



## RESEARCH ARTICLE

### CBCT IN THE EARLY DIAGNOSIS OF RHINO-MAXILLARY MUCORMYCOSIS

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#### ABSTRACT

Mucormycosis is a very aggressive invasive fungal disease. One of its type is the rhino-maxillary (RMM) type which predominantly involved nose and maxilla. Commonly, this disease occurs in persons with immunosuppression, diabetic ketoacidosis and those on antibiotics, steroid or immunomodulators which are now commonly used in the Covid 19 treatment. Early diagnosis and prompt treatment can reduce the mortality and morbidity of this fatal fungal infection. In most of the cases more emphasis is given to Computed Tomography (CT) for the diagnosis, while the use of Cone beam computed tomography (CBCT) is one of the most unappreciated imaging method in the early diagnosis of mucormycosis. CBCT is a comparatively recent scanning technology in dentistry, provides images equivalent to medical CT at reduced costs and radiation doses. This article explains the significance, use and the need of CBCT in the early diagnosis of RMM.

#### INTRODUCTION

India is currently fighting the second wave of Covid-19. And even as we wait for the tide to turn and for vaccinations to catch up, we have to deal with another rising risk, that is mucormycosis which is adding to the morbidity and mortality of Covid-19. Mucormycosis is a very aggressive and invasive fungal disease which is currently a fungal emergency affecting a variety of patient groups.<sup>1</sup> Commonly, this disease affects person with underlying Diabetes mellitus, immunosuppression, diabetic ketoacidosis and also those on antibiotics, steroids or immunomodulators<sup>2</sup> that are implemented for the treatment of Covid-19. It has a high mortality rate which ranges from 20–50% in case of localised lesion and approximately 70–90% in disseminated cases,<sup>3,4</sup> whereas those patients with confined infection to the sinus area are said to have the best prognosis. Early diagnosis and application of multimodal treatment, including appropriate antifungal therapy, may have a positive impact on clinical outcomes in patients with mucormycosis, including improved survival rates.<sup>5</sup>

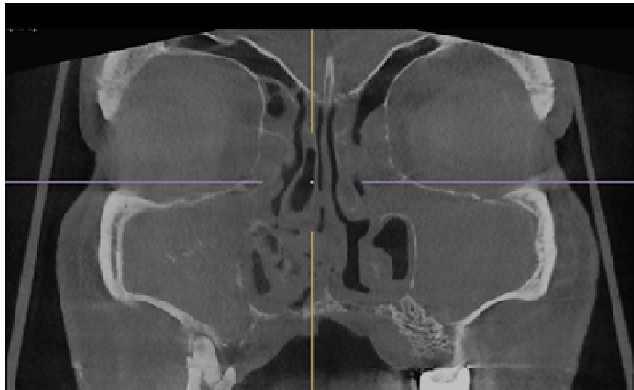
**Covid 19 and Mucormycosis:** The ongoing Corona virus disease 2019 (Covid-19) pandemic, caused by a novel severe-acute-respiratory-syndrome-coronavirus- 2 (SARS-CoV-2), has caused more than 110 million cases and more than 2.4 million deaths globally. There are increasing reports of the occurrence of bacterial and fungal co-infections in Covid-19 patients.<sup>6</sup>

Firstly, the Covid-19 is associated with extensive pulmonary parenchymal disease that results in destructive pulmonary changes which may take weeks to resolve and thus may serve as a nidus for fungal infection.<sup>7</sup> Secondly, Covid-19 is associated with severe immune system abnormalities and these dysregulations may promote pathogenesis of mucor.<sup>8</sup> Thirdly, severe COVID-19 disease leads to mechanical ventilation and prolonged intensive care unit stay which may predispose the patients to bacterial and fungal infections. Also, the fungal co-infection may occur secondary to immunosuppressive medication used for Covid-19 management.<sup>9</sup> It is important to understand the vital role played by these medications and oxygen therapy in the treatment of Covid-19, thus preventing the mortality in these patients. Hence judicious use of these medications is advisable.

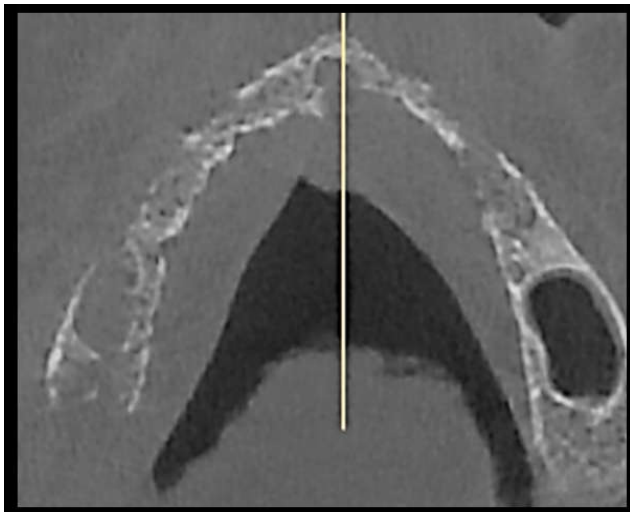
**How mucormycosis affects the soft tissues and bones?:** To understand the typical imaging features of mucormycosis, the underlying disease process must be understood. The fungal spores enter into the human body through the inhalation or ingestion of dirt particles and occasionally it may invade the orbit or open wounds.<sup>10</sup> This infection usually begins in nasal mucosa or palate and spreads into the paranasal sinuses, skin of the face, cribriform plate and brain, either by direct extension or through vascular channels.<sup>11</sup> Once the fungus enters into the blood stream, it starts penetrating the arterial walls causing endothelial damage leading to intravascular thrombosis, infarction and ultimately tissue necrosis.<sup>5</sup> This tissue necrosis can be seen as discoloration, inflammation, or ulcerations at the site of infection during clinical examination, however the initial bone changes cannot be seen clinically and hence radiographic imaging plays an important role. In mucormycosis, the initial changes in bone occur due to the

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blockage of blood supply to the bone. Hence, initial radiographic features include decrease in bone density and changes in trabecular pattern. In later stages, osteolytic changes can be evident.



**Figure 1. Coronal section of CBCT image showing erosion of the maxillary alveolar ridge, medial wall of maxilla, lateral wall of nasal cavity and complete opacification of maxillary sinus and ethmoid sinus of left side**



**Figure 2. Axial section of CBCT image at the level of sphenoid bone, showing erosion of right ethmoidal trabeculae, lateral wall of nasal cavity, opacification of left ethmoid sinus and right sphenoid sinus with air entrapment**

**Early diagnosis is the key to treatment of mucormycosis:** A review of 208 cases of rhino-orbital-cerebral mucormycosis published in literature between 1970 and 1993 have found the following frequently observed symptoms and signs<sup>12</sup>:

- Fever – 44 percent
- Nasal ulceration or necrosis – 38 percent
- Periorbital or facial swelling – 34 percent
- Decreased vision – 30 percent
- Ophthalmoplegia – 29 percent

It is essential for the clinician to maintain a high index of suspicion in populations at risk, as early diagnosis can be life-saving.<sup>13</sup> Clinical symptoms usually begin as nonspecific malaise and headache, progressing to acute sinusitis, facial edema and pain, orbital symptoms, rhinorrhea, and eventual ophthalmoplegia, blindness, and lethargy.<sup>14</sup> In the current scenario, it is crucial to take a proper history about Covid-19 infection, hospitalisation and drug therapy.<sup>15</sup>

**Limitations of OPG in the early diagnosis:** After the clinical diagnosis, if the patient is suspected to have mucor then selecting a proper imaging technology is necessary. Most of the times a suspected patient is referred for orthopantomogram (OPG). But there are certain limitations of OPG in the diagnosis of mucormycosis as follows:

1. Limited area of imaging
2. Initial changes in bone density are not clearly distinguishable
3. Poor visualization of sinus linings
4. Lack of fine anatomic detail
5. Objects situated outside the focal trough appears distorted or obscured
6. Magnification, geometric distortion, and overlapped images of teeth are inherent disadvantages

**What about CT?:** Currently more emphasis is given on CT PNS for the preliminary diagnosis of mucormycosis, especially during the second wave. CT definitely covers a larger area but its biggest limitation is its inability to show initial bone changes. However cone beam computed tomography (CBCT) scan usually provides a higher resolution than a CT scan.<sup>16</sup> This aids in recognizing the minute changes in trabecular pattern or decrease in cortical thickness. Now talking about rhinomaxillary variant, it is essential to demarcate the affected areas in the alveolar bone, palate, nasal floor, be it a localised, unilateral or bilateral area. The major limitation of CT scan is that the viewing software accompanying a CT device does not usually have the functions specific to dentistry. This means that users have to export the data to CBCT viewing software or a third-party DICOM viewer. However, the viewing software accompanying a CBCT device may not recognize or allow data to be imported from other devices. These practical issues may hinder users from reading the image generated by a CT scan for oral and maxillofacial use.<sup>17</sup> As CBCT devices are designed for dental use, the viewing software accompanying the device is likely to be tailor-made for oral and maxillofacial purposes. For instance, the 3D image data can be viewed not only in conventional axial, sagittal and coronal views, but also as a simulated panoramic view as well as a cross-sectional view of the dental arches. Another important factor is the radiation dose. If we are talking about a post covid patient, then during the treatment he might have undergone HRCT scan. Radiation dose associated with HRCT of chest is much higher than a routine chest scan. Even with reduced radiation dose scanning technique, the radiation dose of HRCT can exceed the radiation dose of a chest radiography by 100 times.<sup>18</sup> Again exposing the patient with initial symptoms to such high radiation is irrational. Thus, it is important to identify clinical situations in which techniques with lower radiation dose such as CBCT can be chosen over CT scan. Additionally there is a lot of burden on the CT scanning centers due to the patients of Covid 19. It has been speculated that CT scans are the latest super spreaders. If a covid positive person is undergoing the scan, he can spread the virus in the air as well as surfaces. Disinfecting the scanner and the room after every patient is recommended but looking at the number of patients undergoing the scans, it's hardly practiced. Therefore risking the patient for infection or re infection of covid-19, just for screening purpose in suspected mucormycosis cases seems unreasonable.

**Why CBCT?:** CBCT in the early diagnosis of mucormycosis is one of the most underrated imaging method. Recently, several CBCT system have become available, which are

specifically designed to image hard tissues in the maxillofacial region.<sup>19</sup> This results in new diagnostic possibilities with increased diagnostic image quality. With the available CBCT systems, high-contrast structures can be visualized at a very low radiation doses.<sup>20</sup> CBCT with a large FOV can not only scan the alveolar bone and teeth but also all the paranasal sinuses-maxillary, ethmoidal, sphenoid and frontal along with the orbits. The advantage of CBCT is that it can capture minute osseous changes including subtle trabecular pattern as well as integrity of cortical borders without any superimposition. hence markedly contributing to early diagnosis and management of the disease.<sup>20</sup> Thus CBCT may have a role in the early stages of mucormycosis, providing detailed information about extensions into all the sinuses (Figure 1) and maxillo-mandibular bones; but in cases of orbital and intracranial extensions, MDCT or MRI would be the imaging of choice.<sup>21</sup>

#### Common radiographic features of mucormycosis as seen on CBCT:

As we have seen how the fungus attacks the system by causing avascular necrosis, the most noticeable radiographic feature is the changes in bone density. So initially there is decrease in density and changes in trabecular pattern, (Figure 2) which are often difficult to notice on CT scan. Also, the irregular outline with disruption in the buccal and palatal cortical plates can be seen.<sup>21</sup> In advanced cases typical moth eaten appearance can be seen.(Figure 3) Another important feature is opacification of the affected sinus.<sup>22</sup> The severity is decided upon the number and type of sinuses involved. In advanced cases, osteolysis is the common feature observed in the walls of maxillary sinus, nose, and zygoma can be seen.<sup>21</sup>

**Limitations of CBCT in the diagnosis of mucor:** CBCT, as an alternative to CT, has become more widely accepted as a diagnostic technique for 3D imaging in jaw lesions .but it has limited soft-tissue definition due to a poor contrast resolution. Invasive fungal infections with intracranial and orbital extensions cannot be completely evaluated in CBCT. Besides, soft tissue infiltration with fat stranding are unlikely to be recognized in CBCT.

Therefore, CBCT may have a role in the early stages of mucormycosis, providing detailed information about extensions.

#### When to advice CBCT?

- Patients with red flags- history of Covid-19 infection, hospitalization, steroid administration, uncontrolled diabetes mellitus, other immunocompromised states.
- Lesions in the areas involving intra-oral areas, nose, palate, teeth
- Clinical features like- periapical abscess, multiple draining sinuses, multiple mobile teeth, intra-oral ulcers, lesions, gingival inflammation and bleeding.
- Others-odontogenic pain with no any visible etiology, nasal discharge.

#### Conclusion

The incidence of mucormycosis is increasing at an unexpected rate during this Covid-19 pandemic. The immunocompromised elderly age group with history of Covid-19 infection are at the highest risk of developing mucormycosis. Thus CBCT should be recommended in such patients as a screening tool for the early detection of bone changes associated with mucormycosis

which helps in early diagnosis and prompt treatment of this dreadful disease.

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