



ORIGINAL RESEARCH PAPER

Radio-Diagnosis

SPECTRUM OF IMAGING FINDINGS IN FUNGAL RHINOSINUSITIS: A PICTORIAL REVIEW

KEY WORDS: Fungal Rhinosinusitis, Imaging, CT Scan, MRI

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ABSTRACT

Fungal rhinosinusitis (FRS) encompasses a wide spectrum of sinonasal diseases ranging from indolent, non-invasive colonization to aggressive, life-threatening invasive infection. With the increasing prevalence of diabetes mellitus, immunosuppression, and post-viral immune dysfunction, particularly after COVID-19, the incidence of FRS has risen significantly. Accurate and early diagnosis is crucial because invasive forms carry high morbidity and mortality if not promptly treated. Computed tomography (CT) and magnetic resonance imaging (MRI) play a pivotal role in detecting disease, defining its extent, identifying complications, differentiating invasive from non-invasive forms, and providing essential information to clinicians and surgeons. This pictorial review illustrates the characteristic imaging features of invasive and non-invasive fungal rhinosinusitis with correlation to histopathological findings¹.

Classification of Fungal Rhinosinusitis

I. Invasive Fungal Sinusitis

- Acute invasive fungal sinusitis (AIFS)
- Chronic invasive fungal sinusitis (CIFS)
- Chronic granulomatous invasive fungal sinusitis (CGIFS)

II. Non-Invasive Fungal Sinusitis

- Allergic fungal sinusitis (AFRS)
- Fungus ball (fungal mycetoma)

I. Invasive Fungal Sinusitis



Figure 1. Coronal CT images of the paranasal sinuses demonstrating invasive fungal sinusitis. (A) Coronal soft-tissue window image shows a heterogeneous soft-tissue density lesion (arrow) occupying the right maxillary sinus with extension into the right nasal cavity. (B) Corresponding coronal bone window image at the same level demonstrates widening of the right maxillary ostium with erosion of the middle turbinate (arrow). (C) Coronal soft-tissue window image at the level of the sphenoid sinus reveals a soft-tissue density lesion within the sphenoid sinus with erosion of the sinus walls and partial extension toward the orbital apex (arrow). (D) Coronal bone window image more clearly delineates the bony destruction of the sphenoid sinus walls (arrow), confirming aggressive invasive disease.

1. Acute invasive fungal sinusitis (AIFS)

Acute invasive fungal sinusitis (AIFS) is the most aggressive subtype, typically occurring in immunocompromised patients, such as those with poorly controlled diabetes or on prolonged corticosteroids or immunosuppressants. It is characterized histologically by rapid angioinvasion and necrosis. Computed tomography (CT) often reveals mucosal thickening with hypoattenuating sinus opacification, subtle or frank bone erosion, periantral fat stranding, and extrasinus soft-tissue extension. Magnetic resonance imaging (MRI) demonstrates devitalized mucosa and necrotic tissue as T2 hypointense areas with lack of expected post-contrast enhancement a phenomenon often described as the "black turbinate sign." MRI also better delineates complications such as orbital cellulitis, cavernous sinus thrombosis, and intracranial extension. A recent narrative review has emphasized MRI's role in early detection of these imaging signatures and how the absence of mucosal enhancement on T1-weighted images combined with restricted diffusion correlates with angioinvasion and necrosis typical of AIFS [2]. AIFRS has become increasingly recognized in the post-COVID-19 era, with imaging demonstrating typical involvement of the maxillary and ethmoid sinuses, frequent bone erosions, and extrasinus spread to adjacent spaces including the orbit and pterygopalatine fossa [3].

2. Chronic Invasive Fungal Sinusitis (CIFS)

Chronic invasive fungal sinusitis (CIFS) is a slowly progressive form of fungal infection that evolves over weeks to months and is typically seen in patients with mild immunosuppression, such as those with diabetes mellitus, chronic steroid use, or other systemic illnesses. Histopathologically, CIFS is characterized by fungal hyphae invading the mucosa, submucosa, and occasionally bone, without the extensive vascular invasion and tissue necrosis seen in acute invasive disease. On computed tomography (CT), CIFS commonly demonstrates unilateral or asymmetric sinus opacification associated with bony remodeling, cortical thinning, and focal areas of bone erosion, reflecting the indolent yet invasive nature of the disease. There may also be extension into adjacent soft tissues, including the orbit or pterygopalatine fossa. Magnetic resonance imaging (MRI) typically shows lesions with heterogeneous signal intensity on T1- and T2-weighted images, corresponding to a mixture of

inflammatory tissue, fibrosis, and fungal elements. Variable enhancement is seen after contrast administration, reflecting active inflammation and fibrotic reaction. MRI is particularly useful in delineating soft-tissue involvement and subtle extrasinus extension, which are critical for treatment planning [4].



Figure 2: Imaging findings of chronic invasive fungal rhinosinusitis with cavernous sinus and intracranial extension. (A) Coronal Contrast-enhanced CT image of the paranasal sinuses coronal view demonstrates mucosal thickening within the sphenoid sinus with mild soft-tissue extension toward the orbital apex. (B) Contrast-enhanced CT image coronal view shows features of cavernous sinus thrombosis, characterized by irregularly enhancing cavernous sinus walls. (C) Coronal contrast-enhanced T1-weighted MRI image of the same patient reveals irregularly enhancing walls with central non enhancing areas, confirming cavernous sinus involvement. (D) Axial contrast-enhanced T1-weighted MRI image demonstrates a heterogeneously enhancing lesion extending from the left orbital apex to the left cerebellopontine angle, indicating extensive intracranial spread of disease.

3. Chronic Granulomatous Invasive Fungal Sinusitis (CGIFS)

Chronic granulomatous invasive fungal sinusitis (CGIFS) is a rare subtype of invasive fungal sinusitis that usually occurs in immunocompetent individuals, particularly in certain geographic regions. It is characterized histopathologically by granulomatous inflammation with multinucleated giant cells, epithelioid cells, and embedded fungal hyphae. Clinically, CGIFS often presents as a slowly enlarging mass lesion with facial swelling or proptosis. On CT imaging, CGIFS typically appears as a well-defined or expansile soft-tissue mass involving one or more paranasal sinuses, often with associated bone erosion, sclerosis, or remodeling. Compared with CIFS, the mass-like appearance may be more pronounced. MRI characteristically shows hypointense signal on T2-weighted images due to the dense granulomatous tissue and the presence of fungal elements containing paramagnetic substances. Post-contrast images reveal variable but often moderate enhancement. The imaging appearance may mimic neoplastic processes, making awareness of this entity crucial for accurate diagnosis [5].

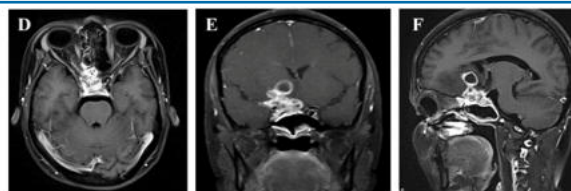
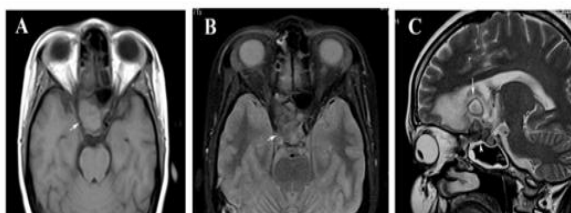


Figure 3: MRI features of Chronic Granulomatous Invasive Fungal Sinusitis (CGIFS) with orbital apex and intracranial involvement. (A) Axial T1-weighted image demonstrates an isointense soft-tissue mass involving the right orbital apex with suprasellar extension (arrow). (B) Axial T2-weighted image shows the lesion to be isointense (arrow). (C) Sagittal image reveals a hypointense suprasellar component with an associated small conglomerate abscess in the right frontal lobe and surrounding vasogenic edema, indicating intracranial spread. (D) Axial contrast-enhanced T1-weighted image demonstrates a heterogeneously and intensely enhancing mass in the right orbital apex. (E, F) Coronal and sagittal contrast-enhanced T1-weighted images show the orbital apex lesion with ring-enhancing intracranial abscess formation in the right frontal lobe, confirming intracranial extension of CGIFS.

II. Non-Invasive Fungal Sinusitis.

1. Allergic fungal sinusitis (AFRS)

Allergic fungal sinusitis (AFRS) is an immunologic condition seen in atopic, immunocompetent patients, and represents a hypersensitivity reaction to fungal antigens. Histopathologically, AFRS shows allergic mucin with eosinophils and Charcot-Leyden crystals without tissue invasion. CT typically reveals hyperdense sinus contents with sinus expansion, thinning or remodeling of bony walls, and often multiple sinus involvement with associated nasal polyposis. On MRI, the allergic mucin displays a characteristic combination of T1 hyperintensity and T2 hypointensity due to high protein content and metals within the mucin, with peripheral mucosal enhancement. These imaging features correlate well with the underlying allergic mucin and provide high specificity for AFRS in appropriate clinical contexts [6].

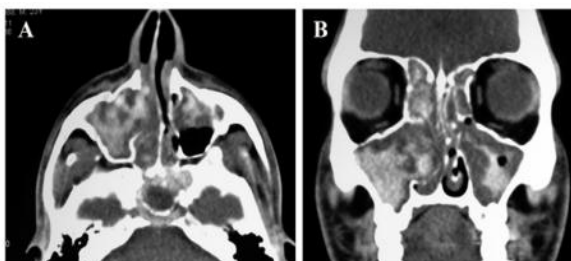


Figure 4: Imaging features of Allergic Fungal Rhinosinusitis (AFRS). (A) Axial CT image of the paranasal sinuses shows heterogeneous hyperattenuating allergic mucin filling the bilateral maxillary sinuses and ethmoid air cells, with areas of mixed density giving a characteristic “double-density” appearance, suggestive of allergic fungal debris. (B) Coronal CT image demonstrates expansile sinus opacification involving the maxillary and ethmoid sinuses with smooth bony remodeling and thinning of the sinus walls, without frank bony destruction.

2. Fungus ball (Fungal mycetoma)

Fungus ball (fungal mycetoma) represents a dense conglomeration of fungal hyphae within a sinus, most commonly the maxillary sinus, without mucosal invasion. On non-contrast CT, fungus balls show a **hyperattenuating focal sinus mass often with calcifications**, and on MRI they typically demonstrate **marked T2 hypointensity** due to dense fungal material. In a large analysis of 119 cases, CT appearance of hyperdense sinus contents and frequent intralesional calcifications were highly characteristic, while

MRI demonstrated marked T2 hypointensity compatible with dense fungal debris [7].

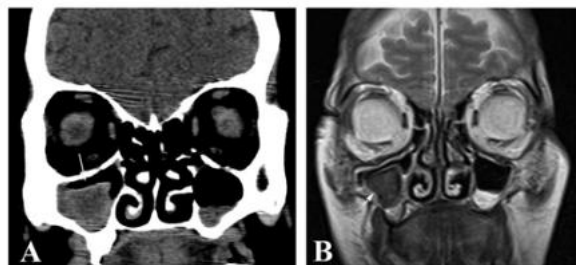


Figure 5. Imaging features of fungal ball (fungal mycetoma). (A) Coronal CT image of the paranasal sinuses demonstrates a focal hyperattenuating mass within the maxillary sinus (arrow), with associated mucosal thickening. The sinus walls are preserved, with no evidence of bony erosion or extra sinus extension, favoring a non-invasive fungal process. (B) Coronal T2-weighted MRI shows a markedly hypointense lesion within the involved maxillary sinus (arrow), characteristic of dense fungal concretions due to the presence of paramagnetic elements. The surrounding sinus mucosa shows mild inflammatory changes, consistent with a fungal ball.

CT remains the gold standard for sinonasal imaging [1] due to its superior ability to detect subtle bony changes and hyperdense fungal elements, while MRI excels in evaluating soft-tissue and intracranial/orbital extensions, especially critical in invasive disease. Early recognition of characteristic imaging patterns allows prompt and appropriate therapeutic intervention, which is crucial in reducing morbidity and mortality associated with invasive fungal rhinosinusitis.

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