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Role of MRI and CT imaging in rhino-orbito-cerebral mucormycosis in post Covid patients

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Introduction

Rhinocerebral mucormycosis is a life-threatening infection caused by saprophytic fungi Absidia, Rhizopus and Mucor [1]. There has been a tremendous increase in number of cases of rhino-orbito-cerebral involvement with mucor in the COVID era, as reported from India.

It has significant morbidity and mortality. Fungal infections are more common in those patients who are treated with corticosteroids or supplementary oxygen and in diabetics [2]. As the nature of the disease itself is still not understood completely, it remains unanswered that whether the fungal infections are the outcome of complications of the disease or its management [3]. It is well established that management of ROCM involves early clinical and radiological diagnosis, identifying risk factor, prompt antifungal therapy and surgical debridement when indicated [4].

The disease originates in the Sino nasal mucosae and extends rapidly to neighboring structures, including orbit and sometimes brain. ROCM is characterized by a very high residual morbidity and mortality due to Angio invasive property of the fungus, which causes vascular occlusion resulting in extensive tissue necrosis.

Aims and Objective

To describe the imaging findings of acute invasive rhino-orbito-cerebral mucormycosis (ROCM) in Covid 19 positive patients

To describe the intracranial complications of invasive mucormycosis.

To describe the intraorbital complications of invasive mucormycosis.

Material and methods

Sample size

We studied rhino-orbito-cerebral involvement in 25 patients of suspected acute invasive ROCM. In many there were also few additional follow up scans done after debridement.

Study Period

The study performed at a tertiary care hospital from May 01, 2021 to 15 March, 2022.

Study Population

All the patients had positive reverse transcriptase polymerase chain reaction test for COVID 19 and were hospitalized with clinically severe disease as per the guidelines laid down during the second wave in India. They were on intravenous steroids and oxygen. Nine patients (30%) had diabetes mellitus.

Method of selection

Patient presented with headache, facial and/or orbital pain with visual disturbances during or after COVID 19 treatment. CT or MRI examination of the brain, paranasal sinuses and orbits was done, with intravenous contrast wherever possible. In three patients, contrast could not be given due to deranged renal function. The presence of mucormycosis was confirmed by histological diagnosis in all of them following clinico-radiological diagnosis of acute invasive ROCM.

Study design

Retrospective and Observational study.

Imaging

Multiplanar MR imaging was performed on 1.5 T GE MEDICAL SYSTEMS Signa HDxt MRI machine for brain, orbit and paranasal sinuses. T1 weighted(T1W), T2 weighted(T2W), fluid-attenuated inversion recovery (FLAIR), pre, post-contrast fat saturated T1 weighted, diffusion weighted images (DWI) were obtained.

CT scans were performed on Siemens Somatom Definition AS 64 X 2 slice machine using a routine brain protocol with reconstruction of images in paranasal sinus protocol.

All the cases were assessed for involvement of the paranasal sinuses, orbits and brain. On MRI, signal alterations in the paranasal sinus mucosa and patterns of enhancement after intravenous contrast agent were evaluated. Involvement of the peri antral soft tissues, orbits, brain parenchyma, vessels and adjacent bones was also assessed.

On CT, partial/ complete sinuses involvement and bony erosions were evaluated. The imaging findings were broadly categorized into five groups based on the extent of regional involvement, namely Sino-nasal, periantral, orbital, bony and intracranial and vascular involvement. Descriptive statistical methods were used for analysis.

Imaging

1. Sinonasal involvement

All these patients had hypo dense mucosal thickening in one or more sinuses. Few patients have paranasal sinuses wall erosions.

Figure 1 (a): Figure 1 (b):

Computed tomography findings in mucormycosis. Fig. 1 (a) Coronal view of face shows mucosal thickening of left maxillary and anterior ethmoidal air cells, obliteration of the osteo-meatal complex, erosion of maxillary and ethmoidal antrum.

Fig. 1 (b) Non-contrast CT scan demonstrates hypodense soft tissue thickning of right maxillary sinus with inflammatory changes in premaxillary, retro antralfat and facial muscles and extensive erosion of anterior and medial walls of maxillary and ethmoidal antrum (arrows

Mucosal thickening was seen in 23 different sinuses in these patients. It was predominantly T1W hypointense, T2W intensity patterns were variable as predominantly hyperintense in 12 (52%) sinuses, isointense or

hypointense in 6 (26%) sinuses or predominantly hypointense in 5(21%) sinuses.

Figure 2 (a): Figure 2 (b):

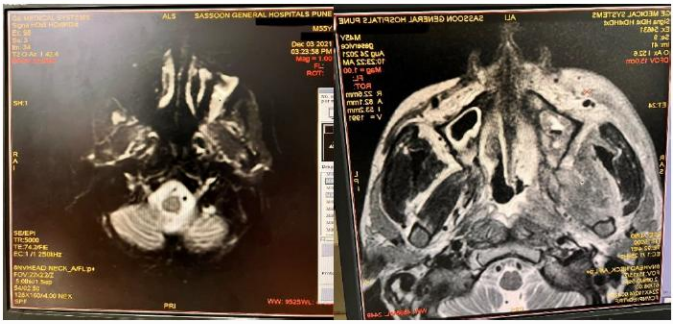


Figure 2 (c): Figure 2 (d):

Magnetic resonance imaging findings in mucormycosis.2 (a) axial Fat Sat image showing hyperintense polypoidal soft tissue fillingleft maxillary antrum2(b). T2 weighted images showing showing hyperintense soft tissue in left ethmoidal sinus. 2(c) Diffusion weighted images show high signal intensity in left maxillary sinus and 2(d)axial Fat Sat image showing hyperintense polypoidal soft tissue filling bilateral maxillary sinus, ethmoidal sinus

Periantral involvement

This was seen in 9patients (30%), suggesting highly specific finding of the disease. Most common involvement was retro antral fat streakiness seen in followed by premaxillary fat streakiness in patients. Two patients had premaxillary abscess formation too. The inflammation was seen extending into adjacent buccal fat, facial muscles, pterygopalatine fossa and the masticator space. Most common muscle involved was the medial pterygoid. Extension of inflammation to the temporal fossa and infratemporal fossa is also seen.

Fig 3: (a) and 3(b) Imaging in early peri antral inflammation showing premaxillary and retro antral fat infiltration.

Orbital involvement

Thirteen patients (43%) showed features of orbital involvement. Proptosis and extra-conal fat streakiness were the most common findings, seen in 12 patients (93%).

In four patients who had complete ophthalmoplegia, three showed conical shape of globe with stretched optic nerve and one showed perineural enhancement along optic nerve extending till the orbital apex (Chandler grade 4 involvements).

Figure 4 (a): Figure 4 (b):

Fig. 4 (a) showing proptosis and extra-conal fat streakiness involvement Fig. 4(b) showing extra and intraconal fat involvement of right orbit with proptosis.

4. Intracranial and vascular extension

Five patients (16%) had intracranial extension of the disease process seen as meningeal enhancement, Basi frontal lobe abscess or ipsilateral cerebral infarcts due to internal carotid artery thrombosis. One patients had cavernous sinus thrombosis which was seen as non-enhancing T2 hyperintense sinus.

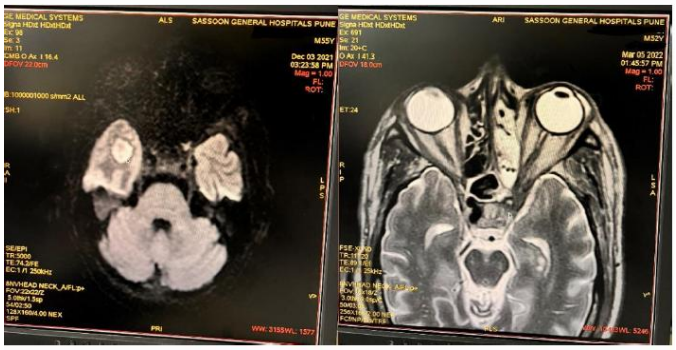


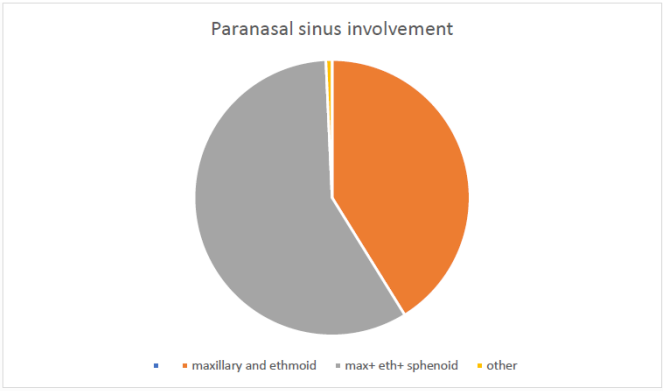
Figure 5 (a): Figure 5 (b):

Figure 5 (c):

Intra cerebral and vascular complications. Fig.5 (a) DWI image showing area of diffusion restriction in right temporal lobe. Fig.5 (b) non-enhancing soft tissue replacing left cavernous sinus with loss of flow void in internal carotid artery suggestive of thrombosis. Fig 5 (c) Axial T2 FLAIR image showing edema in right temporal lobe.

Results

A total of 25 examinations were included in the study. There were 19 males (76%) and 06 females (24%) with ages ranging from 18 to 87 years.All the MRI examinations used intravenous contrast. CT examinations were done without contrast in same patients. Sino-nasal mucosal thickening was the most common finding in almost all the cases (96%). In most of the patients, more than one of ipsilateral sinuses was involved. The most commonly involved sinuses were maxillary and ethmoid sinuses together in 17 patients (68%), followed by maxillary, ethmoid and sphenoid in combination in 23 patients (92%).

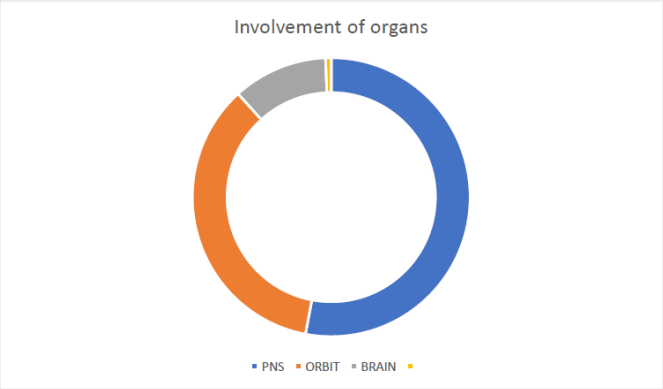


Graph 1:

2patients (%) showed variable sinus contents. Periantral infiltration was seen in 14 patients (56%). Orbital involvement was seen in 16 (64%). Cerebral and vascular complications were noted only in 5 (20%) and 1 patient (4%), respectively.

Table 1:

Organ involvement	PNS	BRAIN	ORBIT
	23	5	16



Graph 2:

Sinus Involvement	Maxillary + ethmoid	Maxillary + ethmoid sphenoid	other
	17	19	03

Rhino cerebral mucormycosis arises from nasal and sinus mucosa and then spreads rapidly to nearby areas like orbit and brain. The orbital extension occurs along the nasolacrimal duct, dehiscent medial orbital wall or the anterior and posterior ethmoid orifices. Spread to brain occurs through the orbital apex, traversing vessels or the Cribiform plate of ethmoid bone.[6] The fungus adheres to the internal elastic lamina of the blood vessels causing thrombosis and results in ischemia and necrosis of tissues. Cavernous sinus thrombosis may also complicate mucormycosis. Cerebral injury in ROCM may result from direct extension of fungus or due to internal carotid artery ischemia.

Discussion

There is involvement of the combination of maxillary, ethmoid and sphenoid sinuses in 23 patients (92%), out of whom all had Periantral involvement and 16(64%) had concomitant orbital involvement.

CT scan shows findings of Sino-nasal disease, mass effect, bony involvement and involvement of Periantral tissues and orbit. However, contrast enhanced MRI is superior to CT at demonstrating early mucosal abnormalities, non-enhancing devitalized tissues, orbital apex involvement and intra-cerebral extension.

After the administration of gadolinium, the lesions showed three patterns of enhancement on MRI—intense homogenous enhancement in 43%, intense patchy enhancement in 24% and no enhancement in 33%. As a basic principle, increased tissue contrast enhancement in Invasive Fungal Rhinosinusitis implies active infection with inflammation, whereas loss of contrast enhancement signifies devitalization and necrosis [5].

Restricted diffusion was seen in the areas of non-enhancement. In brain restricted diffusion is seen in the areas of tissue ischemia and infarcted regions.

The main advantage of MRI is early identification of extra-Sino nasal involvement and extension in orbit and vascular invasion these findings, although subtle, pointed to an aggressive infective etiology rather than malignancy, given the short duration of history and immunocompromised status. Four out of 25 patients (16%) had palatal necrosis. Maxillary alveolar erosions were also quite commonly seen in 5 (20%) and 2 patients (8%), respectively.

Involvement of the optic nerve, orbital apex, intracranial compartment and vascular structures was seen in 4%, 4%, 20% and 8% patients only. Here, the differential diagnosis which could be considered includes bacterial infection/cellulitis, inflammatory pseudotumor, paranasal sinus tumor, Grave's disease, carotico-cavernous fistula and cavernous sinus thrombosis.

However, in bacterial etiology, blindness is a much later finding and early visual loss would favor the diagnosis of ROCM [21].Also, the rapidly progressive inflammatory changes without much bone involvement should suggest the suspicion of ROCM. The final diagnosis, however, rests on histopathology.

Conclusion

COVID-19 infection and its management were the risk factors for mucormycosis. Early diagnosis and prompt medical and surgical intervention was the mainstay of treatment for mucormycosis. Contrast enhanced MRI and plain CT are the imaging tools that can assess the complete extent of disease. MRI is better modality for demonstrating the sinus, orbital, intracranial and vascular complications. Bony erosion is a significant observation in acute invasive form well appreciated on CT. Awareness and careful attention should be given to the subtle but often present radiological features of Sino nasal mucosal enhancement. This along with combined demonstration of nasal, sinus, Periantral and orbital disease allows the radiologist to help refine the diagnosis of acute invasive rhino-orbito-cerebral mucormycosis in the clinical setting of COVID-19. This can greatly reduce the high morbidity and mortality associated with this disease. Magnetic resonance imaging is highly useful imaging modality for the diagnosis of ROCM and shows T2-W hyperintense signal intensity in Sino nasal mucosa and infiltrating lesion in orbit. MRI determines the extent of invasion very well. Cavernous sinus thrombosis and internal carotid artery narrowing is well depicted by MRI. DWI may add specificity to the diagnosis by showing restricted diffusion in the path of fungal invasion.

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Abbreviations

ROCM: Rhino-orbito-cerebral mucormycosis

COVID-19: Corona virus disease -19

RT-PCR: Reverse transcriptase polymerase chain reaction

SARS-CoV2: Severe acute respiratory syndrome corona virus 2

CT: Computed tomography

MRI: Magnetic resonance imaging