Learning objectives

1. To describe the normal anatomy of paranasal sinuses highlighting the routes of spread.
2. To describe the role of CT and MRI in rhinocerebral mucormycosis.
3. To review and illustrate the importance of clinico-radiological correlation in therapeutic decision making.

Background

Mucormycosis are infections produced by fungi of the class phycomycetes [1]. There are six forms of mucormycosis namely rhinocerebral, pulmonary, gastrointestinal, cutaneous, disseminated or uncommon [2&3]. The most commonly isolated species were Rhizopus followed by Mucor & Cunninghamella [3]. Rhinocerebral mucormycosis clinically present with rhinosinusitis, pansinusitis, and rhino-orbital or rhinocerebral manifestations [3]. Rhinocerebral mucormycosis is the most common form of mucormycosis & present as acute infections of the nose and paranasal sinuses. It may cause death by occlusion, rupture, thrombosis of arteries or invasion of the brain [4]. These fungi are ubiquitous and are considered non - pathogenic. However, patients with debilitating diseases like diabetic acidosis & those on steroids or immunosuppressive drugs are highly susceptible to infection with these fungi [5]. One of the first description of rhinocerebral mucormycosis was by Baum et. al [6]. The fungal hyphae enters the nasal cavity and paranasal sinuses via inhaled dust particles. It sporulates in tissues & the hyphae then enter the blood vessel walls & also into the veins & lymphatics causing arteritis, with thrombosis & infarction of the organ supplied by these vessels [7]. Direct spread through the cribriform plate into the anterior cranial fossa may also occur via perineural spread. Treatment strategies include aggressive surgical debridement, intravenous amphotericin B therapy, and control of blood glucose. Central nervous system involvement is associated with dismal survival rates of 20% to 60% [8].

Imaging findings OR Procedure details

The radiographic findings of mucormycosis of the sinuses were first described by Green et al. [9], who noted three typical signs:

*nodular thickening of sinus linings, absence of fluid levels, and spotty destruction of bony walls of the sinuses.*
Addlestone and Baylin [10] reported similar findings, but noted that sinus wall destruction could be extensive rather than spotty, that sclerosis of the osseous walls of sinuses could be seen in chronic cases, and that the typical mucosal thickening in the sinus was smooth rather than nodular.

**Infiltration of the periantral fat planes** with rim of soft-tissue attenuation of variable thickness along the walls of the sinuses represent the **earliest imaging finding** in rhinocerebral mucormycosis [fig. 1] & should suggest the possibility of invasive fungal sinusitis.

Areas of **increased density**, with well defined, markedly hyperdense foci are seen within the inflammatory reaction. This hyperdensity is attributed to calcium phosphate and calcium sulfate deposits in necrotic areas of the mycetoma [3] Fungal disease of the sinuses is demonstrated radiologically as a nodular mucoperiosteal inflammation leading to **homogeneous opacification of the sinus cavity & bony erosion** [fig.2].

**Soft-tissue infiltration** of the deep face is characterized by obliteration of the normal fat planes in the infratemporal fossa, pterygopalatine fossa & pterygomaxillary fissure [fig. 3].

Thickening and lateral displacement of the medial rectus muscle are characteristic of orbital invasion. Proptosis occurs because of enhancing soft-tissue mass at the orbital apex and the cavernous sinuses. **Orbital involvement** can result in cellulitis, subperiosteal abscess, orbital abscess or cavernous sinus thrombosis[fig. 4].

**Intracranial findings** include infarcts related to vascular thrombosis, mycotic emboli, and frontal lobe **abscesses**. Intracranial involvement would result in epidural and subdural abscesses and cavernous and sagittal sinus thrombosis [fig. 5].

Lack of enhancement of the superior ophthalmic vein or ophthalmic and internal carotid arteries is related to **vasculitis and thrombosis** [fig. 6].

MR imaging may be used in the initial evaluation of **complicated sinusitis** because of its ability to better depict **advanced disease** involving the orbit [fig.7&8]or brain, extraaxial space and meninges,and the cavernous sinuses [figs. 9].

MR imaging, especially the nonenhanced T1 weighted images are sensitive to minor pathologic abnormalities in the **skull base**[fig. 10]. The characteristic finding is lost T1 signal hyperintensity of skull base marrow fat.
In mucormycosis the affected sinuses appear **profoundly hypointense on T2 weighted & iso to hypo intense on T1 weighted images**. This is attributed to the presence of calcium concretions, air & ferromagnetic elements like manganese, iron & magnesium.

Images for this section:

![Image](image_url)

**Fig. 1:** *Infiltration of the right periantral fat planes with rim of soft-tissue attenuation*
Fig. 2: Areas of increased density within the nasal cavities and maxillary antrum

Fig. 4: Intraorbital spread through the left infraorbital foramen
Fig. 5: Intracranial extension with right frontal lobe abscess.
**Fig. 6:** Right ICA occlusion by invasive mucormycosis & resultant acute right MCA territory infarct.
**Fig. 10:** Fig 10. Skull base involvement

![Skull base involvement](image)

**Fig. 3:** Fig. 3 Spread of mucormycosis

![Spread of mucormycosis](image)

**Fig. 7:** Fig.7 Involvement of the left orbital apex by mucor. Also note the meningeal enhancement.

![Involvement of the left orbital apex](image)
Fig. 9: Fig.9 Right cavernous sinus and intracranial extension by mucormycosis. Also note the intense loss of signal on T2w images.
Fig. 8: Intraocular muscle involvement by mucormycoses
Conclusion

1. Cross-sectional imaging plays a vital role in detection and delineating the spread of mucormycosis which is vital to therapeutic decision making.

2. CT scan helps in the delineation of extent of bony involvement.

3. MRI has an edge over CT scan in detecting base of skull, perineural, intraorbital and intracranial extension.

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References


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