Multidetector Computed Tomography and MR Imaging Findings in Mycotic Infections

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KEYWORDS

• CT • MR imaging • Fungal • Imaging • Opportunistic • Infections

KEY POINTS

- Human fungal infections vary from simple colonizations, as in an aspergilloma, to frank invasive infections.
- Imaging characteristics are variable and depend on the type of fungal infection as well as the host response.
- Common imaging features of fungal infection on multidetector computed tomography and MR imaging are highlighted in this article to familiarize readers with characteristic imaging features that facilitate early and accurate diagnosis.

INTRODUCTION

The global incidence of fungal infections continues to increase, particularly in patients with compromised immune function and chronic systemic disorders. Among the pathogenic fungi, there are 2 distinct groups:

1. Primary pathogens that most frequently infect healthy individuals. These include species like *Blastomyces*, *Coccidioides*, *Histoplasma*, and *Paracoccidioides*.
2. Opportunistic invaders. These fungi invade debilitated or immunocompromised individuals. Fungal infections in individuals with human immunodeficiency virus (HIV) infection and organ/stem cell transplant recipients on immunosuppressive therapy are prototype examples. Prototype examples of opportunistic fungi include *Aspergillus*, *Candida*, and *Cryptococcus*.[1,2]

Knowledge of the spectrum of imaging findings that support the diagnosis helps in prompt treatment. This article therefore reviews predisposing factors, epidemiology, pathogenicity, clinical manifestations, and imaging morphology of different fungal infections.

CENTRAL NERVOUS SYSTEM INFECTION

Fungal infections of the central nervous system (CNS) are rare and occur mostly in immunocompromised patients, especially those with HIV

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infection and transplant recipients. Select CNS fungal infections such as mucormycosis are seen most frequently in patients with long-standing and uncontrolled diabetes mellitus (**Fig. 1**). In addition, some fungal infections are endemic to specific geographic areas: coccidioidomycosis, blastomycosis, and histoplasmosis are endemic in the southwest, Midwest, and the northeastern parts of the United States respectively.

On magnetic resonance (MR) imaging, fungal abscesses appear as solid or ring-enhancing lesions. On diffusion-weighted imaging (DWI), low apparent diffusion coefficient has been found in fungal abscesses.[3] The fungal abscesses typically show restricted diffusion caused by high viscosity and cellularity; the pattern of diffusion restriction may be heterogeneous or peripheral ringlike.[3] On MR spectroscopy, fungal lesions show increased levels of lipids, lactate, alanine, acetate, succinate, and choline. Unidentified multiple signals between 3.6 and 3.8 ppm are caused by the presence of trehalose sugar in the fungal wall.[4]

The common fungi to affect the brain include *Aspergillus*, *Mucor*, *Cryptococcus*, *Candida*, and *Blastomyces* species.

Aspergillosis

Invasive aspergillosis is seen in patients on chemotherapy and immunosuppressive therapy after solid organ or bone marrow transplant. Intracranial aspergillosis may occur from hematogenous spread, CSF seeding, or contiguous extension from adjacent tissues. The 2 main types of aspergillosis are rhinocerebral and cerebrovascular forms. Rhinocerebral aspergillosis results from contiguous spread of infection from the nasal cavity and paranasal sinuses to the brain. Hematogenous seeding leads to occlusion of large and medium-sized arteries by the hyphal forms.

Imaging patterns consist of infarcts, single or multiple ring-enhancing lesions caused by abscess formation, and dural or parenchymal infiltration caused by contiguous spread from paranasal sinuses or orbital infections. The *Aspergillus* species are angioinvasive; they produce elastase that digests the vessel wall, thereby causing microhemorrhage. Vessel wall weakening may lead to development of mycotic aneurysms.

Hematogenous Spread

Acute infarcts are an early manifestation, and are best detected by using DWI. Involvement of the basal ganglia is a characteristic finding. Cerebritis is usually located in the basal ganglia and deep white matter and does not show enhancement. An abscess most often results in the infarcted brain.

Fungal abscesses typically show an irregular outer margin of the wall and peripheral rim enhancement. A nonenhancing intracavitary projection caused by fungal elements containing paramagnetic substances is also typically seen. Restricted diffusion is common in the projections and the walls of the abscess. Fungal vasculitis may lead to mycotic aneurysm formation.[5,6]

Rhinocerebral Spread

Initial manifestation may show nonspecific mucosal thickening with enhancement of the sinuses on computed tomography (CT) or MR imaging. Infiltration and erosion of the bone with

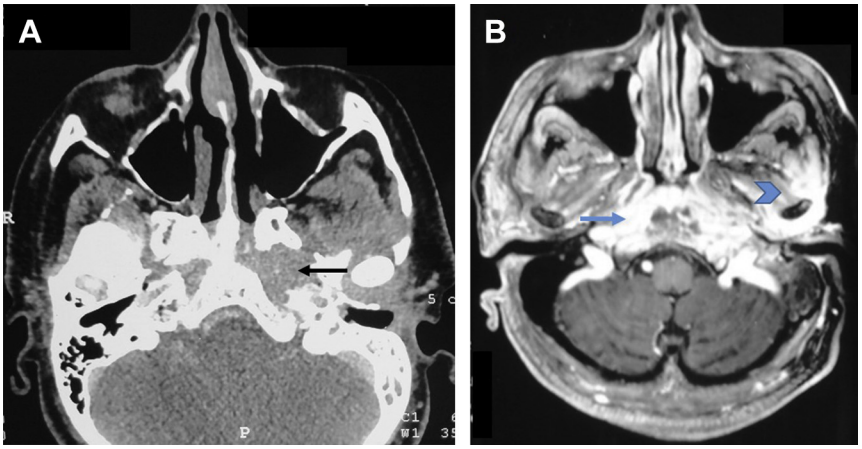

Fig. 1. A 52-year-old uncontrolled diabetic with *Aspergillus fumigatus* infection involving the skull base. Axial contrast-enhanced CT scan (*A*) shows infiltrative soft tissue (*arrow*) destroying the left petrous apex. Axial post-contrast T1 fat-suppressed magnetic resonance (MR) image (*B*) shows extensive infiltrative enhancing soft tissue in the skull base involving clivus (*arrow in B*) and bilateral petrous apex and extending into left masticator space and left temporomandibular joint (*arrowhead in B*).