Section: Skin & VD

Original Research Article

CUTANEOUS MANIFESTATIONS OF MUCORMYCOSIS IN THE BACKGROUND OF COVID-19 PANDEMIC IN INDIA

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ABSTRACT

Background: Mucormycosis is an aggressive and fatal angioinvasive fungal infection caused by Mucorales. It can be classified into rhino-orbital-cerebral, pulmonary, cutaneous, gastrointestinal, disseminated, and mucormycosis at uncommon sites. Uncontrolled diabetes mellitus has been the most important risk factor in developing countries. Although rare, a sudden surge of coronavirus disease-associated mucormycosis was observed amidst the second wave of Covid-19 in India.

Aims/Objectives: To study specific and non-specific cutaneous manifestations of mucormycosis as well as predisposing factors that led to the spike in number of cases.

Methods: 223 diagnosed cases of mucormycosis were analysed with demographic details, past illnesses, sites of involvement, cutaneous manifestations, comorbidities, diagnostic findings and treatment. A brief history of Covid-19 infection and related treatment was obtained from the patients.

Results: Median age was 45.2 years. 202 (90.5%) patients were diabetic, 214 patients (95.9%) suffered a recent Covid-19 infection, oxygen support was given to 175 (78.4%) patients and 218 (97.7%) patients had history of intake of steroids. Most common specific cutaneous manifestation was swelling (73.1%), followed by blackish discolouration (56.1%), necrotic eschar (24.3%), purpuric lesions (17%) and nodular lesions (12.2%). Non-specific manifestations included urticaria (32.1%), thrombophlebitis (17.8%), suture related complications (64.3%), bed sores (26.7%), cellulitis (35.7%) and others.

Conclusion: Treatment with systemic steroids and oxygen support during Covid-19 infection were common culprits of mucormycosis predisposition in the current scenario. Swelling, blackish discolouration, necrotic eschar, purpuric lesions and nodular lesions are common cutaneous findings. Early diagnosis can be established with the identification of these cutaneous manifestations. Imaging, mycological and histological investigations and a multidisciplinary approach with medical and surgical intervention may enhance the chances of survival.

Keywords: Mucormycosis; Cutaneous; Covid-19; Pandemic.

INTRODUCTION

India faced a severe second wave of Covid-19 infections starting February 2021, reporting upto 0.4 million cases in a day. Even as the deadly second wave was still ravaging, another impending threat emerged as a challenge in the form of coronavirus disease-associated mucormycosis. Mucormycosis is an angioinvasive fungal infection caused by Zygomycetes, from the family Mucoracea, in the order Mucorales.[1] This infection commonly proceeds in aggressive and rapid course and typically affects immunocompromised patients. The classic risk factors are underlying diabetes or ketoacidosis, malignancies, malnutrition, solid organ transplantation, deferoxamine therapy, HIV infection, drug

injections, burns, trauma and steroid use.[2-4] According to anatomic involvement, this condition can be classified mainly into six forms: (i) Rhino-orbital-cerebral (ii) cutaneous (iii) pulmonary (iv) gastrointestinal (v) disseminated (vi) mucormycosis at uncommon sites.[5] Cutaneous mucormycosis can be further classified into primary and secondary forms. When infection in skin is acquired by direct inoculation it is termed as primary cutaneous mucormycosis and when it is acquired by dissemination from other sites (commonly rhinocerebral), it is considered to be secondary cutaneous mucormycosis.[6] The most common clinical morphology is an erythematous to purple indurated plaque that turns necrotic with a rim of surrounding erythema and may develop into an eschar. This article will focus on the cutaneous manifestations of mucormycosis in the background of Covid-19 pandemic.

MATERIALS AND METHODS

This cross-sectional observational study was conducted at one of the largest tertiary care centre of North India. 223 diagnosed cases of mucormycosis belonging to all age groups, who were admitted in designated wards and ICUs, were included in the study. Unoperated as well as post operative cases were included. At our centre, the diagnosis of mucormycosis was based on the guidelines issued by Ministry of Health and Family welfare, Govt. of India and ICMR; derived from the 'Global guideline for the diagnosis and management of mucormycosis'.[7] According to which, out of 3 parameters (clinical, radiological and histopathological) if any two were present, the patient was diagnosed as a case of mucormycosis.

Information on demography, past illnesses, sites of involvement, cutaneous manifestations, comorbidities, treatment (medical and surgical), laboratory and radiological findings, was recorded. Skin biopsy was taken from the lesion of cutaneous mucormycosis and sent for histopathological examination with H&E and special stains. Pictorial documentation was done and results were processed by statistical analysis in the form of numbers and percentages.

RESULTS

A total of 223 cases of mucormycosis were observed. 186 patients (83.4%) belonged to the age group of 40-60 years; median age was 45.2 years. Of the total 223 patients, 170 (76.3%) were males and 53 (23.7%) were females.

214 patients (95.9%) gave the history of acquiring Covid-19 infection in last six months, proven by a RT-PCR test. History of diabetes was noted in 202 (90.5%) patients, both prolonged as well as recently diagnosed. 138 (61.8%) cases of hypertension, 2 (0.9%) cases of malignancy, 6 (2.7%) cases of transplant and 1 (0.4%) patient of HIV were found to have acquired this infection.

Patients were asked to provide information about history and treatment of Covid -19 infection and mainly three parameters were observed, i.e. duration of hospital stay, history of oxygen support and history of intake of steroids as a part of treatment. 198 (88.7%) patients were admitted at some point of time while being infected with Covid-19 virus during last six months and mean duration of hospital stay was 8 days. Oxygen support was given to 175 (78.4%) patients. 218 (97.7%) patients provided information about intake of steroids, including both treatment at home as well as treatment on admission in a hospital. (Table 1)

170 (76.2%) patients had rhinocerebral mucormycosis, 41 (18.3%) patients had cutaneous mucormycosis, 53 (23.7%) patients had pulmonary, 10 (4.5%) patients had gastrointestinal and 2 (0.9%) patients had disseminated form of the disease. (Table 2)

97 (43.4%) patients had some form of cutaneous manifestations, out of which 41 (18.3%) patients had manifestations specific to mucormycosis while 56 (25.1%) had non-specific manifestations which were related to hospital stay, intravenous medications, acquired infections, operation/ suture related, preexisting manifestations, drug allergies and others. Among the cutaneous specific manifestations, the commonest finding was swelling (73.1%), followed by blackish discolouration (56.1%), necrotic eschar (24.3%), purpuric lesions (17%) and nodular lesions (12.2%) over affected area (Figure 1). Non-specific manifestations included urticaria (32.1%), thrombophlebitis (17.8%), suture related complications (64.3%) (Figure 2), bed sores (26.7%), cellulitis (35.7%) and other findings like mask dermatitis, dermatophytosis and xerosis (75%). (Table 3) Biopsy specimens were obtained from 182 patients (81.6%) and were sent for histopathological examination with haematoxylin-eosin (HE) and periodic acid-Schiff stain (PAS). Branching fungal hyphae was visualized in 158 patients (70.8%) and rest of the patients were diagnosed by clinical findings and radiological imaging.

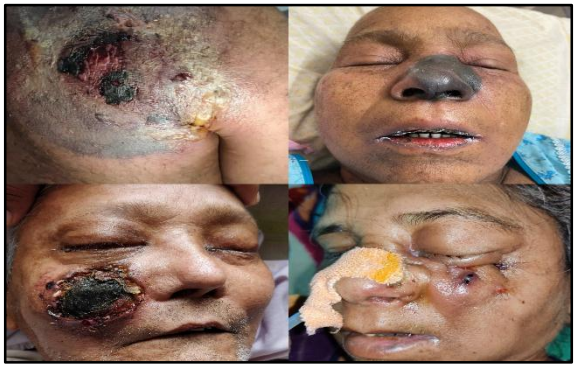

Fig 1: Indurated plaques of cutaneous mucormycosis that turned necrotic to develop into eschar

Fig 2: Tenderness, oozing and swelling at the site of sutures.

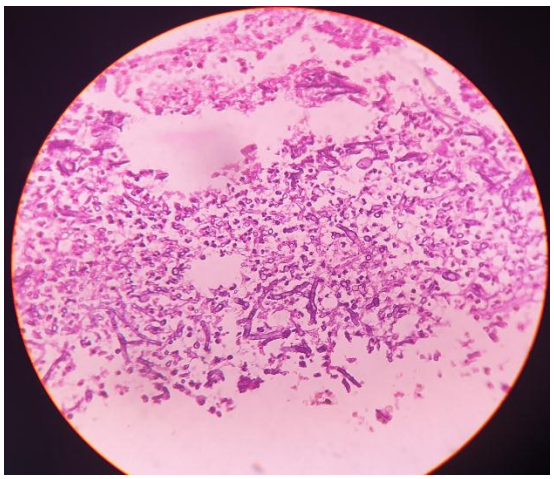

Fig 3: 100x(H&E) Mucorales hyphae appear ribbonlike with an irregular pattern of branching at 90 degrees

Table 1: Demographic data of mucormycosis cases

Parameters		No. of patients (n= 223)	Percentage (%)
Median age (years)		45.2	
Sex	Male	170	76.3
	Female	53	23.7
COVID Status	Positive	214	95.9
	Negative	9	04.0
Past History	Diabetes	202	90.5
	Malignancy	02	0.9
	Hypertension	138	61.8
	HIV	01	0.4
	Transplant recipient	06	02.7
Covid-19 Treatment History		198	88.7
Oxygen support		175	78.4
Systemic steroids		218	97.7
Mean duration of indoor treatment (days)		8	

Table 2: Various forms of mucormycosis according to site of involvement

SITE OF INFECTION	No. of patients (n=223)	Percentage (%)
Rhino-orbito-cerebral	170	76.2
Cutaneous	41	18.3
Pulmonary	53	23.7
Gastrointestinal	10	04.5
Disseminated	02	00.9

Table 3: Prevalence of cutaneous manifestations of mucormycosis

SPECIFIC (cutaneous mucormycosis)	No. of patients (n=41)	Percentage (%)
Necrotic eshar	10	24.3
Swelling	30	73.1
Blackish discoloration	23	56.1
Purpuric lesions	07	17.0
Nodules	05	12.2
NON-SPECIFIC	**No. of patients (n=56)**	**Percentage (%)**
Urticaria	18	32.1
Thrombophlebitis	10	17.8
Bed sores	15	26.7
Suture related	36	64.3
Cellultis	20	35.7
Others (melasma, xerosis, dermatophytoses, mask associated dermatitis)	42	75.0

DISCUSSION

Mucormycosis is a rare fungal infection but the incidence has increased globally over past two decades particularly in France, Spain, Belgium, US and India. In France, the incidence increased from 0.7 per million in 1997 to 1 per million in 2006.[8] A single centre study in Spain reported incidence 1.2 per 100,000 in 2006 which increased to 3.2 cases per 100,000 in 2015.[9] In India, increasing incidence of mucormycosis was reported by Chakrabarti et al., who found its incidence to be 12.9 cases per year between 1990–1999, 35.6 cases per year between 2000–2004, which rose to 50 cases per year between 2006–2007. In another study conducted in South India between 2015 to 2019, 38 patients of

mucormycosis were reported.[10] Whereas, 223 patients of mucormycosis were admitted in our tertiary care hospital over a period of 3 months amidst the second wave of covid 19 infection in 2021. As reported in November 2021, the nationwide data states that 51,775 cases of mucormycosis were identified during the pandemic and more than 4000 cases succumbed to this condition. It was declared as a notifiable disease under the Epidemic Disease Act for objective analysis and estimation of true incidence.

Most common affected age group in previous studies was 41-60 years which was similar to our study.[10] In previous reports no sex predilection has been observed but in our study the male female ratio was 3.2: 1.

Mucromycosis is an uncommon and aggressive fungal infection caused by group of filamentous moulds of the order Mucorales. Mucorale comprises of various genera (Rhizopus, Mucor, Rhizomucor, Lichtheimia, Cunninghamella and Saksenaea).[11-14] In a study done in north India, *Rhizopus arrhizus* was the most commonly isolated species and *Apophysomyces variabilis* was commonly obtained from cutaneous mucormycosis.[15] These fungi are ubiquitous and usually present in soil, decaying organic matter, wood, fruits, animal matter and bread.[16,17]

In cutaneous disease, the fungus is commonly acquired in skin by direct inoculation (contaminated dressing, surgery, burns, motor vehicle accidents, needle, insect bite) whereas in other forms of mucormycosis, inhalation and ingestion are common routes. When high amounts of sporangiospores invade deeper into the dermis, they aggressively spread into subcutaneous fat, muscle, fascia and bone. Invasion of hyphae into the vessels leads to tissue necrosis.[17]

In developing countries, uncontrolled diabetes mellitus (DM) is involved in causation of a considerable number of mucormycosis cases. Globally, DM was reported to be the primary cause of mucormycosis in 27 to 52% of patients.[18,19] In India too, previous studies have shown uncontrolled DM to be the most important risk factor.[20] In fact, a substantial number of diabetic patients (16 to 23%) remain undiagnosed before the presentation of mucormycosis.[21] The high prevalence of mucormycosis in diabetics is probably due to acidic and glucose rich environment.[22] Chakarabarti et al reported uncontrolled DM in 58% and diabetic ketoacidosis in 38% cases of rhino-orbito-cerebral mucormycosis. In our study, out of 223 patients 90.5% patients were diabetic.

Other systemic risk factors of immunosuppression like haematological malignancies, chronic diseases, transplant recipients, immunosuppressive therapies, chemotherapeutic agents, HIV, malnutrition, intravenous drugs also contribute to fungal infections.[23] Lesser-known predisposing factors are iron overload and desferoxamine injections.[24] Few cases were also reported in haematopetic stem cell transplant recipients who received voriconazole. [25-27]

In our study, history of infection with covid 19, oxygen support and steroid administration as a part of treatment, proved to be important risk factors for the development of mucormycosis. Nosocomial infections and longer duration of hospital stay can also be attributed to the occurrence of mucormycosis. Ried *et al* reviewed various forms of mucormycosis according to their incidence and found rhino-orbital-cerebral mucormycosis (25-39%) to be the most common followed by pulmonary (24-30%), cutaneous (19-26%), gastrointestinal (2-11%) and disseminated (15-23%) forms.[5] In rare cases, other sites like bones, joints, heart and peritoneum can be involved. In comparison, a study from North India reported higher incidence of cutaneous mucormycosis (31%) with rhino-orbital-cerebral mucormycosis (61.5%) still being the commonest presentation.[15] In our study, we observed highest incidence of rhino-orbital-cerebral mucormycosis (76.2) followed by pulmonary (23.7%) and cutaneous (18.3%) mucormycosis.

Cutaneous mucormycosis is classified into two types: primary and secondary. When infection in skin is acquired by direct inoculation it is termed as primary cutaneous mucormycosis and when it is acquired by dissemination from other sites (commonly rhinocerebral), it is considered to be secondary cutaneous mucormycosis.[28] According to extent of involvement, some authors further subcategorize it into localized, deep, or disseminated forms. Arms and legs are most commonly affected in primary form but any site can be involved. The most common clinical morphology is an erythematous to purple indurated plaque at inception, which turns necrotic with a rim of surrounding erythema and may later develop into an eschar.[28,29] Other presentations like tender nodules, ulcers, targetoid lesions, purpuric lesions, and scaly plaques can also be seen.[30-37] Lesions in patients with underlying diabetes tend to develop necrosis and cellulitis.

Secondary cutaneous mucormycosis has acute onset and high mortality. It is commoner than primary form. Initially, it presents as sinusitis and later progresses to form a necrotic eschar.[28,38] Cases with necrotic ulcers in oral mucosa have been reported. Features specific to rhino-orbital-cerebral disease like fever, periorbital edema and cellulitis, proptosis, loss of vision, ophthalmoplegia, and other neurological deficits are frequently encountered in secondary cutaneous mucormycosis.

Non-specific cutaneous lesions which are not directly related to the diseases process but manifest due to prolonged hospital stay, intravenous medications, drug allergies, hospital acquired infections, operation / suture related complications and preexisting dermatological conditions, also accompany specific cutaneous lesions of mucormycosis. These include bed sores, thrombophlebilitis, urticaria, contact dermatitis, dermatophytosis, pyoderma, secondarily infected sutures or surgical site, cellulitis, xerosis,

and mask induced dermatitis. In our study hospital acquired infections and suture related complications were the commonest findings noted.

Signs and symptoms of rhino-orbital-cerebral mucormycosis may include fever, headache, facial pain, nasal congestion, swelling of periorbital tissues, and dark nasal or palatine mucosa eschar.[39] Orbital invasion is characterized by development of cellulitis, chemosis, proptosis, and decreased vision.[40] High mortality is observed in intracranial progression via direct extension or angioinvasion, which may occur rapidly within days.[11,41]

Pulmonary mucormycosis manifests as prolonged fever that does not respond to broadspectrum antibiotics. Fever is accompanied by non-productive cough, hemoptysis, pleuritic chest pain and dyspnea. HRCT is performed to determine the extent of pulmonary involvement. Radiographic features include cavitations; centrilobular nodules; perilesional ground glass opacities; air-crescent sign and reverse halo sign. Involvement of pulmonary vessels may result in complications like necrotizing pneumonia and fatal hemoptysis.[5]

Gastrointestinal mucormycosis is rare and mainly presents as necrotizing enterocoloitis with swollen, erythematous and tender abdomen. Most commonly appendix, caecum or ileum are involved, but any part of the gut may be affected. Gastrointestinal perforation leads to peritonitis and death.

Invasion of endothelial cells in the vascular system by Mucorales results in disseminated mucormycosis, which can originate from any primary site, most commonly from pulmonary mucormycosis.

In patients with suspected mucormycosis, imaging techniques, mycological and histological investigations are required for definitive diagnosis.[7] In cases with pulmonary symptoms, a pulmonary CT scan should be performed and in cases of sinusitis, cranial CT or MRI is recommended. In a diagnosed case of sinustis, endoscopy should be performed to diagnose mucormycosis. For eye or brain involvement, MRI is preferred instead of a CT scan. Biopsy is strongly recommended for cases where mucormycosis is the potential diagnosis. Direct KOH microscopic examination showing non-septated, hyaline hyphae aids in early detection. For confirmation, tissue sections stained with haematoxylin-eosin (HE), periodic acid-Schiff stain (PAS), or Grocott-Gomori's methenamine-silver stain (GMS), or both should be performed.[42,43] Histopathologically, Mucorales hyphae appear to be non-septate or pauci-septate, with a variable width of 6–16 µm, sometimes up to 25 µm. In tissue, the hyphae appear ribbon-like with an irregular pattern of branching at 90 degrees (Figure 3). Ideally biopsy specimen should be deep enough to include subcutaneous fat and should be taken from center of the lesion. Besides demonstration of fungi, edema, thrombosis, necrosis and an infiltrate of polymorphonuclear cells, plasma cells, and eosinophils can be observed. Fungal cultures in Sabouraud and potato dextrose agar media should be performed. [16] Molecular identification with semi-nested qPCR, HRM, or multiplex target (18s, ITS, 28s or rDNA) and immunohistochemical staining with specific primary reagents can be performed for direct detection and specific diagnosis of species.

A multidisciplinary approach is necessary to enhance the chances of survival in cutaneous mucormycosis. Management comprises of aggressive surgical debridement and systemic antifungal treatment.[44] Survival rates are higher when both surgical and medical measures are performed together. Necrotic and infected tissue should be completely resected along with a rim of surrounding normal tissue. In case of progression, surgery must be repeated.[4] The antifungal of choice is deoxycolate amphotericin B (d-AmB); however, lipid formulations are preferred because of their better safety profile and less nephrotoxicity.[45] Studies have shown that amphotericin B (AmB) is the most active drug against mucorales. Standard dose of d-AmB is 0.25-0.75mg/kg/per day. In severe cases and in immunocompromised patients, the recommended doses for d-AmB are 1-1.5mg/kg/day. The dose of liposomal amphotericin B (L-AmB) is 5-10mg/kg/day, and the dose of amphotericin B lipid complex is 5 mg/kg/day. Posaconazole in the dose 400 mg BD p.o. has proven effective as second line therapy in medical management.[46,47] Isavuconazole has been recently approved in United States for the treatment of invasive mucormycosis.[48]

The present study is important in the current scenario of Covid-19 pandemic, which saw a sudden surge of mucormycosis cases in a short period of time. This study emphasizes the need of further awareness of the disease from the point of view of a dermatologist so that aggressive measures can be taken for early diagnosis and treatment.

There were certain limitations of our study. Due to lack of resources, molecular diagnosis could not be established. Microbiological identification of species by fungal culture was not recorded for each patient. Initial cutaneous lesions were missed in the patients who underwent surgical debridement before the initiation of study. Proper pictorial documentation could not be achieved for patients who were clinically unstable. Due to limitation of time, outcome of treatment and mortality rate could not be recorded.

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