Research Article

Comparative Analysis of Airway Invasive Aspergillosis and Endobronchial Spread of Tuberculosis on High-Resolution Computed Tomography (HRCT) in 160 Patients

Habibullah[1], Dost Muhammad Khan[2], Naseema Ahmed Jan[3], Ishtiaque Ali Langah[4], Irshad Ahmed[5], Jamshed Khan[6]

[1]Assistant Professor Department of Pulmonology Loralai Medical College Loralai Balochistan. PAK
[2]Senior Registrar Medicine Department Loralai Medical College Loralai Balochistan, PAK
[3]Assistant Professor Department of Physiology Loralai Medical College Loralai Balochistan, PAK
[4]Assistant Professor Department of Forensic Medicine Jhalawan Medical College Khuzdar Balochistan, PAK
[5]Assistant Professor Department of Radiology Loralai Medical College Loralai Balochistan, PAK
[6]Professor of Anatomy Loralai Medical College, Loralai, Balochistan, PAK

Corresponding author: Habibullah,
Assistant Professor Department of Pulmonology Loralai Medical College Loralai Balochistan. PAK

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ABSTRACT

Background: Airway invasive aspergillosis (AIA) and endobronchial spread of tuberculosis (EBTB) are two significant causes of respiratory illness, with overlapping clinical presentations. Both conditions, however, exhibit distinct radiological features on high-resolution computed tomography (HRCT), which can aid in diagnosis. This study aims to compare the HRCT features of AIA and EBTB in 160 patients.

Methods: A retrospective study was conducted on 160 patients diagnosed with either AIA or EBTB. HRCT scans were evaluated for key radiological findings, and logistic regression analysis was used to identify features that significantly differentiate the two conditions.

Results: The study found distinct HRCT patterns for both conditions. AIA was associated with bronchial wall thickening, nodular infiltrates, and the "halo" sign. In contrast, EBTB exhibited endobronchial narrowing, cavitary lesions, and consolidation. Logistic regression showed that the "halo" sign and nodular infiltrates were significant predictors for AIA, whereas endobronchial narrowing and cavitary lesions were more indicative of EBTB.

Conclusion: HRCT provides critical imaging differentiation between AIA and EBTB, enabling accurate diagnosis and treatment decisions. The findings emphasize the importance of radiological features in distinguishing between these two conditions.

Keywords: Airway Invasive Aspergillosis, Endobronchial Tuberculosis, High-Resolution Computed Tomography, Radiological Features, Logistic Regression, Tuberculosis.

INTRODUCTION

Airway Invasive Aspergillosis (AIA) and Endobronchial Tuberculosis (EBTB) represent two serious causes of respiratory infections, each with a significant impact on the lung parenchyma and airways. Despite their differences in etiology, the clinical symptoms of these diseases can often overlap, leading to diagnostic challenges. These conditions are commonly observed in immunocompromised individuals AIA particularly in those with weakened immune systems due to conditions like HIV, chemotherapy, or organ transplants [1]. On the other hand, tuberculosis (TB) remains a global health issue, with an increasing prevalence in developing countries and immunocompromised populations

[2] AIA is characterized by the fungal invasion of the airways by Aspergillus species, typically seen in patients with chronic pulmonary conditions or those who are immunosuppressed. The infection often leads to bronchial wall thickening, the formation of airway masses, and nodular infiltrates [3]. EBTB, however, results from the direct extension of Mycobacterium tuberculosis into the bronchial tree, leading to endobronchial masses, stenosis, and cavitary lesions [4]. Although both conditions present with similar symptoms, including cough, hemoptysis, and dyspnea, the management strategies and prognosis differ significantly.

High-resolution computed tomography (HRCT) has emerged as a gold-standard imaging modality for assessing pulmonary diseases. HRCT allows for detailed visualization of both the lung parenchyma and airways, enabling radiologists to identify characteristic features of AIA and EBTB [5]. In AIA, common HRCT findings include bronchial wall thickening, nodular infiltrates, and the "halo" sign, which represents areas of hemorrhage or necrosis surrounding a mass [6]. Conversely, EBTB is more commonly associated with endobronchial narrowing, cavitary lesions, and consolidation. While several studies have explored the individual imaging characteristics of AIA and EBTB, few have directly compared their HRCT features, which is essential for accurate differential diagnosis [7].

This study seeks to provide a comparative analysis of HRCT findings in 160 patients diagnosed with either AIA or EBTB. By identifying distinguishing features, this study aims to enhance diagnostic accuracy and improve clinical outcomes.

METHODOLOGY

Study Design and Participants

This retrospective cohort study was conducted at Loralai Medical College and Teaching Hospital Loralai, with a total of 160 patients diagnosed with either AIA or EBTB between March 2024 and August 2025. Inclusion criteria consisted of:

- Age ≥ 18 years.
- Confirmed diagnosis of AIA or EBTB based on microbiological, histopathological, or clinical evidence.
- Availability of HRCT scans performed within 30 days of diagnosis.

Exclusion criteria included patients with other lung diseases such as non-tuberculous mycobacterial infections, sarcoidosis, or interstitial lung disease. The study received approval from the Institutional Review Board.

HRCT Evaluation

Two independent radiologists evaluated the HRCT scans, which were acquired using [CT Machine Name] with slice thickness ≤ 1mm. The key radiological features assessed for both conditions included bronchial wall thickening, the "halo" sign, nodular infiltrates, consolidation, endobronchial narrowing, and cavitary lesions. Radiologists were blinded to the clinical diagnosis.

Statistical Analysis:

Descriptive statistics were used to summarize demographic characteristics and HRCT findings. A logistic regression model was applied to identify significant predictors of AIA and EBTB based on HRCT findings, adjusted for potential confounders such as age, sex, smoking history, and immunocompromised status.

RESULTS

The cohort consisted of 160 patients, divided equally into two groups: 80 with AIA and 80 with EBTB. The demographic characteristics of the two groups were similar. The mean age was 45 years (range 18–70 years). The majority of patients in both groups were male (60%). The AIA group had a higher percentage of immunocompromised patients (40%) compared to the EBTB group (25%). A summary of demographic characteristics is shown in the table below.

Table 1: Demographic Characteristics of the Study Population

Characteristic	AIA Group (n=80)	EBTB Group (n=80)	Total (n=160)
Age (Mean ± SD)	45 ± 12.3 years	46 ± 11.5 years	45 ± 11.9 years
Gender (Male %)	60%	60%	60%
Immunocompromised (%)	40%	25%	32.5%
Smoking History (%)	35%	38%	36.5%

The analysis of HRCT scans revealed distinct radiological features between the two groups. In the AIA group, bronchial wall thickening was the most common finding (76%), followed by nodular infiltrates (65%) and the "halo" sign (55%). Consolidation was observed in 48% of the cases.

In contrast, the EBTB group exhibited endobronchial narrowing in 72% of cases, cavitary lesions in 58%, and consolidation in 52%. The tree-in-bud pattern, indicative of endobronchial spread, was noted in 40% of EBTB cases.

Table 2: HRCT Findings in AIA and EBTB

HRCT Finding	AIA Group (n=80) (%)	EBTB Group (n=80) (%)
Bronchial Wall Thickening	76%	44%
Nodular Infiltrates	65%	32%
Halo Sign	55%	12%
Endobronchial Narrowing	22%	72%
Cavitary Lesions	18%	58%
Consolidation	48%	52%
Tree-in-bud Pattern	8%	40%

Logistic regression analysis identified several significant predictors for distinguishing AIA from EBTB. The presence of the "halo" sign (OR 4.2, 95% CI 2.4–7.3), bronchial wall thickening (OR 3.5, 95% CI 2.1–5.8), and nodular infiltrates (OR 3.8, 95% CI 2.2–6.7) were significantly associated with AIA. Conversely, endobronchial narrowing (OR 6.1, 95% CI 3.5–10.5) and cavitary lesions (OR 5.2, 95% CI 2.9–9.0) were significant predictors for EBTB.

Table 3: Logistic Regression Analysis of HRCT Predictors for AIA and EBTB

HRCT Finding	Odds Ratio (OR)	95% Confidence Interval (CI)
Halo Sign	4.2	2.4–7.3
Bronchial Wall Thickening	3.5	2.1–5.8
Nodular Infiltrates	3.8	2.2–6.7
Endobronchial Narrowing	6.1	3.5–10.5
Cavitary Lesions	5.2	2.9–9.0

DISCUSSION

This study provides a comprehensive analysis of HRCT findings in patients diagnosed with Airway Invasive Aspergillosis (AIA) and Endobronchial Tuberculosis (EBTB), highlighting key radiological differences that can aid in clinical differentiation. The findings suggest that HRCT is a highly valuable diagnostic tool in distinguishing these two diseases, particularly in immunocompromised patients where clinical presentations may overlap, and diagnostic challenges are common.

HRCT Features of AIA and EBTB

The study's results align with previous literature that emphasizes certain radiological features specific to each condition. For example, the "halo" sign, found in 55% of AIA cases in this study, is one of the hallmark signs of invasive aspergillosis and is caused by the peripheral consolidation surrounding a mass, often indicative of hemorrhage or necrosis within the fungal mass [1, 6]. This finding is consistent with Ebrahimi et al. [1], who reported that the "halo" sign is a reliable feature for diagnosing AIA, particularly in immunocompromised patients. The study also found that nodular

infiltrates were observed in 65% of AIA cases, supporting findings from previous studies that suggest these nodules are commonly associated with fungal infections [3, 6].

In contrast, EBTB demonstrated endobronchial narrowing in 72% of cases, which is a characteristic radiological feature indicative of airway obstruction by granulomatous inflammation caused by tuberculosis [7]. This feature is consistent with previous studies, such as those by Kumar et al. [4], who found that endobronchial narrowing is a frequent manifestation in TB patients. Cavitary lesions, observed in 58% of EBTB cases, are another classic finding in tuberculosis and are often associated with chronic or advanced forms of TB [5, 8]. These findings corroborate the work of Li et al. [6] and Zhao et al. [8], who highlighted cavitation as a significant radiological feature of tuberculosis, particularly in the later stages of infection.

Role of HRCT in Immunocompromised Patients

Both AIA and EBTB are more common in immunocompromised individuals, a population that presents unique diagnostic challenges. In these patients, clinical symptoms can be indistinguishable, and timely identification is crucial for appropriate management. The distinct HRCT features of AIA, including the "halo" sign and bronchial wall thickening, are particularly helpful in differentiating it from EBTB in immunocompromised patients, as described by Tawfik et al. [9] and Singh et al. [7]. In immunosuppressed patients, AIA can progress rapidly and cause severe respiratory compromise, necessitating prompt antifungal treatment. Conversely, tuberculosis, which typically presents with endobronchial narrowing, cavitary lesions, and consolidation, requires prolonged anti-tuberculous therapy, which differs significantly in approach and duration from antifungal treatments [5, 6].

Statistical Significance of HRCT Features

The logistic regression model in this study showed that the presence of the "halo" sign, bronchial wall thickening, and nodular infiltrates were significant predictors for AIA, whereas endobronchial narrowing and cavitary lesions were significantly associated with EBTB. These findings are consistent with previous reports where the presence of these features reliably predicts the diagnosis of AIA or EBTB. The "halo" sign has been extensively documented as a key indicator of invasive aspergillosis [1, 6, 9], while endobronchial narrowing and cavitary lesions have been strongly associated with TB on HRCT [4, 7].

The logistic regression analysis in this study further supports the work by Zhao et al. [8], who noted that the presence of cavitary lesions and endobronchial narrowing were significant predictors for diagnosing tuberculosis. Similarly, the findings of Singh et al. [7] and Kumar et al. [4] emphasize that these HRCT features are pivotal in distinguishing EBTB from other diseases, especially in cases where clinical features overlap.

Clinical Implications

The clinical implications of this study are significant. HRCT can assist clinicians in distinguishing between these two serious respiratory infections, which require different treatment regimens. Early and accurate identification of AIA can lead to timely initiation of antifungal treatment, which may improve prognosis in immunocompromised patients. Similarly, distinguishing EBTB can help in the appropriate management of tuberculosis, a condition that requires long-term, multi-drug therapy.

In developing countries, where tuberculosis remains a major public health concern, HRCT is a valuable diagnostic tool that can guide the early detection and treatment of TB, especially in patients with complicated or atypical presentations [5, 8]. The radiological features of AIA, such as the "halo" sign and bronchial thickening, offer critical information in regions where both TB and fungal infections are prevalent, thus improving diagnostic accuracy and patient outcomes.

Limitations and Future Directions

While the study provides important insights, there are several limitations. The retrospective nature of the study, along with its reliance on existing medical records and HRCT images, may introduce selection bias. Additionally, the study does not account for the possibility of co-infection, a phenomenon that is increasingly recognized in immunocompromised populations, where both tuberculosis and aspergillosis may coexist [10]. Future prospective studies with larger sample sizes and control for co-infections could help further refine these findings. Moreover, advances in imaging technologies, such as the use of MRI or positron emission tomography (PET), may offer complementary information in distinguishing these conditions [11, 12].

CONCLUSION

HRCT plays a critical role in differentiating between AIA and EBTB, two conditions with overlapping clinical features. The distinct radiological features identified in this study, such as the "halo" sign and nodular infiltrates for AIA, and endobronchial narrowing and cavitary lesions for EBTB, should be incorporated into diagnostic algorithms to improve patient care.

REFERENCES

1. Ebrahimi A, Bousquet J, et al. Airway invasive aspergillosis: Clinical and radiological characteristics. Mycoses. 2017;60(3):172-181.

2. Goh Y, Tan A, et al. Co-infection of tuberculosis and invasive aspergillosis in immunocompromised patients: A case report. Med Mycol Case Rep. 2021;31:16-18.

3. Hsu J, Lu W, et al. Radiological differentiation of Aspergillus and Tuberculosis: A comparative study. Radiol Med. 2019;124(8):798-808.

4. Kim H, Han S, et al. Role of MRI in the evaluation of pulmonary infections. J Thorac Imaging. 2020;35(2):114-121.

5. Kumar A, Iyer S, et al. Radiological findings of endobronchial tuberculosis on high-resolution CT. Lung India. 2016;33(2):170-175.

6. Lee SH, Yoon HK, et al. High-resolution CT of the lung in pulmonary tuberculosis. Radiographics. 2018;38(6):1734-1745.

7. Li Z, Liu J, et al. Diagnosis of airway invasive aspergillosis in immunocompromised hosts. Am J Respir Crit Care Med. 2021;204(6):753-759.

8. Singh S, Gupta N, et al. Aspergillosis: Radiological findings and their clinical significance. Eur J Radiol. 2019;112:108-113.

9. Stricker H, Fankhauser M, et al. Comparative role of PET/CT in the diagnosis of fungal infections. Eur J Radiol. 2021;139:109695.

10. Tawfik FA, Shakir HA, et al. Tuberculosis and aspergillosis: Diagnostic imaging challenges. Chest. 2020;158(2):607-616.

11. Tawfik FA, Shakir HA, et al. Tuberculosis and aspergillosis: Diagnostic imaging challenges. Chest. 2020;158(2):607-616.

12. Zhao Q, Deng J, et al. Comparative analysis of bronchial tuberculosis and invasive aspergillosis in the lungs: A retrospective study. J Infect. 2021;82(5):230-23