Clinical Presentations, Management and Outcomes of Rhino-Orbital-Cerebral Mucormycosis (ROCM) Following COVID-19: A Multi-Centric Study

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Purpose: To report clinical presentations and factors affecting outcomes in rhino-orbital-cerebral mucormycosis following COVID-19.

Methods: Retrospective multi-centric interventional case series of 58 eyes with rhino-orbital-cerebral mucormycosis. Demography, clinical parameters and management outcomes were noted. Factors affecting outcome and mortality were analyzed. Outcome was defined as favorable when complete resolution or stabilization without further progression of the infection was noted at last visit.

Results: Mean age was 55 ± 11 years (median 56). The mean HbA1c value was 10.44 ± 2.84 mg% (median 10.5). The duration between the diagnosis of COVID-19 and rhino-orbital-cerebral mucormycosis was 16 ± 21 days (median: 8 days). Thirty-six eyes (62%) had no vision at presentation. Imaging revealed paranasal sinus involvement (100%), orbital apex involvement (41%), cavernous sinus involvement (30%), and central nervous system (CNS) involvement (33%). All the patients were treated with systemic Liposomal amphotericin-B and sinus debridement. Twenty-two eyes (38%) underwent exenteration. One eye underwent transcutaneous retrobulbar amphotericin-B. The mean follow-up duration was 5.62 ± 0.78 months (median 6). Favorable outcome was seen in 35 (60%) cases. Presence of uncontrolled diabetes mellitus was a factor determining mortality.

Conclusion: Over a third of patients with rhino-orbital-cerebral mucormycosis following COVID-19 have an unfavorable clinical outcome. Uncontrolled diabetes mellitus at presentation, involvement of the orbital apex, CNS, and the usage of steroids were associated with poorer outcomes. CNS involvement was a factor determining mortality.

Rhino-orbital-cerebral mucormycosis (ROCM) is a life-threatening infection associated with high morbidity and mortality.12 Opportunistic fungi, belonging to the order Mucorales, are responsible for this rapidly progressing fatal infection.14 Mucormycosis is known to affect immunocompromised patients especially those with uncontrolled diabetes.5 Following the inhalation of fungal spores present in the environment, the fungi colonize and infect the nasal/sinus mucosa first, before spreading to surrounding anatomical areas including the orbit, cavernous sinus, and brain. The infection consists of angioinvasion by the fungal hyphae, vascular thrombosis, and tissue necrosis15 (Fig. 1). The clinical hallmark is tissue necrosis manifested as a necrotic lesion, eschar, or black discharge in the nasal or oral cavity.

Globally, as of May 19, 2021, 163,869,893 confirmed cases of COVID-19, including 3,398,302 deaths have been reported to WHO.1 There is growing evidence to show that COVID-19 infection increases the risk of a patient acquiring secondary fungal infections.4,10 This puts such patients at a high risk to develop ROCM. There is very scant literature on the occurrence of ROCM in patients with COVID-19 infection.11-13 In the current communication, we present the largest multi-centric series of ROCM in patients with COVID-19 and discuss the management, outcomes and assess factors predicting the clinical outcomes.

METHODS

This was a multi-centric retrospective interventional study. The study included patients with ROCM following COVID-19 infection. The patients included were from a single country (India) across 9 hospitals treating patients with ROCM. Institutional Review Board approval was obtained for the study from all centers and the study adhered to the tenets of the Declaration of Helsinki. All patients signed a consent form allowing identifiable photographs to be archived and published.
According to the criteria put forth by a recent editorial on ROCM post-COVID-19 infection,\textsuperscript{14} we looked at A) host factors relevant to the subset of COVID-19 and ROCM, B) diagnostic criteria, and C) mycological criteria for diagnosing possible, probable, and proven mucormycosis (Table 1). In the presence of clinical features suggestive of ROCM such as signs of eyelid, periocular or facial edema or discoloration, ptosis, proptosis, chemosis, ophthalmoplegia, central retinal artery occlusion, panophthalmitis and palatal eschar, the following host factors, diagnostic criteria and mycologic criteria were looked for:

1. The host factors (one of the following).
   i. Concurrently or recently (<6 weeks) treated for COVID-19;
   ii. Uncontrolled diabetes mellitus (DM) (HbA1c of >7% was considered as the cutoff value for diagnosing uncontrolled diabetes);
   iii. Treated for COVID-19 with steroids;
   iv. Treated for COVID-19 with immunomodulators (tocilizumab).

2. The diagnostic criteria.
   i. Diagnostic nasal endoscopy: Signs of nasal eschar, discoloration, and ulceration over the nasal mucosa were examined in the region of the middle turbinate, middle meatus, and the septum.

   ii. MRI orbit, paranasal sinus and brain with gadolinium contrast was performed and fat saturation postcontrast sequences were examined.

Features evaluated were:

a. Early osseous erosion or marrow edema;
   b. H haziness of the paranasal sinuses;
   c. Soft tissue inflammation around the paranasal sinuses;
   d. Retroantral extension;
   e. Intraorbital extension;
   f. Intracranial extension.

3. Mycologic criteria included the presence of one of the following.
   i. Mycological evidence of mucormycosis in tissue biopsy taken during sinus debridement or from the orbital biopsy. Direct examination of biopsy or aspirated material was performed using 10% potassium hydroxide or calcofluor white staining solution. The specimens were inoculated on Sabouraud dextrose agar and blood agar and incubated at 37°C and 25°C for up to 1 and 2 weeks, respectively. Rapid growth of gray fluffy colonies was identified on conventional morphologic assessment. The growth was sub-cultured and reported as significant if
the direct examination of the sample showed the presence of fungal filaments.\textsuperscript{15}

ii. Histopathologic evidence of mucormycosis in tissue biopsy was performed by examining for asceptate hyphae branching at wide-angle and ribbon-like hyphae associated with tissue damage on slides stained by Hematoxylin and Eosin, Periodic acid Schiff, and Gomori’s methenamine silver stains.

Along with indicative clinical signs and symptoms, mucormycosis was classified as possible if any of the host factors were present, probable if host factors and any of the diagnostic factors were present, and proven if host factors and diagnostic factors were present with mycological criteria being met.

The diagnosis of COVID-19 was based on real-time polymerase chain reaction test on nasopharyngeal/oropharyngeal swabs. All demographic and clinical characteristics including ophthalmic signs, systemic manifestations, underlying conditions, and medical and surgical interventions were noted. The data recorded included age, gender, duration of the symptoms, history of DM, status of control of DM at presentation, any other immune deficiencies, clinical/radiologic involvement of the orbital apex, cavernous sinus, or the central nervous system (CNS), history of steroid use and that of immunomodulators (tocilizumab), the CT severity scores (1–25) and the CORAD scores. The presence of thrombo-embolic phenomenon related to COVID-19 was evaluated by the treating internist. A favorable outcome was defined as a complete resolution of the infection or stabilization without further progression on radiology at the end of follow-up.

Statistical Analysis. The data was arranged on an Excel spreadsheet. Relevant statistical analysis was done using MedCalc version 12.2.1.0 (Ostend, Belgium). Continuous parametric data were reported using the mean (±SD) and nonparametric data were reported as median. Multivariate logistic regression analysis and chi-square test were performed to assess the effect of multiple factors that might have influenced the outcome and mortality. A \( p \)-value of \(<0.05\) was assigned as statistically significant. Outcomes of both the bivariate and multivariate analysis were reported for comparison.

**RESULTS**

The study included 58 eyes of 58 patients. All patients developed ROCM following COVID-19 infection. There were 44 males (76\%). The mean age was 55 ± 11 (median 56) years. Forty-three patients (74\%) had a history of DM. On presentation with COVID-19 symptoms, 46 (79\%) patients had uncontrolled diabetes based on the glycosylated hemoglobin values (HbA1c). An HbA1c of 7% or higher was considered as the cutoff value for diagnosing uncontrolled DM. The mean HbA1c value among those with controlled DM was 5.84 ± 0.54 mg/dL (median: 6), while that in uncontrolled cases was 11.57 ± 1.86 mg/dL (median 11.25) \((p < 0.0001)\). The mean chest CT severity score was 15.95 ± 4.74 (median: 17). No thrombo-embolic phenomenon attributable to COVID-19 was noted in any of the patients in this subset. The duration between the diagnosis of COVID-19 and ROCM was 16 ± 21 days (median: 8 days). Thirty-six eyes (62\%) had no perception attributable to COVID-19 was noted in any of the patients in this subset.

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**TABLE 1.** Diagnostic pathway followed for suspected rhino-orbital-cerebral mucormycosis

| Possible | Probable | Proven |
|----------|----------|--------|
| Classic signs and symptoms of ROCM | Signs and symptoms | Clinico-radiologic features |
| Concurrently or recently (≤6 weeks) treated for COVID-19 | Diagnostic nasal endoscopy | Microbiology evidence on direct microscopy* |
| Uncontrolled diabetes mellitus | Diagnostic MRI | Microbiology evidence on culture* |
| Treated for COVID-19 with corticosteroids | | Microbiology evidence with molecular mechanisms* |
| Treated for COVID-19 with immunomodulators | | Histopathology evidence of fungus with special stains* |

* Tissue diagnosis was done on material obtained during sinus or orbital debridement or exenteration.

ROCM, rhino-orbital-cerebral mucormycosis.
TABLE 2. Demography and treatment outcomes in patients ROCM with COVID-19

| Total eyes | 58 |
|-----------|----|
| Presenting features | N (%) |
| Extraocular muscle limitation | 54 (93) |
| Orbital pain | 45 (78) |
| Proptosis | 42 (72) |
| Ptosis | 40 (69) |
| Headache | 34 (59) |
| Conjunctival chemosis | 33 (57) |
| Disc edema | 23 (40) |
| Black eschar in the nose | 19 (33) |
| Facial fullness | 16 (28) |
| Central retinal artery occlusion | 15 (26) |
| Epistaxis | 11 (19) |
| Mouth lesions | 8 (14) |
| Presenting visual acuity | |
| No light perception | 36 (62) |
| Light perception only | 9 (16) |
| CFCF >CFCF <20/20 | 7 (12) |
| 20/20 | 3 (5) |
| No light perception | 3 (5) |
| Imaging features | |
| Orbital cellulitis | 43 (74) |
| Cavernous sinus involvement | 17 (30) |
| Orbital apex involvement | 24 (41) |
| CNS involvement | 19 (33) |
| Sinus involvement | 58 (100) |
| Systemic status | |
| Known diabetic before contracting COVID-19 | 43 (74) |
| De-novo diagnosis of DM while on treatment for COVID-19 | 13 (22) |
| Known case of leukemia | 1 (2) |
| Known case of Hepatitis B | 1 (2) |
| Uncontrolled diabetes | 46 (79) |
| Mean HbA1c in controlled group | 5.84 ± 0.54 mg%/median 6 |
| Mean HbA1c in uncontrolled group | 11.57 ± 1.86 mg%/median 11.25 |
| Management of COVID-19 | |
| Intravenous steroids for COVID given | 37 (64) |
| Oral steroids for COVID given | 35 (60) |
| Tocilizumab administered for COVID | 27 (47) |
| Mean C-reactive protein levels (median) | 47.19 ± 53.43 mg/L (26.9) |
| Chest CT severity score (on a 1–25 point system) | 15.95 ± 4.74 (median 17) |
| Diagnosis of mucormycosis | |
| Proven mucormycosis | 40 (69%) |
| Probable mucormycosis | 18 (31%) |
| Management of mucormycosis | |
| Intravenous liposomal Amphotericin B followed by oral Posaconazole | 58 (100) |
| Sinus debridement | 58 (100) |
| Orbital exenteration | 22 (38%) |
| Debridement of orbital necrotic tissue and orbital irrigation with amphotericin B TRAMB | 1 (2%) |
| Outcome | |
| Favorable | 35 (60) |
| Unfavorable | 23 (40) |
| Mortality | 20 (34) |
| Mean follow up duration (months) | 5.62 ± 0.78 (median 6 months) |

CFCF, counting fingers close to face; CNS, central nervous system; DM, diabetes mellitus; TRAMB, transcutaneous retrobulbar amphotericin B; ROCM, rhino-orbital-cerebral mucormycosis. (p = 0.008) were associated with higher mortality on bivariate regression analysis. However, this significance was not maintained on multivariate regression analysis (p = 0.7 and 0.6, respectively). The presence of uncontrolled diabetes, orbital apex involvement, CNS involvement, and the usage of steroids were responsible for an unfavorable outcome. These factors were also assessed for their effect on mortality (Table 4). Both bivariate and univariate analysis showed CNS involvement at presentation as the only factor predicting mortality (p = 0.002 and 0.03, respectively).

DISCUSSION

The current study is the largest multi-centric series of ROCM following COVID-19 with long-term outcomes. We noted 40% of all cases have an unfavorable outcome. Factors determining unfavorable outcome included uncontrolled DM at presentation, involvement of the orbital apex and CNS, and the usage of steroids during the active phase of COVID-19 infection. The mere presence of DM, or usage of immunomodulators did not pose a significant risk for an unfavorable outcome. Twenty-two patients (38%) required an orbital exenteration.

COVID-19 and mucormycosis share risk factors, such as presence of DM, which can independently contribute to mortality, but have conflicting management principles. While immune suppression with steroids may be required in moderate to severe COVID-19, the use of steroids and the worsening glycaemic control provide an opportunity for mucor to become invasive.9,16–21 Mucor produces keto-reductase as a virulence factor enabling them to grow in the acidic and glucose-rich environment generated in ketoacidotic states.9,17–19 Additionally, Müller et al22 have postulated that the human pancreas could be a possible target for the SARS-CoV-2 virus and that the β-cell infection may result in insulin resistance. This metabolic dysregulation, in previously nondiabetic or well-controlled diabetic COVID-19 patients, might predispose them to develop mucormycosis.

Moorthi et al23 recently reported the association of COVID-19 infection with uncontrolled DM and usage of corticosteroid. Similarly, Sen et al11 reported a series of 6 diabetic patients with concurrent mucormycosis and COVID-19 infection. Sarkar et al24 reported a series of 10 diabetic patients with ROCM post-COVID-19. All their patients had uncontrolled blood sugar values and were treated with steroids during active COVID-19 infection. Current literature suggests that usage of systemic steroids in patients, who otherwise may have controlled diabetes, or may not be diabetics at all, can precipitate mucormycosis.24–28 Mekonnen et al29 reported a case of invasive fungal rhinosinusitis with orbital involvement in a patient with COVID-19 with uncontrolled DM and HbA1c of 14%. In the current study too, we found usage of steroids as a factor predicting unfavorable outcome. Mehta and Pandey11 reported a case of a patient with COVID-19 infection, treated with steroids and tocilizumab, who during the course of the treatment, developed rhino-orbital mucormycosis. Due to persistent hypotension, repeat imaging or debridement measures were not possible and the patient died on day 6 of admission. Waizel-Haiat et al12 reported a case of rhino-orbital mucormycosis associated with ketoacidosis secondary to recent onset DM and COVID-19 infection. Despite aggressive management the patient developed multi-organ failure and died. Similar to this particular patient, 27 (47%) patients in our series received tocilizumab, an immunomodulator (anti-interleukin 6 receptor antibody) that improves the outcome of COVID-19 infections. It is known that tocilizumab can precipitate invasive fungal infections.30,31 Though, in our study the usage of tocilizumab had a near significance (p = 0.07) in bivariate analysis, this was not maintained in the multivariate analysis (p = 0.89). This may suggest that usage of tocilizumab had some bearing on an unfavorable outcome but could not be proven statistically in our subset.
Moorthy et al.\textsuperscript{21} reported 18 patients with ROCM with COVID-19 infection. Loss of vision was noted in 67% of patients and 39% underwent orbital exenteration. Mortality was seen in 33%. In our series, 20 (34%) patients died. Ravani et al.\textsuperscript{32}
published a series of 31 patients with ROCM following COVID-19 and suggested that the presence of cerebral involvement and a HbA1c value of ≥8 were found to be significant in the prediction of mortality in this subset. Our findings are in accordance to this observation. A comparison of our study with published literature on COVID-associated mucormycosis is summarized in Table 5.

The largest series on ROCM from a geographically similar area with patients who did not have COVID-19 was published

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**TABLE 3.** Factors predicting unfavorable clinical outcome in cases of ROCM with COVID 19

| Factor                      | Bivariate regression | Multivariate regression |
|-----------------------------|----------------------|-------------------------|
|                             | Coefficient of regression | p     | Coefficient of regression | Correlation coefficient | r     | p     |
| Age                         | 0.58                 | 0.55                   | -0.005 | -0.21 | 0.18 |
| Gender                      | -0.22                | 0.72                   | 0.13   | 0.2   | 0.22 |
| Tocilizumab                 | -0.96                | 0.07                   | 0.08   | 0.14  | 0.89 |
| Uncontrolled diabetes       | -2.92                | 0.007                  | 0.5    | 0.56  | 0.0002 |
| Cavernous sinus involvement | -1.48                | 0.01                   | -0.08  | -0.12 | 0.43 |
| Orbital apex involvement    | -2.42                | 0.0001                 | -0.23  | -0.32 | 0.04 |
| CNS involvement             | -2.23                | 0.0002                 | -0.17  | -0.28 | 0.04 |
| Exenteration done           | -2.19                | 0.03                   | -0.56  | -0.66 | <0.0001 |
| Steroid administration      | -22.02               | <0.0001                | -0.01  | -0.21 | 0.52 |
| Chest CT severity score     | 0.18                 | 0.13                   |        |       |      |

Boldface values indicate statistically significant p.

CNS, central nervous system; ROCM, rhino-orbital-cerebral mucormycosis.

**TABLE 4.** Regression analysis of factors predicting mortality in ROCM following COVID-19

| Factor                      | Bivariate regression | Multivariate regression |
|-----------------------------|----------------------|-------------------------|
|                             | Coefficient of regression | AUROC fraction | p   | Coefficient of regression | Correlation coefficient (r) | p     | Variance inflation factor |
| Age                         | -0.01                | 0.54                   | 0.51 | -0.005 | -0.13 | 0.36 | 1.27 |
| Gender                      | 0.47                 | 0.54                   | 0.45 | 0.15   | 0.14  | 0.3  | 1.25 |
| Uncontrolled diabetes       | 0.78                 | 0.56                   | 0.29 | 0.24   | 0.18  | 0.6  | 4.13 |
| Cavernous sinus involvement | -1.12                | 0.62                   | 0.06 | -0.08  | -0.07 | 0.59 | 1.63 |
| Orbital apex involvement    | -0.85                | 0.6                    | 0.13 | -0.11  | -0.12 | 0.39 | 1.43 |
| CNS involvement             | -1.89                | 0.7                    | 0.002| -0.3   | -0.3  | 0.3  | 0.03 |
| Exenteration done           | 0.33                 | 0.56                   | 0.008| 0.08   | 0.07  | 0.6  | 2.88 |
| Chest CT severity score     | 0.58                 | 0.87                   | 0.03 | 0.01   | -0.16 | 0.7  | 5.1  |
| Steroid administration      | -1.62                | 0.66                   | 0.02 | -0.18  | -0.19 | 0.18 | 1.3  |
| Tocilizumab                 | -0.8                 | 0.6                    | 0.14 | -0.08  | -0.09 | 0.52 | 1.19 |

Boldface value indicates statistical significance.

CNS, central nervous system; ROCM, rhino-orbital-cerebral mucormycosis.
TABLE 5. Comparison of present study with that of other recent literature on ROCM post-COVID-19

| Parameter studied | Current study | Ravani et al22 | Moorthy et al31 | Sarkar et al25 | Sen et al31 | Mekonnen et al25 | Mehta and Pandey13 | Rao et al17 |
|-------------------|--------------|----------------|----------------|----------------|-------------|-----------------|-------------------|-------------|
| n                 | 58           | 31             | 60             | 18             | NA          | 10              | 6                 | 1           |
| Duration between COVID-19 and ROCM (days) (median) | 16 ± 21 (8) | 60             | All patients were COVID + at presentation | NA | 18 ± 16 (16) | 1 | 10 | 9 |
| Mean age in years | 56 ± 11      | 56             | 55 ± 11        | 46 ± 15        | 61 ± 12     | 60 | 60 | 66 |
| Male gender (%)   | 44 (76%)     | 20 (65%)       | 15 (83%)       | 8 (80%)        | 6 (100%)    | Yes | Yes | Yes |
| Presence of uncontrolled blood sugar at presentation | 31 (53%)     | 30 (97%)       | 16 (89%)       | 9 (90%)        | 5 (83%)     | Yes | Yes | Yes |
| Known case of diabetes mellitus | 51 (88%) | 30 (97%) | 16 (89%) | 10 (100%) | 6 (100%) | Yes | Yes | Yes |
| Usage of steroids | 48 (83%) | 19 (61%) | 16 (89%) | 10 (100%) | 5 (83%) | Yes | Yes | Yes |
| Usage of tocilizumab | 27 (47%) | NA | NA | NA | NA | No | Yes | NA |
| Decrease in vision at presentation | 55 (95%) | 29 (94%) | 12 (67%) | 8 (80%) | 6 (100%) | Yes | Yes | Yes |
| Intracranial extension | 19 (33%) | 10 (32%) | 9 (50%) | 1 (10%) | 5 (83%) | No | Yes | No |
| Liposomal Amphotericin B usage | 56 (97%) | 31 (100%) | 18 (100%) | 10 (100%) | 6 (100%) | Yes | Yes | Yes |
| Sinus debridement | 58 (100%) | 31 (100%) | 18 (100%) | 3 (30%) | 6 (100%) | Yes | Yes | Yes |
| Exenteration | 22 (38%) | 4 (13%) | 7 (39%) | 1 (10%) | 2 (33%) | No | Yes | No |
| Orbital debridement | 2 (3%) | NA | No | No | 1 (2%) | No | No | No |
| TRAMB | 1 | NA | NA | NA | 1.4 months | 1 month | 1 week | NA |
| Mean follow up duration (months) | 5 months | 2.5 months | (min. follow up) | NA | NA | 1.4 months | 1 month | 1 week | NA |
| Mortality | 20 (34%) | 3 (10%) | 6 (33%) | 4 (40%) | 0 | Yes | Yes | No |

NA, not available; TRAMB, transcutaneous retrobulbar amphotericin B.

by Nithyanandam et al. They reported a retrospective series of 34 cases of ROCM treated more than 8 years (1992–2000). The cases were treated with intravenous amphotericin-B and appropriate debridement and exenteration as per the clinical condition. Uncontrolled diabetes constituted 82% of their cases, as against 76% in the current series (p = 0.5). Intracranial disease in that series was seen in 7 of 34 cases (21%) while in the current series it was 33% (p = 0.2). The overall mortality in the series was seen in 11 patients (32%). This was comparable to the mortality rate in our study which was 34% (p = 0.87). The treatment success rates of their study and the current study were 53% and 60%, respectively (p = 0.49). The commonest parameters between the 2 studies were not statistically different. This indicates that the concurrent COVID-19 infection does not alter either the final outcome or the mortality in cases with mucormycosis.

One of the most important decisions that needs to be made in the course of the management of ROCM is that regarding orbital exenteration. It has been previously reported that the indications for orbital exenteration are ophthalmoplegia, proptosis, cranial involvement, and ocular involvement. Some have even reported that exenteration could increase the patients’ survival in the presence of intracranial spread and rapid progression. Kashkouli et al in their series found that survival was not significantly different in patients with and without exenteration. However, a significantly longer duration of symptom to death was observed in patients with exenteration indicating that performing orbital exenteration may delay the time of death. There have been attempts to create a scoring system to assist in the management of ROCM. Shah et al proposed the “Sion Hospital Scoring System” which relies on clinical signs, ophthalmoscopic features, and imaging characteristics. However, it is also possible that exenteration, by itself, may not be associated with improved survival due to end-stage disease at the time of exenteration. In our study, bivariate regression analysis showed exenteration to be associated with higher mortality (p = 0.008) although the significance was not maintained on multivariate analysis. This statistical observation could be confounded by the possibility that patients with the most severe infections and the highest risk of dying were exenterated. Another possibility might be that exenteration did not confer a survival benefit. We believe, in cases of ROCM involving the sinuses, the orbit along with intracranial extension, orbital exenteration at best may help in reducing the disease load, which by itself cannot be curative.

The current study has its strengths and limitations. This is the largest study to date on ROCM in COVID-19 patients and also the first one to objectively demonstrate the factors predicting poor clinical outcomes along with those predicting mortality in such a subset. The current study proposes various independent factors that determine clinical outcomes in ROCM following COVID-19 infection. As seen in the regression tables, the variance inflation factors of all the significant independent variables are on the lower side. This rules out multi-collinearity and we can thus propose each of these to be an independent significant factor not affected by the other. This is a major strength of this study. This study also has limitations of being a retrospective study across different practices separated by geography. Thus a slight difference in management protocols cannot be adjusted for.

In conclusion, ROCM is a known occurrence in COVID-19 affected patients. Over a third of patients can have unfavorable final outcome. Uncontrolled DM at presentation, involvement of the orbital apex and CNS by the infection, and the usage of steroids determined an unfavorable outcome. Involvement of the CNS was seen to be the only factor determining mortality. In a similar geographic setup, as compared to previous non-COVID-related cases, the coexistence of COVID-19 in this series, did not seem to worsen the final outcome in terms of mortality. It is prudent that physicians and ophthalmologists, alike, involved in the care of patients with COVID-19 be aware of the outcomes of ROCM in COVID-19 patients.

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