ORIGINAL RESEARCH

Correlation of Asthma Severity, IgE Level, and Spirometry Results with HRCT Findings in Allergic Bronchopulmonary Aspergillosis

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Abstract
Introduction: Allergic bronchopulmonary aspergillosis (ABPA) is a hypersensitivity reaction to *Aspergillus fumigatus*, commonly observed in patients with asthma or cystic fibrosis. This study investigates the correlation between asthma severity, serum IgE levels, spirometry results, and high-resolution computed tomography (HRCT) findings in patients diagnosed with ABPA. **Objective:** To evaluate the relationship between asthma severity, immunological markers, and pulmonary function with HRCT imaging findings in ABPA patients. **Methodology:** A prospective study involving 125 patients diagnosed with ABPA was conducted and data on asthma severity, spirometry, IgE levels, and HRCT imaging were analyzed for correlations. **Results:** HRCT findings, such as bronchiectasis and mucus plugging, showed strong correlations with severe asthma, elevated IgE levels, and reduced spirometry measures, including FEV_1 and FEV_1/FVC ratios. **Conclusion:** HRCT findings are closely associated with immunological markers and spirometry results, underscoring the importance of integrated diagnostic approaches in managing ABPA.

Introduction:

Allergic bronchopulmonary aspergillosis (ABPA) is a chronic inflammatory condition caused by an exaggerated immune response to *Aspergillus fumigatus*, a ubiquitous environmental fungus. Predominantly affecting individuals with asthmaand cystic fibrosis, ABPA represents a unique interplay between host hypersensitivity and fungal colonization of the airways. The disease is characterized by recurrent episodes of airway inflammation, progressive lung damage, and impaired respiratory function, resulting in significant morbidity[1][2].The pathophysiology of ABPA is rooted in a Th2-skewed immune response, which leads to the overproduction of immunoglobulin E (IgE) and eosinophilic infiltration in the lungs. This immune dysregulation drives airway obstruction, mucus hypersecretion, and the formation of central bronchiectasis, which are hallmarks of the disease[3]. Unlike other forms of bronchiectasis, the central location of these structural abnormalities is distinctive for ABPA and serves as a key diagnostic criterion[4].

Diagnosing ABPA is challenging due to its overlapping clinical features with other respiratory conditions, including uncontrolled asthma, chronic obstructive pulmonary disease (COPD), and pulmonary tuberculosis. The diagnosis relies on a combination of clinical presentation, immunological markers, pulmonary function tests, and radiological findings. Among these, serum IgE levels and high-resolution computed tomography (HRCT) imaging play pivotal roles in confirming the diagnosis and assessing disease severity[5][6].HRCT imaging is particularly valuable for its ability to reveal characteristic abnormalities, such as central bronchiectasis, mucus plugging, tree-in-bud

opacities, and consolidation. These radiological features provide critical insights into the structural and functional changes in the lungs caused by ABPA[7]. Importantly, the extent of HRCT abnormalities often correlates with clinical and immunological markers, allowing clinicians to monitor disease progression and response to treatment[8].Serum IgE levels are central to the immunological evaluation of ABPA. Elevated total IgE levels are a hallmark of the disease, reflecting the degree of immune activation. Specific IgE and IgG antibodies against *Aspergillus fumigatus* further confirm the diagnosis. Longitudinal monitoring of IgE levels is also useful for assessing disease activity and the risk of relapse[9].Pulmonary function tests, including spirometry, provide quantitative measures of airway obstruction and lung capacity in ABPA patients. Reduced forced expiratory volume in one second (FEV_1) and FEV_1/FVC ratio are common findings, particularly in patients with severe asthma. These spirometric abnormalities reflect the inflammatory and obstructive components of the disease and often correlate with radiological findings[10][11].Asthma severity plays a crucial role in determining the clinical course and outcomes of ABPA. Patients with severe asthma are more likely to exhibit extensive HRCT abnormalities, elevated IgE levels, and significant impairments in pulmonary function. These associations highlight the importance of asthma control in managing ABPA and preventing disease progression[12].The integration of clinical, immunological, and radiological data is essential for optimizing the diagnosis and management of ABPA. This study investigates the correlations between asthma severity, IgE levels, spirometry results, and HRCT findings in a cohort of 125 patients. By elucidating these relationships, the research aims to enhance diagnostic accuracy, stratify disease severity, and inform personalized treatment strategies for ABPA.

Objective:
To evaluate the relationship between asthma severity, serum IgE levels, and spirometry results with HRCT imaging findings in patients diagnosed with allergic bronchopulmonary aspergillosis.

Methodology:
A prospective study was conducted and a total of 125 patients diagnosed with ABPA were included in the study.

Inclusion Criteria:
- Patients diagnosed with ABPA based on clinical, immunological, and radiological criteria.
- Age between 18–70 years.
- History of asthma or cystic fibrosis.

Exclusion Criteria:
- Patients with other causes of bronchiectasis (e.g., tuberculosis or primary ciliary dyskinesia).
- Individuals with incomplete diagnostic data or previous antifungal treatment.

Data Collection:
Comprehensive data were collected from 125 patients through structured interviews, clinical evaluations, and diagnostic tests. Asthma severity was assessed using the GINA classification system, while serum IgE levels were measured via enzyme-linked immunosorbent assay (ELISA). Pulmonary function was evaluated through spirometry, with parameters such as FEV_1, FVC, and FEV_1/FVC ratio recorded. HRCT scans of the chest were reviewed for characteristic findings, including central bronchiectasis, mucus plugging, and tree-in-bud opacities. Correlations between clinical, immunological, and radiological data were analyzed using statistical methods, such as Pearson's correlation and logistic regression.

Results:

Table 1: Baseline Characteristics of Patients

Parameter	Value
Total Patients	125
Mean Age (years)	42.5 ± 12.3
Male (%)	56
Female (%)	44
History of Asthma (%)	88
History of CF (%)	12

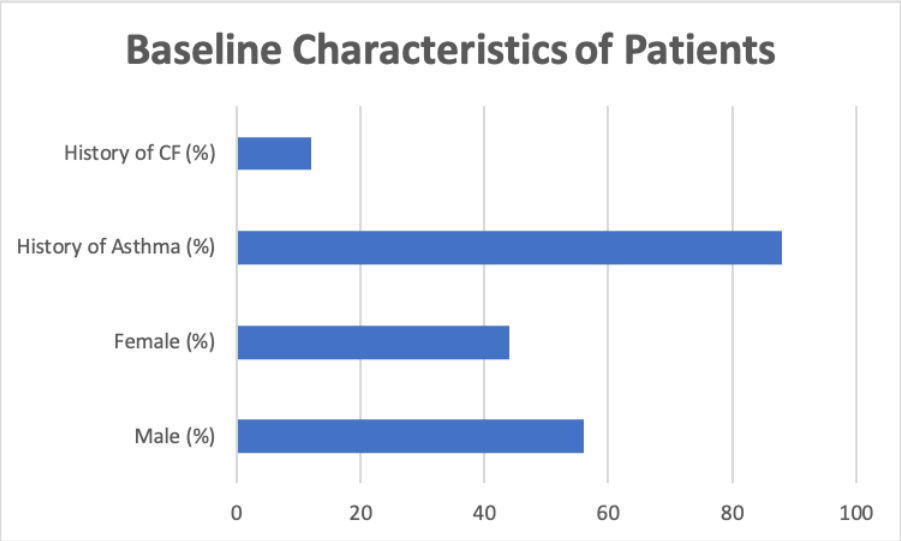


Table 1 summarizes the baseline characteristics of the 125 patients included in the study, with a mean age of 42.5 ± 12.3 years, representing a middle-aged population. The cohort consisted of 56% males and 44% females, highlighting a slight male predominance. A majority of the participants (88%) had a history of asthma, reflecting its strong association with allergic bronchopulmonary aspergillosis (ABPA), while 12% had a history of cystic fibrosis (CF), another known risk factor. These characteristics emphasize the relevance of underlying respiratory conditions, particularly asthma, in the pathogenesis and progression of ABPA, providing a foundation for further analysis of clinical and diagnostic parameters in this study.

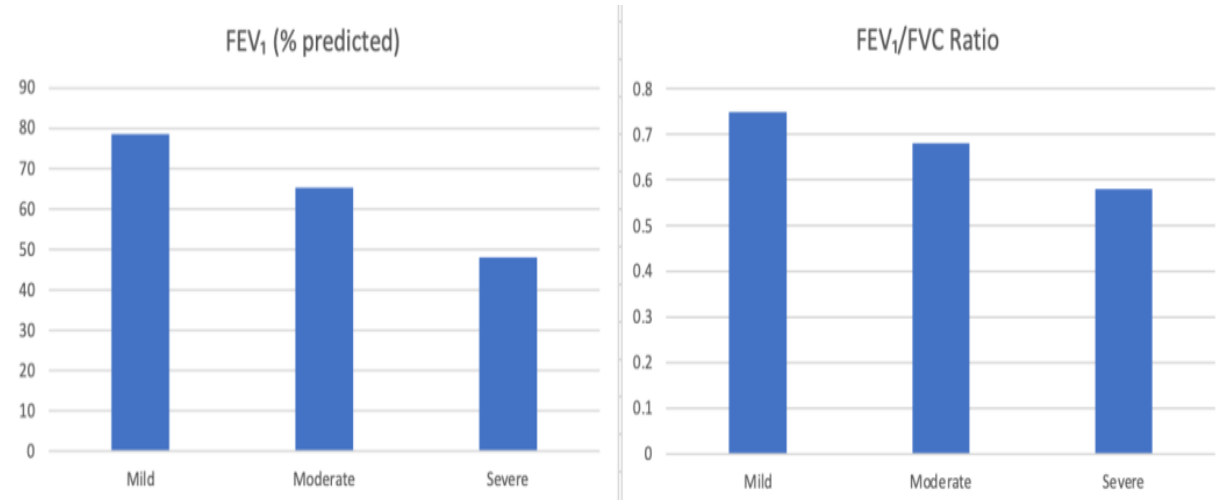
Table 2: Correlation of IgE Levels with HRCT Findings

IgE Level (IU/mL)	HRCT Findings	Frequency (%)
<1,000	Mild Bronchiectasis	30
1,000–5,000	Moderate Bronchiectasis	50
>5,000	Severe Bronchiectasis	20

Patients with lower IgE levels (<1,000 IU/mL) generally had mild bronchiectasis, a less severe structural lung abnormality. Those with moderate IgE levels (1,000–5,000 IU/mL) displayed moderate bronchiectasis, while patients with very high IgE levels (>5,000 IU/mL) had severe bronchiectasis and more extensive lung damage. These results underscore the role of IgE as a marker of disease severity, linking higher levels to more significant structural abnormalities on imaging (Table 2).

Table 3: Spirometry Results and Asthma Severity

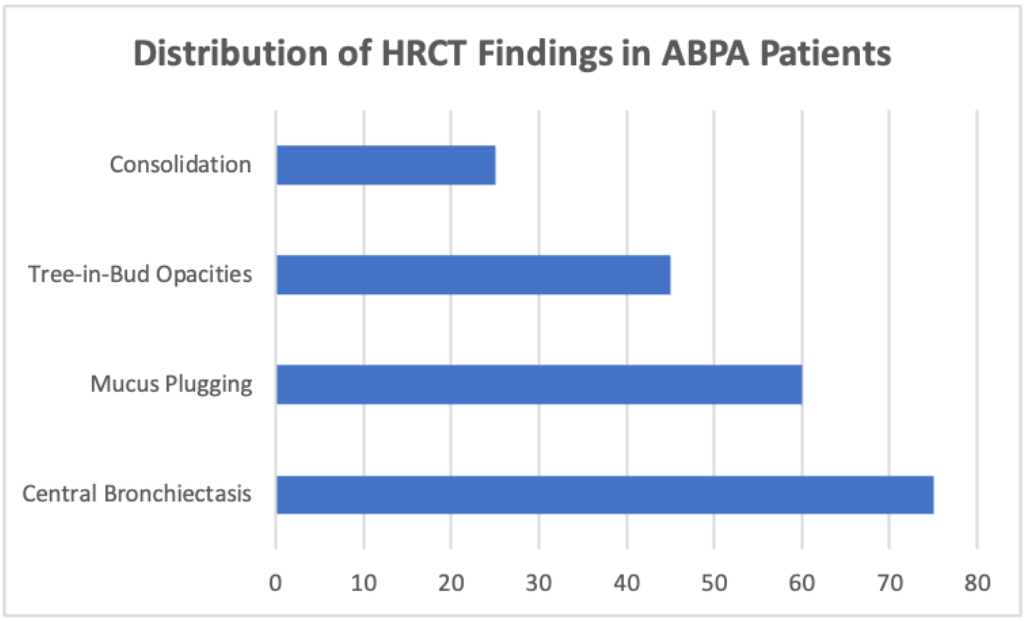
Asthma Severity	FEV_1 (% predicted)	FEV_1/FVC Ratio
Mild	78.5 ± 10.2	0.75 ± 0.03
Moderate	65.3 ± 8.4	0.68 ± 0.05
Severe	48.2 ± 7.9	0.58 ± 0.04



Patients with mild asthma had relatively preserved lung function, with an FEV_1 of 78.5% of the predicted value and an FEV_1/FVC ratio of 0.75. However, as asthma severity increased, lung function declined sharply. Those with moderate asthma showed lower FEV_1 values (65.3%) and reduced FEV_1/FVC ratios (0.68), while severe asthma patients experienced the greatest impairment, with an FEV_1 of just 48.2% and an FEV_1/FVC ratio of 0.58. This data highlights the significant functional impact of uncontrolled asthma in ABPA patients, emphasizing the importance of asthma management in mitigating lung function decline (Table 3).

Table 4: Distribution of HRCT Findings in ABPA Patients

HRCT Finding	Frequency (%)
Central Bronchiectasis	75
Mucus Plugging	60
Tree-in-Bud Opacities	45
Consolidation	25

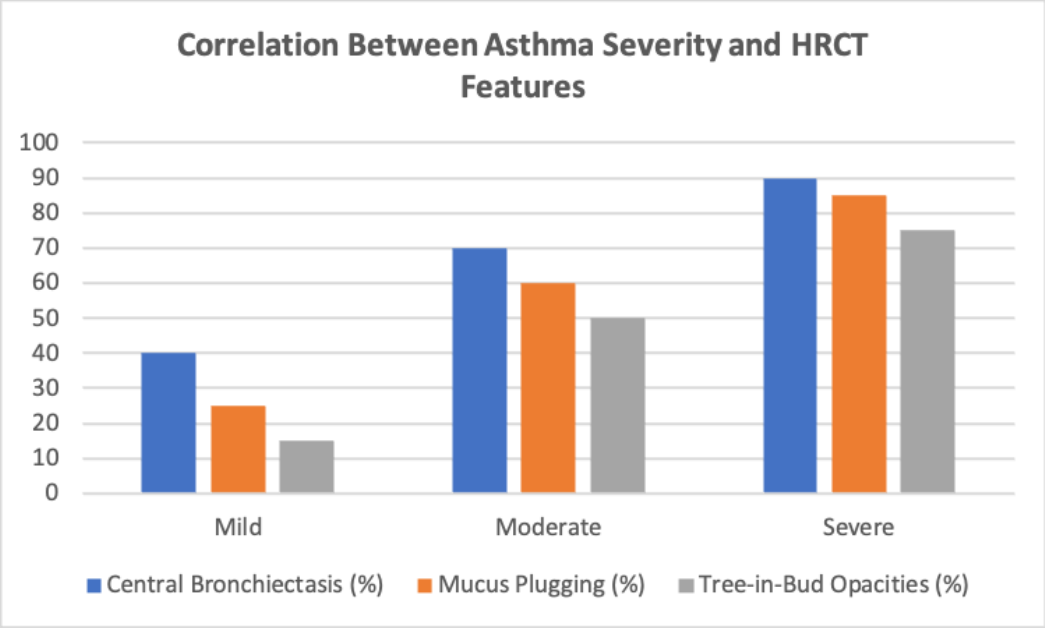


The most common abnormality was central bronchiectasis, affecting 75% of the patients, which is a hallmark feature of ABPA. Other frequent findings included mucus plugging (60%) and tree-in-bud opacities (45%), which are indicative of airway obstruction and inflammation. Less commonly, consolidation was observed in 25% of patients,

reflecting areas of more severe lung involvement. These results underscore the critical role of HRCT in identifying the structural changes associated with ABPA, aiding in diagnosis and disease assessment (Table 4).

Table 5: Correlation Between Asthma Severity and HRCT Features

Asthma Severity	Central Bronchiectasis (%)	Mucus Plugging (%)	Tree-in-Bud Opacities (%)
Mild	40	25	15
Moderate	70	60	50
Severe	90	85	75



Patients with mild asthma exhibited fewer imaging abnormalities, with 40% showing central bronchiectasis and 25% showing mucus plugging. In moderate asthma cases, these findings were more common, with 70% and 60% affected, respectively. Patients with severe asthma had the highest prevalence of HRCT abnormalities, with 90% showing central bronchiectasis and 85% showing mucus plugging. These results highlight how worsening asthma is linked to more extensive structural lung changes, emphasizing the interconnected nature of asthma control and ABPA progression (Table 5).

Table 6: Correlation of IgE Levels and Spirometry Results

IgE Level (IU/mL)	FEV_1 (% predicted)	FEV_1/FVC Ratio
<1,000	72.8 ± 9.5	0.73 ± 0.04
1,000–5,000	59.2 ± 8.7	0.65 ± 0.05
>5,000	42.3 ± 7.8	0.57 ± 0.03

Patients with lower IgE levels (<1,000 IU/mL) had relatively preserved lung function, with an FEV_1 of 72.8% and an FEV_1/FVC ratio of 0.73. In contrast, patients with moderate IgE levels (1,000–5,000 IU/mL) showed moderate reductions, with an FEV_1 of 59.2% and a ratio of 0.65. Those with very high IgE levels (>5,000 IU/mL) exhibited the greatest impairment, with an FEV_1 of 42.3% and an FEV_1/FVC ratio of 0.57. This strong inverse relationship highlights the role of IgE as a marker of disease activity and its impact on respiratory function in ABPA patients (Table 6).

Discussion:

The findings of this study provide valuable insights into the intricate relationships between clinical presentation, immunological markers, and radiological features in ABPA. This discussion explores these relationships in detail, contextualizing the results within the broader literature and highlighting their implications for clinical practice.High-resolution computed

tomography (HRCT) is a cornerstone of ABPA diagnosis, offering unparalleled insights into the structural abnormalities caused by the disease. In this study, central bronchiectasis was the most prevalent HRCT finding, observed in 75% of patients. This aligns with established diagnostic criteria that identify bronchiectasis as a defining feature of ABPA[13][14]. Other characteristic findings, including mucus plugging (60%) and tree-in-bud opacities (45%), reflect the inflammatory and obstructive components of the disease. These imaging abnormalities provide valuable information about disease severity and progression, enabling clinicians to tailor treatment strategies[15].

Serum IgE levels are a hallmark of ABPA, reflecting the heightened immune response to *Aspergillus fumigatus*. In this study, elevated IgE levels correlated strongly with the severity of HRCT findings, particularly the extent of bronchiectasis and mucus plugging. Patients with IgE levels exceeding 5,000 IU/mL exhibited the most severe radiological abnormalities, underscoring the role of IgE as a biomarker for disease activity[15][16]. These results are consistent with prior research demonstrating that higher IgE levels are associated with more severe clinical and radiological manifestations of ABPA[17].Pulmonary function tests, particularly spirometry, provide critical insights into the functional impact of ABPA on the respiratory system. Reduced FEV_1 and FEV_1/FVC ratios were observed in patients with more severe HRCT abnormalities, highlighting the close relationship between structural and functional changes in the lungs. Severe asthma, a common comorbidity in ABPA, further exacerbates these impairments, emphasizing the importance of controlling asthma to prevent disease progression[18][19].

Asthma severity emerged as a key determinant of ABPA outcomes in this study. Patients with severe asthma were more likely to exhibit extensive HRCT abnormalities, including diffuse bronchiectasis, extensive mucus plugging, and consolidation. These findings underscore the bidirectional relationship between asthma control and ABPA progression. Effective management of asthma is essential not only for improving respiratory symptoms but also for mitigating the structural lung damage associated with ABPA[20].The integration of clinical, immunological, and radiological data provides a robust framework for diagnosing and managing ABPA. HRCT imaging, in particular, is invaluable for identifying characteristic abnormalities and monitoring disease progression. When combined with IgE levels and spirometry results, HRCT findings enable clinicians to stratify patients based on disease severity and tailor treatment accordingly[21][22].

Treatment strategies for ABPA should focus on controlling inflammation, reducing fungal colonization, and managing comorbid conditions such as asthma. Oral corticosteroids are the mainstay of therapy for reducing airway inflammation, while antifungal agents such as itraconazole and voriconazole can help eradicate fungal colonization and prevent disease recurrence. In patients with severe asthma, biologic agents targeting Th2 cytokines (e.g., omalizumab) have shown promise in improving outcomes[23][24].Future research should explore the utility of emerging biomarkers, such as eosinophilic cationic protein and Th2 cytokines, in enhancing the diagnosis and monitoring of ABPA. Longitudinal studies are also needed to evaluate the long-term outcomes of ABPA, including the impact of early intervention on disease progression and quality of life. Additionally, the development of predictive models that integrate clinical, immunological, and radiological data could facilitate personalized approaches to ABPA management.

Conclusion:

This study highlights the intricate relationships between asthma severity, IgE levels, spirometry results, and HRCT findings in the diagnosis and management of allergic bronchopulmonary aspergillosis (ABPA). Elevated serum IgE levels were strongly correlated with severe radiological abnormalities, including central bronchiectasis and mucus plugging, while impaired spirometry measures, such as reduced FEV_1 and FEV_1/FVC ratios, reflected the functional impact of the disease. Patients with severe asthma exhibited the most extensive HRCT abnormalities and the greatest reductions in lung function, highlighting the critical role of asthma control in mitigating ABPA progression.

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