

# Oral and radiological features of mucormycosis in post-Covid patients – a clinical study

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## ABSTRACT

**Introduction.** Mucormycosis, commonly referred to as “black fungus,” has emerged as a life-threatening opportunistic infection, particularly in post-COVID patients. This study aims to evaluate the clinical, radiological, and treatment-related features of mucormycosis in post-COVID patients and assess their outcomes.

**Materials and methods.** This observational clinical study was conducted from April 2021 to October 2021, involving 50 consecutive post-COVID patients who presented with clinical and radiological features of mucormycosis. Demographic data, clinical symptoms, comorbidities, laboratory investigations, radiological findings, and treatment details were collected. Patients underwent computed tomography (CT) to assess bone involvement, sinus, and orbital involvement. Treatment regimens, including antifungal therapy and surgical interventions, were recorded. Patients were followed up for recurrence and long-term outcomes.

**Results.** The majority of the patients were males (58%) and in the 31-45 age group (34%). Diabetes mellitus (60%) and steroid use (80%) were the most common comorbidities. Clinically, 70% of patients presented with soft tissue swelling or necrosis, and 44% had black eschar on the palate. CT findings revealed maxillary bone involvement in 56% of cases and sinus involvement in 50%. Orbital involvement was noted in 20%. Amphotericin B was the most commonly used antifungal therapy (70%), and 60% of patients underwent debridement. The overall recovery rate was 70%, with a recurrence rate of 16%. Facial deformities or ongoing oral issues were noted in 24% of patients during follow-up.

**Conclusion.** Mucormycosis in post-COVID patients is associated with high morbidity, particularly in those with diabetes and those treated with corticosteroids. Antifungal therapy combined with surgical intervention yielded a 70% recovery rate, although recurrence and long-term complications were observed. Early diagnosis, appropriate antifungal therapy, and aggressive surgical management are critical to improving outcomes. Preventive strategies, including better management of comorbidities and judicious use of steroids, are essential in reducing the burden of mucormycosis in post-COVID patients.

**Keywords:** Mucormycosis, post-COVID, antifungal therapy, diabetes mellitus, radiological findings, orbital involvement, steroid therapy

## INTRODUCTION

Mucormycosis (phycomycosis, zygomycosis) is a rare opportunistic fungal infection belonging to the Mucorales order and the Mucoraceae family. It is a rapidly progressing and invasive form of opportunistic fungal infection mainly observed in immunocompromised patients. In the current pandemic,

COVID-19 patients are predisposed to developing fungal infections such as mucormycosis [1]. Predisposing factors include prolonged neutropenia, hemopoietic malignancies, hematopoietic stem cell transplant, organ transplant, prolonged stays in the intensive care unit and uncontrolled diabetes. The rise of mucormycosis in COVID-19 patients is predis-

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posed mainly by poorly controlled diabetes and injudicious use of corticosteroids [2]. Oral manifestations of mucormycosis in COVID-19 patients are more probably caused by co-infections, adverse reactions, and immunity impairment instead of direct COVID-19 infection [3]. Oral and radiological changes are found affecting various facial bones based on the source of infection. Oral lesions are usually seen in the palate and may include varying degrees of mucosal discoloration, swelling, ulcerations, superficial necrotic areas in the palate, bone exposure and necrosis with dark eschar formation [4]. Hence, palatal ulcerations could be the first presenting symptom, leading the patient to the dentist, who can be the first clinician to suspect an infection leading to the diagnosis of mucormycosis [5]. The current COVID-19 pandemic has thrown an extra challenge for health care, with some cases of an uncommon fungal infection being described, which are associated with increased death rate [6]. Successful management of this fulminant infection requires early recognition of the disease, aggressive medical and surgical interventions to prevent the high morbidity and mortality associated with the disease process [7].

The aim of the present study was to evaluate oral and radiographic findings of symptomatic post covid patients that may be useful in predicting the diagnosis of Mucormycosis. The present also postulated that early detection of oral and radiographic findings especially among patients with poorly con-

trolled diabetes mellitus, increases the prognosis of mucormycosis infection.

## MATERIALS AND METHODS

This observational clinical study included 50 consecutive patients attended to OMRD department between April 2021 and October 2021. Subjects included in this study were based on clinical and radiographical features of mucormycosis with concurrent or prior history of COVID-19. Data pertaining to demographics, clinical features, comorbidities and laboratory investigations were collected after obtaining informed consent from all patients. The study was approved by institutional ethics committee.

### Inclusion criteria

- 50 Symptomatic Post Covid patients attended to the Department of OMRD from April 2021 to October 2021 were included in this study.
- Patients who are willing to participate in the radiological examination were included.
- Patients who are willing to give consent to participate in the study were included.

### Exclusion criteria

Post COVID patients without any oral manifestations were excluded.

Oral manifestations were recorded after clinical examination and radiological examination was done using computed tomography.

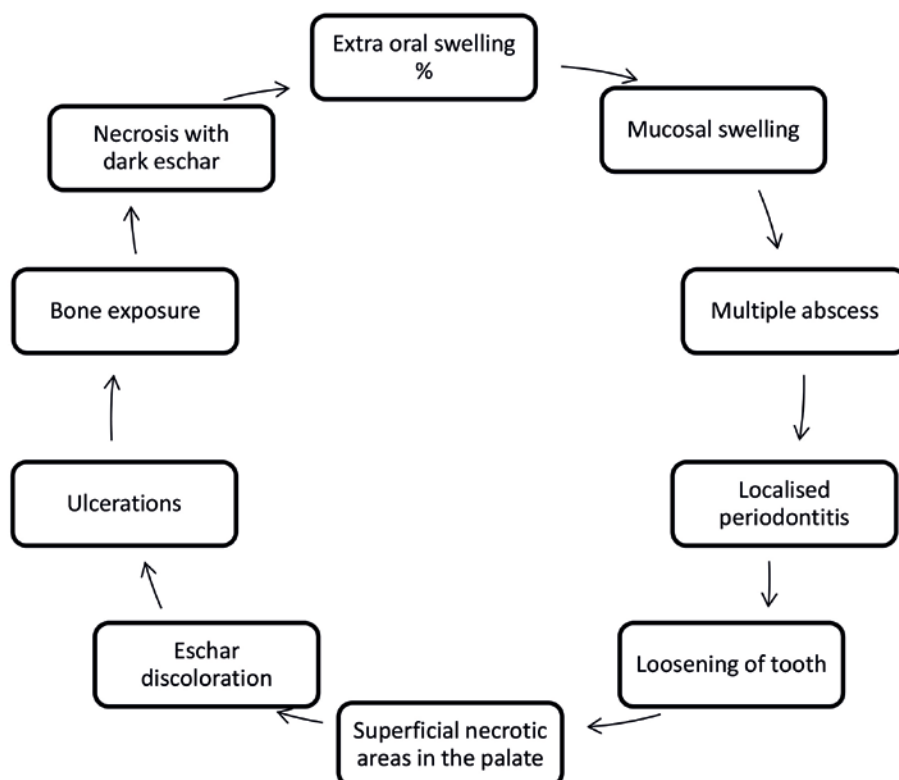


FIGURE 1. Oral manifestations in patients

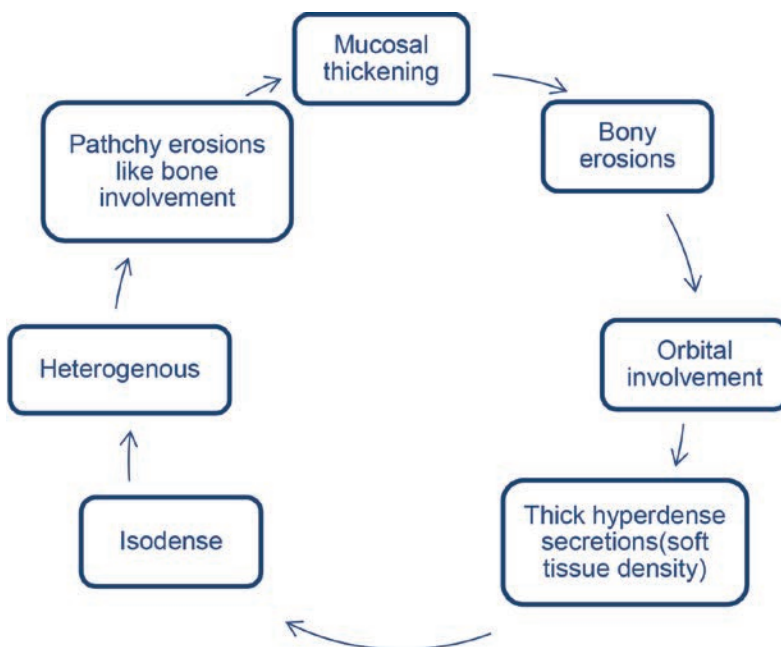


FIGURE 2. Radiological features in patients

RESULTS

Table 1 presents the gender distribution of 115 total cases. Out of these, 86 cases are males, constituting the majority, while 29 cases are females. This indicates a higher prevalence or representation of males in the dataset compared to females.

TABLE 1. Distribution of patients based on gender

| S. No        | Gender  | Number of cases |
|--------------|---------|-----------------|
| 1            | Males   | 86              |
| 2            | Females | 29              |
| <b>Total</b> |         | <b>115</b>      |

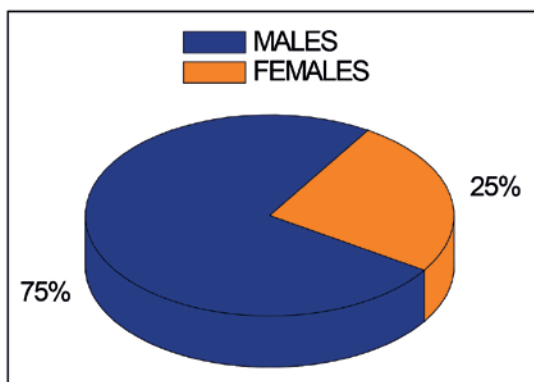


Table 2 highlights the medical history of patients in relation to their diabetic status, COVID-19 infection, use of steroids, and the need for ventilation. Among the patients, 30.43% were diabetic and required both steroids and ventilation, while 34.78% were diabetic but did not need ventilation despite being treated with steroids. On the other hand, 21.73% of the patients were non-diabetic, had COVID-19, and received steroids without the need for

ventilation, and 13.04% were non-diabetic but required both steroids and ventilation. The data suggests that diabetic patients make up a larger portion of the group, with varying levels of treatment depending on the severity of their condition, including the need for ventilation.

TABLE 2. Medical history distribution with percentages

| S. No | Medical history                              | Number of patients | Percentage |
|-------|--|--------------------|------------|
| 1     | Diabetic + Covid + steroids + ventilation    | 35                 | 30.43      |
| 2     | Diabetic + Covid + steroids                  | 40                 | 34.78      |
| 3     | Nondiabetic + Covid + steroids               | 25                 | 21.73      |
| 4     | Nondiabetic + Covid + steroids + ventilation | 15                 | 13.04      |

Table 3 presents oral manifestations observed in patients, focusing on the involvement of the jaw and the presence of black eschar or necrosis. In terms of jaw involvement, 60% of patients had maxillary involvement, 20% had mandibular involvement, and 20% had involvement of both the maxilla and mandible. Regarding black eschar or necrosis, 44% of patients had it on the palate, 36% on other oral structures, while 20% of patients showed no signs of black eschar or necrosis. This data highlights the predominance of maxillary involvement and palate necrosis among the affected patients.

Table 4 summarizes the clinical symptoms observed in patients, categorizing them by severity or type. Regarding pain severity, 24% of patients experienced mild pain, 56% had moderate pain, and 20% suffered from severe pain. In terms of facial swell-

ing, 60% presented with localized swelling, while 40% had diffuse swelling. Ulceration was noted in 35 patients, and necrosis was observed in 25 patients. Additionally, palatal involvement was present in 44% of cases, while 56% had no such involvement.

**TABLE 3.** Distribution of oral manifestations in post-COVID Mucormycosis patients

| S.No | Oral manifestation                | Number of patients | Percentage (%) |
|------|-----------------------------------|--------------------|----------------|
| 1    | Involvement of jaw                |                    |                |
|      | - Maxilla                         | 30                 | 60%            |
|      | - Mandible                        | 10                 | 20%            |
| 2    | - Both maxilla and mandible       | 10                 | 20%            |
|      | Presence of black eschar/necrosis |                    |                |
|      | - On Palate                       | 22                 | 44%            |
|      | - On other oral structures        | 18                 | 36%            |
|      | - No black eschar/necrosis        | 10                 | 20%            |

**TABLE 4.** Distribution of clinical symptoms among post-COVID Mucormycosis patients

| S.No | Clinical symptom    | Severity/ Type | Number of patients | Percentage (%) |
|------|---------------------|----------------|--------------------|----------------|
| 1    | Pain Severity       |                |                    |                |
|      | - Mild              |                | 12                 | 24%            |
|      | - Moderate          |                | 28                 | 56%            |
|      | - Severe            |                | 10                 | 20%            |
| 2    | Facial Swelling     |                |                    |                |
|      | - Localized         |                | 30                 | 60%            |
|      | - Diffuse           |                | 20                 | 40%            |
| 3    | Ulceration          | Present        |                    | 35             |
|      | Necrosis            | Present        |                    | 25             |
| 4    | Palatal Involvement |                |                    |                |
|      | - Present           |                | 22                 | 44%            |
|      | - Absent            |                | 28                 | 56%            |

**TABLE 5.** Distribution of comorbidities among post-COVID Mucormycosis patients

| S. No | Comorbidity   | Number of patients | Percentage (%) |
|-------|---|--------------------|----------------|
| 1     | Diabetes mellitus   |                    |                |
|       | - Fasting blood sugar levels >126 mg/dL                       | 30                 | 60%            |
|       | - Postprandial blood sugar Levels >200 mg/dL                  | 35                 | 70%            |
| 2     | Hypertension  | 25                 | 50%            |
| 3     | Chronic kidney disease  | 10                 | 20%            |
| 4     | Immunosuppressive conditions                                  |                    |                |
|       | - Recent steroid use  | 40                 | 80%            |
|       | - Organ transplant  | 5                  | 10%            |
|       | - Cancer therapy  | 2                  | 4%             |
| 5     | History of prolonged oxygen therapy or mechanical ventilation | 20                 | 40%            |

Table 5 outlines the distribution of comorbidities among post-COVID mucormycosis patients. A significant portion of patients had diabetes mellitus, with 60% having fasting blood sugar levels over 126 mg/dL and 70% having postprandial blood sugar levels above 200 mg/dL. Hypertension was present in 50% of patients, while 20% had chronic kidney disease. Immunosuppressive conditions were also common, with 80% of patients having a history of recent steroid use, 10% having undergone an organ transplant, and 4% receiving cancer therapy. Additionally, 40% of patients had a history of prolonged oxygen therapy or mechanical ventilation.

Table 6 provides an overview of laboratory investigations conducted on post-COVID mucormycosis patients. Blood glucose levels showed that 60% had fasting blood glucose levels exceeding 126 mg/dL, and 70% had postprandial blood glucose levels over 200 mg/dL, indicating hyperglycemia. In terms of glycemic control, 64% of patients had an HbA1c level above 7%. Among the complete blood count (CBC) results, 40% of patients were anemic, and 50% had leukocytosis with a white blood cell count over 10,000/mm<sup>3</sup>. C-reactive protein (CRP) levels, an indicator of inflammation, were elevated in 80% of the patients (above 10 mg/L). Fungal cultures or biopsies revealed that 90% of patients tested positive for mucormycosis, while 10% tested negative.

**TABLE 6.** Laboratory investigations of post-COVID Mucormycosis patients

| S.No | Laboratory investigation                                 | Number of patients | Percentage (%) |
|------|--|--------------------|----------------|
| 1    | Blood Glucose Levels (Diabetic/Hyperglycemia)            |                    |                |
|      | - Fasting blood glucose >126 mg/dL                       | 30                 | 60%            |
|      | - Postprandial blood glucose >200 mg/dL                  | 35                 | 70%            |
| 2    | Hemoglobin A1c levels (glycemic control)                 |                    |                |
|      | - HbA1c >7%  | 32                 | 64%            |
| 3    | Complete blood count (CBC)                               |                    |                |
|      | - Anemia (hemoglobin <13 g/dL in men, <12 g/dL in women) | 20                 | 40%            |
|      | - Leukocytosis (WBC >10,000/mm <sup>3</sup> )            | 25                 | 50%            |
| 4    | C-reactive protein (CRP) (Inflammation)                  |                    |                |
|      | - Elevated CRP (>10 mg/L)                                | 40                 | 80%            |
| 5    | Fungal culture/Biopsy                                    |                    |                |
|      | - Positive for Mucormycosis                              | 45                 | 90%            |
|      | - Negative for Mucormycosis                              | 5                  | 10%            |

Table 7 summarizes the radiological findings in post-COVID mucormycosis patients, focusing on bone, sinus, and soft tissue involvement. Regarding bone involvement, 56% of patients exhibited maxillary destruction, 20% had mandibular destruction, and 14% had destruction of both the maxilla and

mandible, while 10% showed no bone involvement. Sinus involvement was also common, with 50% showing maxillary sinus involvement, 40% showing ethmoidal sinus involvement, and 30% showing sphenoidal sinus involvement. Orbital involvement was present in 20% of patients, while 80% had no orbital complications. Soft tissue swelling or necrosis was present in 70% of patients, while 30% had none. Additionally, signs of osteomyelitis or bone invasion were observed in 36% of patients, while 64% did not exhibit such signs.

**TABLE 7.** Radiological findings in post-COVID Mucormycosis patients

| S.No | Radiological finding                        | Number of patients | Percentage (%) |
|------|---|--------------------|----------------|
| 1    | Extent of bone involvement                  |                    |                |
|      | - Maxillary destruction                     | 28                 | 56%            |
|      | - Mandibular destruction                    | 10                 | 20%            |
|      | - Both maxillary and mandibular destruction | 7                  | 14%            |
|      | - No Bone Involvement                       | 5                  | 10%            |
| 2    | Sinus Involvement                           |                    |                |
|      | - Maxillary sinus involvement               | 25                 | 50%            |
|      | - Ethmoidal sinus involvement               | 20                 | 40%            |
|      | - Sphenoidal sinus involvement              | 15                 | 30%            |
| 3    | Orbital Involvement                         |                    |                |
|      | - Present                                   | 10                 | 20%            |
|      | - Absent                                    | 40                 | 80%            |
| 4    | Soft tissue swelling or necrosis            |                    |                |
|      | - Present                                   | 35                 | 70%            |
|      | - Absent                                    | 15                 | 30%            |
| 5    | Signs of osteomyelitis or bone invasion     |                    |                |
|      | - Present                                   | 18                 | 36%            |
|      | - Absent                                    | 32                 | 64%            |

**TABLE 8.** Treatment parameters for post-COVID Mucormycosis patients

| S.No | Treatment parameter                       | Number of patients | Percentage (%) |
|------|---|--------------------|----------------|
| 1    | Type of antifungal therapy                |                    |                |
|      | - Amphotericin B                          | 35                 | 70%            |
|      | - Posaconazole                            | 10                 | 20%            |
|      | - Other antifungals (e.g., Isavuconazole) | 5                  | 10%            |
| 2    | Surgical intervention                     |                    |                |
|      | - Debridement                             | 30                 | 60%            |
|      | - Surgical resection                      | 10                 | 20%            |
|      | - No surgical intervention                | 10                 | 20%            |
| 3    | Duration of treatment                     |                    |                |
|      | - <4 weeks                                | 15                 | 30%            |
|      | - 4-8 weeks                               | 25                 | 50%            |
|      | - >8 weeks                                | 10                 | 20%            |
| 4    | Outcomes                                  |                    |                |
|      | - Recovery                                | 35                 | 70%            |
|      | - Progression of Disease                  | 10                 | 20%            |
|      | - Death                                   | 5                  | 10%            |

Table 8 outlines the treatment parameters for post-COVID mucormycosis patients. Regarding anti-fungal therapy, 70% of patients were treated with Amphotericin B, 20% with Posaconazole, and 10% with other antifungals such as Isavuconazole. Surgical intervention was performed in 60% of cases through debridement, while 20% underwent surgical resection. Another 20% did not receive any surgical intervention. In terms of treatment duration, 30% of patients were treated for less than 4 weeks, 50% for 4-8 weeks, and 20% for more than 8 weeks. As for outcomes, 70% of patients recovered, 20% experienced disease progression, and 10% resulted in death. These findings show that Amphotericin B and debridement were the most common treatment modalities, with a majority of patients achieving recovery.

**TABLE 9.** Follow-up Parameters for post-COVID Mucormycosis patients

| S. No | Follow-up parameter                        | Number of patients | Percentage (%) |
|-------|--|--------------------|----------------|
| 1     | Duration of follow-up                      |                    |                |
|       | - 1 month                                  | 20                 | 40%            |
|       | - 3 months                                 | 25                 | 50%            |
|       | - >3 months                                | 5                  | 10%            |
| 2     | Recurrence of Mucormycosis                 |                    |                |
|       | - Yes                                      | 8                  | 16%            |
|       | - No                                       | 42                 | 84%            |
| 3     | Functional status post-treatment           |                    |                |
|       | - Residual facial deformity                | 10                 | 20%            |
|       | - Ongoing oral issues (e.g., ulcers, pain) | 12                 | 24%            |
|       | - No significant issues                    | 28                 | 56%            |

Table 9 summarizes the follow-up parameters for post-COVID mucormycosis patients. Regarding the duration of follow-up, 40% of patients were followed for 1 month, 50% for 3 months, and 10% for more than 3 months. Recurrence of mucormycosis occurred in 16% of patients, while 84% had no recurrence. In terms of functional status post-treatment, 20% of patients had residual facial deformity, 24% experienced ongoing oral issues such as ulcers or pain, and 56% reported no significant issues. This data suggests that the majority of patients had no recurrence and experienced minimal post-treatment complications.

## DISCUSSION

Mucormycosis, commonly known as “black fungus,” has emerged as a significant complication in post-COVID patients, particularly those with underlying comorbidities like diabetes and those treated with corticosteroids. This observational study aimed to evaluate the clinical, radiological, and treatment-

related parameters of mucormycosis in 50 post-COVID patients between April 2021 and October 2021. The findings highlight the demographic distribution, comorbidities, clinical manifestations, radiological findings, and outcomes in these patients.

In this study, the majority of the patients were in the 31-45 age group (34%), with a male predominance (58%), which aligns with previous studies that report higher susceptibility in males, especially those with diabetes. The significant proportion of patients presenting with severe pain (20%) and diffuse facial swelling (40%) are consistent with clinical presentations described in prior studies. Oral manifestations, such as maxillary involvement and black eschar on the palate, were noted in 60% and 44% of patients, respectively, echoing previous studies that highlight these as key clinical features.

As seen in previous studies, diabetes mellitus remains a major risk factor for mucormycosis [8]. In this cohort, 60% of patients had diabetes with elevated fasting and postprandial blood glucose levels. This matches earlier studies where diabetes was the most commonly associated comorbidity in post-COVID mucormycosis [9]. Immunosuppressive therapy, particularly corticosteroids, was noted in 80% of patients, highlighting the impact of steroid use on the development of mucormycosis, as corroborated by other studies [10]. Chronic kidney disease and a history of mechanical ventilation were also observed in a significant portion of patients, suggesting the role of systemic immunosuppression and prolonged oxygen therapy in increasing susceptibility to this fungal infection [11].

Radiological findings in this study revealed significant maxillary destruction (56%) and sinus involvement, particularly in the maxillary sinus (50%) and ethmoidal sinus (40%). These findings align with previously published reports, which have described similar CT findings in mucormycosis [12]. Orbital involvement was present in 20% of cases, slightly lower than some studies, which report higher rates of orbital involvement due to the aggressive nature of the infection. The presence of elevated CRP (80%) and leukocytosis (50%) in these patients further highlights the inflammatory response to this fungal infection, similar to findings reported in earlier research [13].

The majority of patients were treated with Amphotericin B (70%), a gold standard antifungal treatment for mucormycosis, and 60% underwent de-

bridement, which is a crucial intervention in these cases. The 70% recovery rate noted in this study is comparable to previous studies, which report recovery rates between 65-75% when aggressive medical and surgical interventions are employed [14]. However, recurrence was noted in 16% of patients during follow-up, similar to recurrence rates reported in the literature.

This study corroborates findings from previous studies conducted on mucormycosis in post-COVID patients. Studies by Kumar et al. and Singh et al. reported similar demographic profiles, with male predominance and a high prevalence of diabetes [1, 15]. The association between steroid use and mucormycosis development, emphasized in this study, has also been widely reported [16]. Radiologically, maxillary bone destruction and sinus involvement remain common across studies. However, compared to earlier studies, the orbital involvement rate in this cohort (20%) was slightly lower than the 30-40% reported in other series [17].

The findings of this study emphasize the need for early diagnosis and treatment, particularly in high-risk populations. The outcomes reinforce the importance of antifungal therapy and surgical interventions in managing mucormycosis. Future studies should focus on long-term outcomes and exploring strategies to reduce recurrence rates.

## CONCLUSION

This study highlights the severe impact of mucormycosis in post-COVID patients, particularly those with diabetes and those treated with corticosteroids. The clinical presentations, radiological findings, and treatment outcomes observed in this study align with previously published data, underscoring the importance of early intervention. Antifungal therapy, combined with surgical debridement, remains the cornerstone of treatment, with satisfactory recovery rates observed. However, given the recurrence rates and the risk of serious complications like facial deformity, long-term follow-up is essential to monitor and manage ongoing issues. Prevention strategies, including judicious use of corticosteroids and better management of comorbid conditions like diabetes, are critical to reducing the burden of mucormycosis in post-COVID patients.

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