocyte count was 9820 cells/mm³, mean ESR was 27.3 mm/hr, and mean BMI was 23.5 kg/m².

Sputum culture was positive in 60% of patients. Pseudomonas aeruginosa was the most commonly isolated organism (28.3%), followed by Klebsiella pneumoniae (11.7%). Chronic colonization was most frequent with Pseudomonas. (Table 3)

Table 3: Sputum culture results of the study population

Sputum Culture	Frequency	Percent
Pseudomonas	17	28.3%

Klebsiella pneumoniae	7	11.7%
Staphylococcus aureus	2	3.3%
Streptococcus pneumoniae	2	3.3%
Acinetobacter baumanii	3	5.0%
E.coli	1	1.7%
E. coli, Acinetobacter	1	1.7%
K.oxytoca, s.pyogenes	1	1.7%
Streptococcus pyogenes	2	3.3%
No growth	25	40%
Total	60	100.0%

Radiologically, chest X-ray most commonly showed right lower zone involvement. (Fig 1) HRCT revealed predominant involvement of the lower lobes, with cystic bronchiectasis being the most common morphological type (66.7%), followed by tubular bronchiectasis (21.6%). (Fig 2

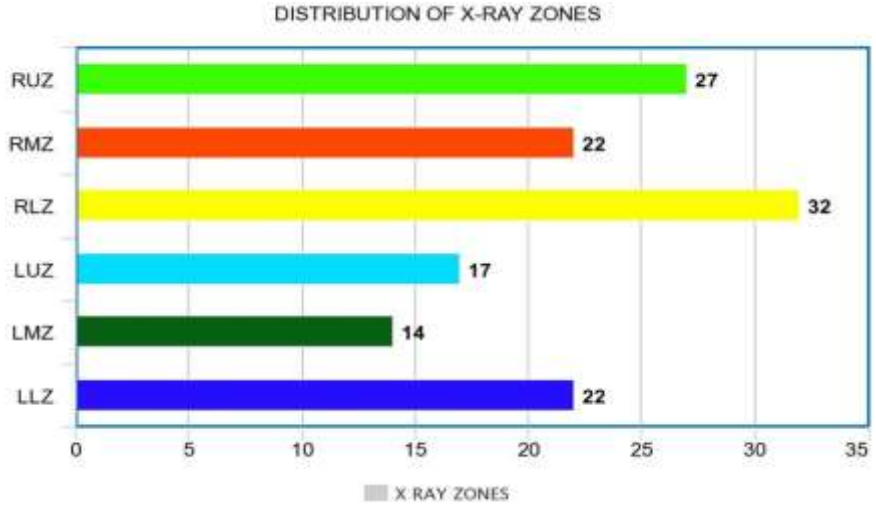

Fig 1: Bar chart showing distribution of Involvement of Zones by Chest X Ray

Table 4: Type of Bronchiectasis

Type of Bronchiectasis	Frequency	Percent
Cystic and tubular	3	5.0%
Cystic and varicose	1	1.7%
Cystic,tubuar,varicose	1	1.7%
Cystic bronchiectasis	40	66.7%
Tubular bronchiectasis	13	21.6%
Varicose	2	3.3%
Total	60	100.0%

Pulmonary function testing showed mixed ventilatory defects in 31.7% of patients, obstructive pattern in 25%, restrictive pattern in 21.6%, while 21.6% had normal spirometry. According to mMRC grading, most patients belonged to Grade II dyspnoea. FACED scoring classified the majority as having mild disease (65%), whereas BSI scoring identified a larger proportion with severe disease (55%).

According to the FACED score, 39 (65.0%) patients had mild bronchiectasis, 14 (23.3%) patients had moderate disease, and 7 (11.7%) patients had severe disease. According to the Bronchiectasis Severity Index (BSI), 13 (21.6%) patients had mild disease, 14 (23.3%) patients had moderate disease, and 33 (55.0%) patients had severe bronchiectasis. Inferential analysis showed that the number of exacerbations significantly correlated with BSI score ($p < 0.001$) but not with FACED score. FACED and BSI scores demonstrated a significant positive correlation with each other ($p < 0.01$). (Table 5)

Table 5: Correlation among Severity Scores and the Disease Outcomes

Variables	Correlation	Duration of illness	mMRC Grade	FACED Score	Exacerbation	BSI Score

Duration of illness	Pearson Correlation	1	.022	.139	.113	.246
	Sig. (2-tailed)		.868	.297	.393	.060
mMRC Grade	Pearson Correlation	.022	1	.451**	.478**	.601**
	Sig. (2-tailed)	.868		.000	.000	.000
FACED Score	Pearson Correlation	.139	.451**	1	.176	.586**
	Sig. (2-tailed)	.297	.000		.181	.000
Exacerbation	Pearson Correlation	.113	.478**	.176	1	.712**
	Sig. (2-tailed)	.393	.000	.181		.000
BSI Score	Pearson Correlation	.246	.601**	.586**	.712**	1
	Sig. (2-tailed)	.060	.000	.000	.000	

Pseudomonas aeruginosa infection was associated with cystic bronchiectasis, mixed spirometric pattern, and the highest disease severity scores on both FACED and BSI scales. (Table 6)

Table 6: Comparison of microorganism with Bronchiectasis Type, Spirometry Pattern and Scoring

Organism	Most common type of bronchiectasis	Most common spirometry pattern	Highest faced score	Highest BSI score
Pseudomonas	Cystic (n=12)	Mixed (n=8)	4 (n=5)	14 (n=3)
Klebsiella	Cystic (n=7)	Mixed (n=2)	0 (n=3)	9 (n=3)
Acinetobacter	Cystic (n=2)	Restrictive (n=2)	3 (n=2)	12 (n=2)

DISCUSSION

A total of 60 patients with bronchiectasis were included in the present study, with a mean age of 53.66 ± 14.44 years (range: 20–85 years) and a slight male predominance (32, 53.3%). This demographic profile reflects the chronic, progressive nature of bronchiectasis, which often becomes clinically evident in middle-aged and older adults. Similar age distributions have been reported by Singh AK et al.[16] while studies by Dole S et al.[17] and Ahmed JA et al.[18] documented a higher prevalence among females. These variations may be influenced by regional differences, healthcare-seeking behavior, and underlying aetiological factors.

Pulmonary tuberculosis sequelae emerged as the predominant aetiology in the present study, accounting for 40 (66.7%) patients. This finding highlights the persistent impact of tuberculosis on chronic respiratory morbidity in developing countries, particularly in South Asia. Comparable observations were reported by Ahmed JA et al.[18] and Dhaker DC et al.[19] where post-tuberculous bronchiectasis constituted a major proportion of cases. In contrast, studies from developed countries, such as Perossi J et al.[20] reported a higher proportion of idiopathic and post-infective bronchiectasis, emphasizing the influence of socioeconomic and epidemiological differences on disease causation.

The majority of patients in this study, 45 (75%), did not have associated comorbidities; however, pulmonary hypertension was the most frequent comorbidity, present in 6 (10%) patients, indicating advanced disease and chronic hypoxic burden. Biomass fuel exposure was reported by 17 (28.3%) patients, reinforcing its role as an important environmental risk factor, as also noted by Ramya VH et al.[21] Most patients were non-smokers and non-alcohol users, suggesting that non-smoking-related factors significantly contribute to bronchiectasis in this population. The mean duration of illness was 9.02 ± 8.0 years, reflecting delayed diagnosis and long-standing disease, a finding consistent with reports by Nursoy MA et al.[22]

Clinically, cough (58, 96.7%) and dyspnoea (56, 93.3%) were the most common presenting symptoms, underscoring the chronic inflammatory and obstructive nature of the disease. Fever and wheeze were observed in approximately one-third of patients, while clubbing was present in 22 (36.6%), predominantly of Grade I or II severity, suggesting chronic hypoxia and long-term disease. Haemoptysis was noted in 8 (13.4%) patients, comparable to rates reported by Singh AK et al.[16] and Ahmed JA et al.[18] Laboratory parameters revealed mild anaemia, elevated ESR, and leukocytosis, reflecting ongoing systemic inflammation and recurrent infections.

Microbiological analysis revealed sputum culture positivity in 36 (60%) patients. Pseudomonas aeruginosa was the most frequently isolated organism (17, 28.3%), followed by Klebsiella pneumoniae (7, 11.7%). Chronic colonization with

Pseudomonas aeruginosa was associated with more severe disease, higher exacerbation rates, and mixed ventilatory defects. Similar microbiological patterns have been reported by Dole S et al.[17] Ahmed JA et al.[18] Ramya VH et al.[21] and Ankit DA et al.[23] all of whom identified Pseudomonas as a key pathogen associated with adverse outcomes.

Radiological evaluation demonstrated predominant lower lobe involvement, with cystic bronchiectasis being the most common morphological type (40, 66.7%), followed by tubular bronchiectasis (13, 21.6%). These findings suggest advanced structural lung damage at presentation. Comparable radiological patterns have been documented by Dole S et al.[17] and Singh AK et al.[16] while Kim SH et al.[24] reported cylindrical bronchiectasis as the predominant type, possibly reflecting earlier disease stages in their cohort.

Pulmonary function testing revealed mixed ventilatory defects in 19 (31.7%) patients, obstructive patterns in 15 (25%), restrictive patterns in 13 (21.6%), and normal spirometry in 13 (21.6%). These findings highlight the heterogeneous functional impairment seen in bronchiectasis. Studies by Dole S et al.[17] and Dhaker DC et al.[19] also reported mixed and obstructive patterns as the most common abnormalities. Most patients in the present study had Grade II dyspnoea on mMRC grading, correlating with spirometric impairment and radiological severity.

Disease severity assessment showed notable differences between scoring systems. FACED scoring classified the majority of patients as having mild disease (39, 65.0%), whereas BSI identified a larger proportion as severe (33, 55.0%). This discrepancy reflects the broader parameters included in the BSI, particularly exacerbation frequency and hospitalization. A significant correlation was observed between exacerbation frequency and BSI score ($p < 0.001$), but not with FACED score, consistent with observations by Perossi J et al.[20] FACED and BSI scores showed a significant positive correlation with each other ($p < 0.01$), supporting their complementary role in disease assessment.

The present study emphasizes the complex interplay between clinical presentation, radiological extent, microbiological colonization, and functional impairment in bronchiectasis. Integrated assessment using validated severity scores, along with microbiological surveillance, is essential for accurate risk stratification and optimized patient management.

Limitations

As this was a hospital-based cross-sectional study, complete evaluation of all underlying anatomical and systemic causes was not feasible, potentially underestimating rare aetiologies and overestimating idiopathic cases. Selection bias may be present, and findings may not be generalisable to the broader community, including milder or asymptomatic cases.

CONCLUSION

Bronchiectasis remains a significant chronic respiratory disease with diverse clinical, radiological, microbiological, and functional manifestations. Pulmonary tuberculosis sequelae emerged as the predominant aetiology, underscoring its continuing impact in developing regions. Cough and dyspnoea were the most frequent symptoms, with cystic bronchiectasis and lower lobe involvement being the common radiological patterns. Pseudomonas aeruginosa was the most frequent pathogen and was associated with greater disease severity. The Bronchiectasis Severity Index correlated better with exacerbation frequency, emphasizing its utility in identifying high-risk patients and guiding long-term management strategies.

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Conflicts of Interest

There are no conflicts of interest

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