SAS Journal of Medicine
Abbreviated Key Title: SAS J Med
ISSN 2454-5112
Journal homepage: https://saspublishers.com

OPEN ACCESS

Radiology

Contribution of Chest CT to the Diagnosis of Angio-Invasive Pulmonary Aspergillosis in Immunocompromised Patients

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DOI: https://doi.org/10.36347/sasjm.2024.v10i09.002 | **Received:** 21.07.2024 | **Accepted:** 29.08.2024 | **Published:** 03.09.2024

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Abstract **Original Research Article**

This study reviews the chest CT characteristics of invasive pulmonary aspergillosis (IPA) in twenty immunocompromised patients, including those with hematological malignancies and end-stage renal disease. Key findings include the CT halo sign—an early indicator manifesting as a lower attenuation zone around pulmonary masses during bone marrow aplasia—as well as multiple small inflammatory masses and clusters of fluffy nodules. The study highlights the importance of early CT detection for effective treatment and monitoring of IPA, emphasizing its role in identifying suitable sites for tissue sampling and improving patient management in high-risk populations.

Keywords: invasive pulmonary aspergillosis (IPA), renal disease, fluffy nodules.

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INTRODUCTION

Angio-invasive pulmonary aspergillosis is a necrotising pneumonia characterised by intra-parenchymal mycelial aspergillus proliferation and invasive damage to the pulmonary vascularisation leading to haemorrhagic infarct lesions. It results from the inhalation of airborne spores of the fungus Aspergillus. Invasive pulmonary aspergillosis (IPA) in immunocompromised patients is often difficult to diagnose. Many pathogens present initially with similar, nonspecific pulmonary findings. The aim of this study was to describe the radiological aspects of angioinvasive pulmonary aspergillosis.

MATERIALS AND METHODS

The medical records and available chest CT scans of twenty immunocompromised patients with documented IPA were reviewed, from 2019 to 2024 in our radiology department. Consecutive 4-mm-thick sections at 1-cm intervals were obtamed from the lung apex to the diaphragm. All images were viewed at lung (width, 1350; center, 400) and mediastinal (width, 420; center, 36) windows.

RESULTS AND DISCUSSION

The average age of the patients was 48 years.

- Twelve patients had hematological malignancies and were undergoing chemotherapy, while eight patients were being monitored for end-stage renal disease (ESRD).
- Clinically, twelve patients experienced dyspnea, nine of whom required oxygen therapy.

Early CT findings of invasive pulmonary aspergillosis include the CT halo sign, which is characterized by a distinctive zone or halo surrounding a round pulmonary mass. This halo has an attenuation lower than that of the center of the mass but higher than that of the surrounding lung parenchyma (refer to Fig. 1).

The CT halo sign is known to appear early in the course of infection during bone-marrow aplasia, before air-crescent formation or cavitation [2, 3]. In patients with acute leukemia, the presence of the CT halo sign strongly suggests invasive aspergillosis. Additionally, early CT findings of invasive pulmonary aspergillosis may include multiple small inflammatory masses or clusters of fluffy nodules (refer to Fig. 2).

Pathologically, Aspergillus invades blood vessels, causing hemorrhagic infarction. Early pulmonary lesions consist of central nodules of necrosis surrounded by a zone of hemorrhage, which corresponds to the CT halo sign [4].

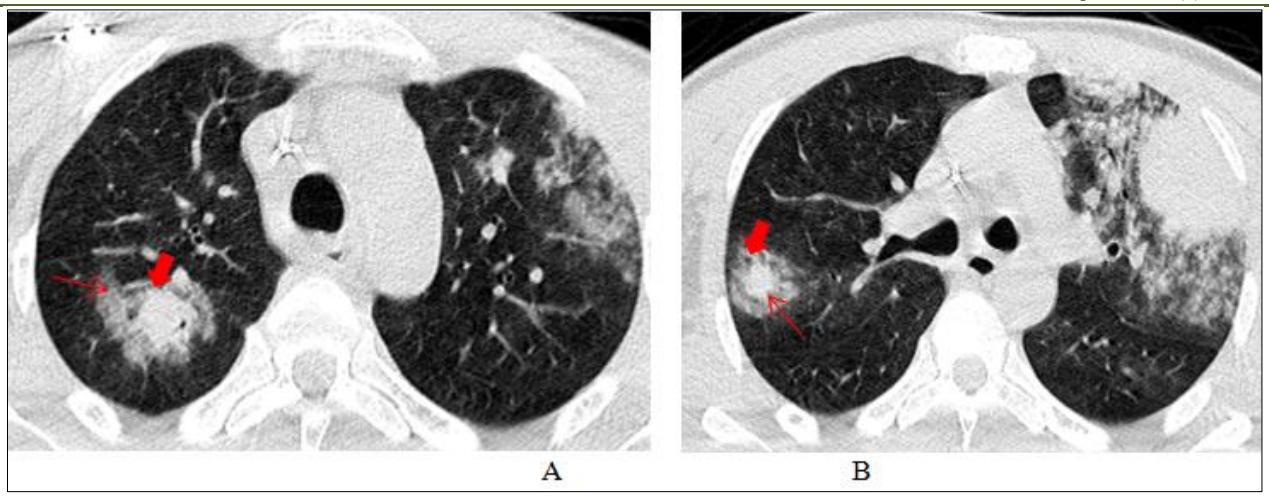

Fig. 1: A and B, Eariy CT findings of invasive pulmonary aspergillosis in a patient with leukemia and aplasia. The CT halo sign represents a discrete zone of lower attenuation (small arrows) surrounding a pulmonary mass (large arrows).

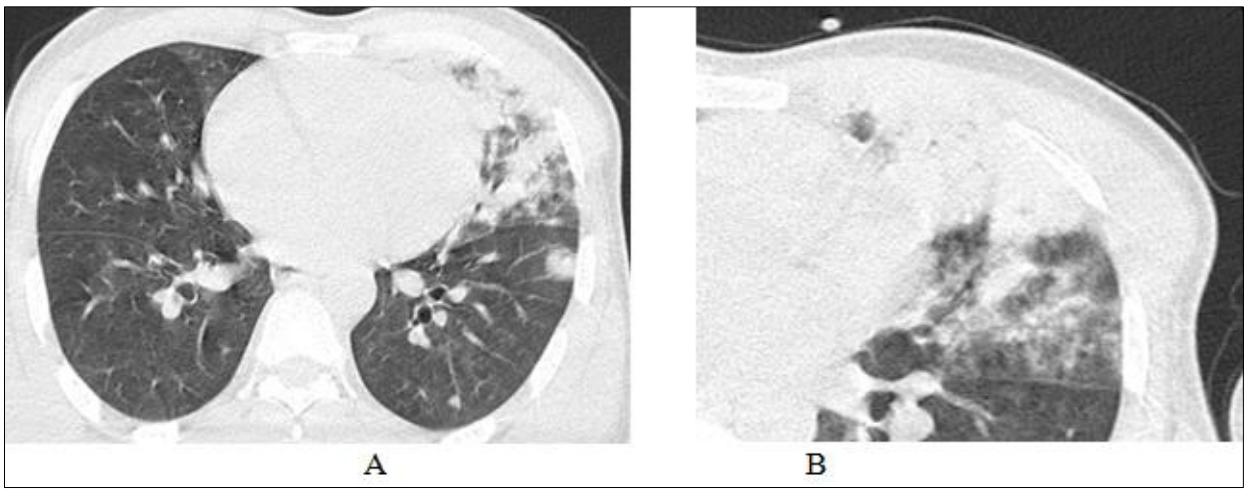

Fig. 2: Early CT findings of invasive pulmonary aspergillosis. A, Multiple small inflammatory masses. B, Clusters of fluffy nodules

In patients with acute leukemia, invasive pulmonary aspergillosis follows a distinct pattern on CT scans. Typically, 2-3 weeks after beginning chemotherapy and during bone-marrow aplasia, one or more pulmonary masses with the CT halo sign appear. These initial lesions grow larger and then develop cavitation or air-crescent formation 2-3 weeks later, around the time of bone-marrow recovery from chemotherapy.

The air-crescent formation is a sign that appears later in the infection, indicating the beginning of the resolution phase. It is caused by the removal of dead tissue at the edges by white blood cells, and is characterized by a central area of dead tissue and Aspergillus surrounded by an air-filled space.

CT scans can provide early clues about the disease process and may help diagnose invasive fungal disease. When an opportunistic infection is found in one area, it often means the disease has spread. CT scans can help determine the extent of the infection without invasive procedures and can detect hidden lung and liver involvement. A definitive diagnosis of opportunistic infections usually requires examining tissue. However, it's challenging to perform invasive procedures on immunocompromised patients due to their respiratory and coagulation issues. As a result, the diagnostic yield is often disappointingly low. For the best results, CT scans are essential for identifying the most suitable and accessible site for lung sampling.

Monitoring disease activity and response to therapy through CT scans is important for guiding treatment. Some infections have distinct patterns of resolution. For example, invasive aspergillosis heals similarly to a pulmonary infarct, fading from the periphery to form a thin-walled cyst or linear scar near the pleura. CT scans are also helpful in detecting relapse during chemotherapy retreatment. In cases where scarring from previous infection makes early detection of reactivation difficult using plain films alone, a baseline CT scan can aid in surveillance.

CONCLUSIONS

Aspergillosis is a serious complication in immunocompromised patients. Early detection on CT is crucial, given the urgency of treatment.

The characteristic CT features include nodules with a halo sign, areas of focal subpleural condensation, a gaseous crescent, rapid excavation, and central hypodensity recognizable in the mediastinal window.

While these signs are not definitive, their presence in the clinical context strengthens the diagnosis.

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