

# Anesthetic and Peri-operative Challenges of COVID-19 Associated Rhino-Orbito-Cerebral Mucormycosis

Minal Harde<sup>1</sup>, Neha Devaraj<sup>2</sup>, Vaishnavi Zile<sup>2</sup>, Pratibha Dighe<sup>3</sup>

<sup>1</sup>Associate Professor, Department of Anaesthesiology, Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, Maharashtra, India, <sup>2</sup>Assistant Professor, Department of Anaesthesiology, Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, Maharashtra, India, <sup>3</sup>Resident, Department of Anaesthesiology, Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, Maharashtra, India

## Abstract

**Purpose:** The purpose of the study was to appraise the anesthetic management, peri-operative course, complications, and outcome of patients undergoing surgery for COVID-19 associated mucormycosis (CAM).

**Methods:** It was an observational retrospective study conducted at a tertiary care teaching public hospital. Detailed perioperative data were collected from all the patients who underwent surgical debridement of CAM.

**Results:** A total of 41 patients were operated for CAM during the study period of 4 months, comprising 31 (75.6%) males and 10 (24.4%) females. Mean age was  $56.07 \pm 11.98$ SD years. About 19.5% patients were reverse transcription polymerase chain reaction (RT-PCR) positive at the time of the procedure. General anesthesia (GA) was administered 85.4% and monitored anesthesia care (MAC) in 14.6% patients. Central vein access was secured in 16 (41.5%) and arterial cannulation in 17 (41.5%) patients. Intraoperative events were observed in 30 (73.17%) patients. They were difficult airway in 17 (41.5%), bronchospasm in 10 (24.4%), desaturation in 5 (12.2%), electrocardiogram (ECG) changes and arrhythmia in 20 (48.8%) and hypotension in 8 (19.5%) patients. Occurrence of intraoperative complications was highly observed in patients of age >60 years, multiple comorbidities, hyperglycemia (blood sugar >140), moderate to severe COVID, CORAD >10, high inflammatory markers (Ferritin, D-dimer), RT-PCR positive status, pre-operative acidosis, hypokalemia, and extensive disease.

**Conclusion:** CAM are emergency procedures providing insufficient time for pre-operative optimization. Anesthesia technique of choice is GA and MAC in select cases. Thorough preparedness for difficult airway management, invasive monitoring, vasopressors, inotropic, venodilators, and antiarrhythmic drugs is vital. Common intraoperative challenges were unstable hemodynamics, ECG changes (arrhythmia, ischemia etc.), and respiratory complications in COVID lung. High vigilance for prompt management of complications in susceptible patients is crucial to reduce morbidity and mortality.

**Key words:** Anesthesia, Complications, COVID-19 associated mucormycosis, COVID-19, Mucormycosis

## INTRODUCTION

The second wave of COVID-19 pandemic in India was accompanied by a surge in mucormycosis, an opportunistic fungal infection. It has been declared as a notifiable disease in 11 states under the Epidemic Diseases

Act 1897. COVID-19 associated mucormycosis (CAM) is a progressive and invasive rhino-orbito-cerebral disease. The triad of high index of suspicion for early diagnosis, antifungal therapy, and urgent surgical debridement is the cornerstone of optimum management. Even after waning of second wave of COVID, CAM continues to be reported and these patients require prolonged course of treatment and repeated surgical debridement under anesthesia.<sup>[1-4]</sup>

Patients undergoing surgery for CAM present multiple challenges for anesthetic and perioperative management. Being an emergency surgical procedure there

Access this article online



www.ijss-sn.com

Month of Submission : 01-2022  
Month of Peer Review : 01-2022  
Month of Acceptance : 02-2022  
Month of Publishing : 03-2022

**Corresponding Author:** Dr. Neha Devaraj, Department of Anaesthesiology, Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, Maharashtra, India.

is usually inadequate time for sufficient investigations and optimization of the patient preoperatively. These patients pose high risk for perioperative challenges and complications due to variety of causes. Managing the interplay of all these challenges to decrease morbidity and mortality in CAM crucial and insights based on experiences is required. Hence, we conducted a retrospective observational study with primary objective to appraise the anesthetic management and perioperative course of all the CAM patients undergoing anesthesia. The demographic parameters, co-morbidities, intraoperative, and post-operative complications, factors associated with it and outcome of the patient were also studied. The derivatives of the study will aid in anticipation of a variety of challenges and complications, prepare for them and manage them promptly and possibly will help to prepare an evidence based standard perioperative management protocol in these patients.

## METHODOLOGY

It was an observational retrospective study conducted at a tertiary care teaching public institute which was converted to a dedicated COVID hospital and tertiary referral center for mucormycosis. Institute's ethics committee approval (ECARP/2021/114) was obtained. Study period comprised of 4 months, from February 15, 2021, to June 15, 2021. Waiver of consent was obtained owing to the observational nature of the study and retrospective data collection. All the patients who underwent surgical debridement of CAM under anesthesia during the study period were included in the study.

Following data were collected from the medical records: demographics (age, sex), associated co-morbidities, detailed airway assessment and Mallampati classification, biochemical parameters and available investigations, electrocardiogram (ECG), available radiological findings from X-Ray chest, and computed tomography (CT) scan of thorax high-resolution CT (HRCT). COVID-19 reverse-transcriptase-polymerase chain reaction (RT-PCR) status on the day of surgery and history, severity of COVID-19 (mild, moderate, and severe) and treatment details including medications and oxygen, ventilator therapy was recorded. American society of Anaesthesiologist Physical Status (ASA-PS) classification, anesthesia techniques and details of anesthesia management, surgical procedure and duration of surgery were recorded. Vital parameters: Heart rate (HR), systolic and diastolic blood pressure, oxygen saturation (SpO<sub>2</sub>), ECG was noted. Intraoperative investigations such as arterial blood gases (ABG), serum electrolytes (sodium, Na<sup>+</sup>, and potassium, K<sup>+</sup>), and blood sugar (BS) were recorded. Perioperative complications, details of interventions and complication management were noted.

Outcome of the patient in the immediate post-operative period and at the end of 1 week was noted and categorized either as discharge, still undergoing treatment or death and the cause of mortality was recorded.

## Statistical Analysis

Qualitative data were represented in form of frequency and percentage. Quantitative data were represented in form of Mean  $\pm$  Standard Deviation (SD), median and interquartile range. Appropriate statistical software, including but not restricted to MS Excel, and PSPP version 1.0.1, was used for statistical analysis. Graphical representation was done in MS Excel package included in Microsoft Office 365. An alpha value (*P*-value) of  $<0.05$  was used as the cutoff for statistical significance.

## RESULTS

A total of 41 patients were operated for CAM during the study period of 4 months, comprising of 31 (75.6%) males and 10 (24.4%) females. Mean age was (56.07  $\pm$  11.980 SD) years. Demographic and investigational parameters across study population are shown in Table 1. Comorbidities were present in 38 (92.7%) patients as depicted in Figure 1, and 25 (60.97%) had multiple comorbidities. All patients had history of COVID within the previous 6 weeks of presentation and eight (19.51%) were positive at the time of the procedure. Figure 2 mentions the details of COVID infection and treatment received.

According to the ASA PS classification, 15 (36.5%) patients were ASA 2 and 23 (56%) were ASA 3, 4 whereas two patients (4.8%) were designated ASA1

**Table 1: Distribution of demographic and investigational parameters across study population**

Parameters	Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference	
Age	56.07	11.980	1.871	52.29	59.85
CT score	14.39	5.152	0.805	12.76	16.02
HB	10.50	1.537	0.240	10.01	10.98
TLC	9.97	3.586	0.560	8.84	11.11
PLT	202.756	67.0846	10.4768	181.582	223.931
PH	7.32	0.041	0.006	7.31	7.33
FBS	220.76	72.334	11.297	197.92	243.59
Creat	2.050	1.1595	0.1811	1.684	2.416
NA	137.122	4.7392	0.7401	135.626	138.618
K	2.91	0.585	0.091	2.73	3.10
CRP	38.34	27.264	4.256	29.74	46.95
LDH	436.83	142.388	22.237	391.89	481.77
Ferritin	610.85	170.899	26.690	556.90	664.79
Surgery duration	125	39.0013	6.0910	112.690	137.310

CT: Computed tomography, PLT: Platelet, FBS: Fetal bovine serum, CRP: C-reactive protein, LDH: Lactate dehydrogenase

status. General anesthesia (GA) was the most common anesthesia technique used, in 35 (85.4%) patients and 6 (14.6%) patients underwent Monitored Anesthesia Care (MAC). MAC converted to GA in four patients due to surgical requirements. GA was administered using standard balanced anesthesia technique. Induction was done using propofol in (80.9%), etomidate (14.6%), and thiopentone sodium (2.43%). Prepared difficult airway cart was ensured for all cases and fiber optic bronchoscope was kept ready for indicated cases. Anesthesia was maintained with atracurium, sevoflurane, and dexmedetomidine. Volume control and pressure control volume guaranteed (PCV-VG) mode of ventilation with application of positive end expiratory pressure was used in all patient.

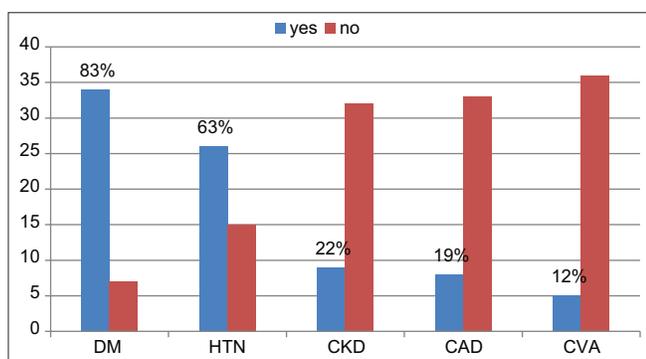


Figure 1: Comorbidities. DM - Diabetes Mellitus, HTN - Hypertension, CKD - Chronic Kidney Disease, CAD - Coronary Artery Disease, CVA - Cerebrovascular accident

Central venous cannulation (CVC) and arterial cannulation were required in 16 (39.02 %) and 17 (41.46%) patients, respectively. Peri-operative course was eventful in 30 (73.17%) patients. Difficult airway was encountered in 18 (43.9%) patients among whom ten had difficult mask ventilation, 13 had difficult laryngoscopy and intubation, and five patients had both. Tracheostomy was done in one patient. Peri-operative events are described in Figure 3. Immediate postoperative intensive care unit (ICU) care was needed in 10 (24.39%) patients for continued hemodynamic and ventilatory support. Five patients (12.2%) came for recurrent surgeries.

We analyzed the risk factors associated with occurrence of perioperative events. The significant factors were presence of more than one comorbidity ( $P = 0.023$ ), moderate to severe COVID 19 ( $P = 0.006$ ), and HRCT score  $>10$  ( $P = 0.006$ ). There was no mortality in the immediate post-operative period. At the end of 1 week from the day of surgery four (9.8%) patients were discharged, 33 (80.5%) were still continuing treatment, and four (9.8%) died due to multiorgan failure in invasive mucormycosis [Figure 4].

## DISCUSSION

A total of 41 patients were operated for CAM, showing male preponderance in the age group of 50–60 years. All the patients had been reported RT-PCR positive within the previous 6 weeks and 19.5% patients were positive at the time of surgery. Most of the patients (92.7%) had

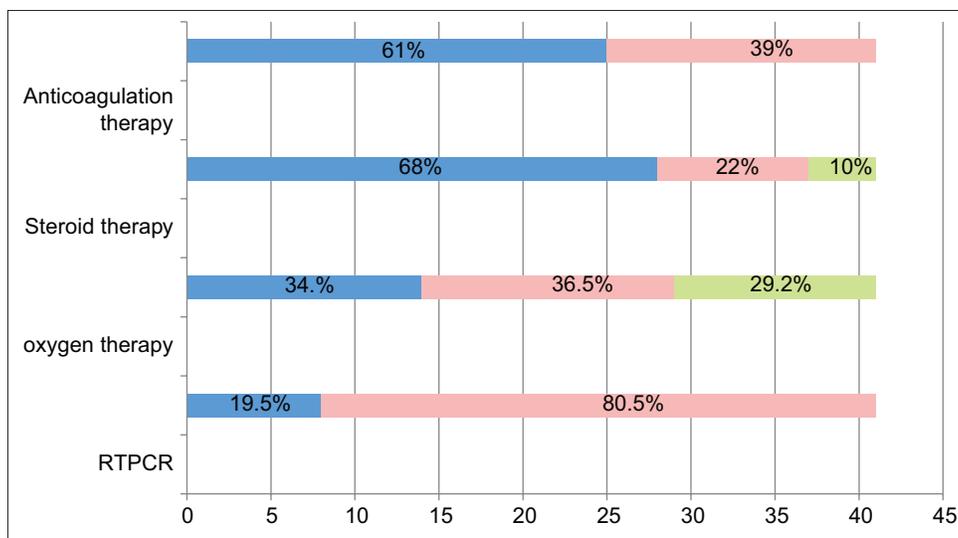
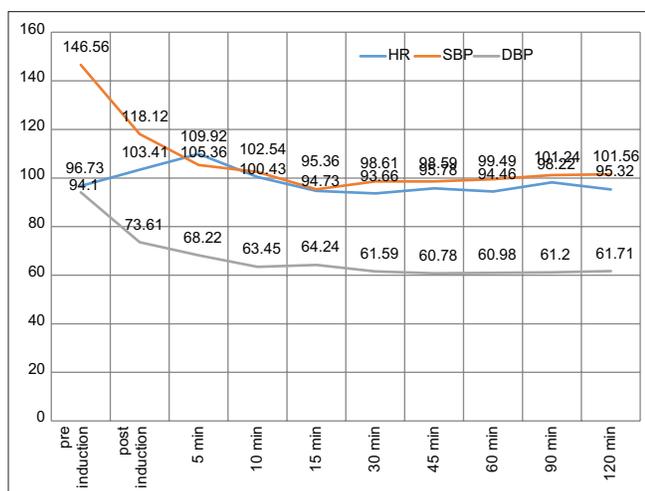


Figure 2: COVID related history  
 Anticoagulation therapy: ■ yes ■ no  
 Steroid therapy: ■ Methylprednisolone ■ Dexamethasone ■ None  
 Oxygen therapy: ■ Non Invasive Ventilation ■ Non rebreathing Mask ■ Nasal Prongs  
 RTPCR: ■ Positive ■ Negative



**Figure 3: Trends of hemodynamic variables. HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure**

uncontrolled comorbidities. Although some comorbidities were pre-existing, many were diagnosed at the time of evaluation for CAM. Use of steroids (Methyl prednisolone or dexamethasone), tocilizumab, oxygen, and raised ferritin were found in most of the patients. Home treated and patients transferred from periphery had not received anticoagulation during COVID. Although we did not study causation of CAM; immunosuppression, hyper-ferritinemia and hyperglycemia in COVID with microthrombi may form favorable conditions for thriving mucor as suggested by Song *et al.*, Rawson *et al.*, and Elinay *et al.*

Invasive mucormycosis has high morbidity and mortality and urgent radical debridement is necessary along with amphotericin therapy. Hence, once diagnosis was made time elapse for preoperative optimization of patients and multi-disciplinary intervention was not advisable and patients were posted as emergency. Most of the patients had uncontrolled hypertension, hyperglycemia, acidosis, and hypokalemia. We observed that the risk stratification by ASA-PS status alone underestimated the perioperative risk as many other factors like active COVID infection and its pulmonary and hematological sequelae, invasive mucormycosis pathology, airway changes, and acute conditions such as hyperglycemia, fever, resting tachycardia, changes in blood gas status, influenced the risk. Hyperglycemia (median BS 215 mg/dl) was the universal finding both preoperative as well as intraoperative period and it was difficult to achieve normoglycemia in spite of insulin infusion. Studies have mentioned that hyperglycemia in COVID is due to pancreatic islet is or stress hyperglycemia and is difficult to optimize. Amphotericin B therapy associated adverse effects such as nephrotoxicity, renal insufficiency, hypokalemia, hypermagnesemia, and metabolic acidemia were observed in most patients. Therefore, perioperative blood sugar, blood gases and electrolytes monitoring

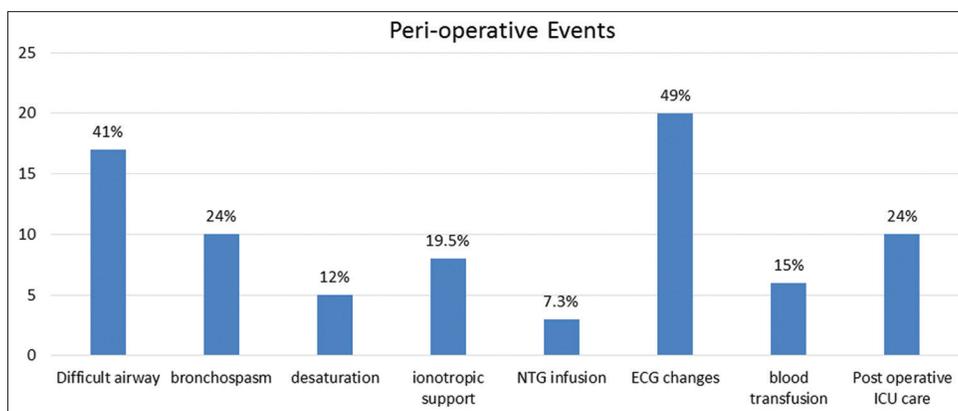
are advised at regular intervals along with titrated insulin therapy and correction of arterial blood pH and dyselectrolytemia.

GA with endotracheal intubation and controlled ventilation with throat packing was the anesthesia technique of choice in 85.4% patients whereas MAC was rendered to 14.6% patients for superficial, small redo debridement and confirmed readiness to convert to GA. MAC was converted to GA in four patients as the disease spread was deeper. Balanced anesthesia with titrated anesthetic doses was used for all patients. Standard monitoring including SpO<sub>2</sub>, NIBP, ECG, urine output for all cases and neuromuscular transmission, gas analysis and airway pressures were additionally monitored for cases under GA.

Difficult airway was found in 18 (43.90%) patients. Challenges during mask ventilation and laryngoscopy were encountered due to facial swelling, extensive invasive mucormycosis involving face, maxilla and teeth, limited mouth opening, obesity, short neck, and restricted neck movements. Four patients had tobacco related oral submucous fibrosis. Video laryngoscope and McCoy blade were used as indicated. Cormack Lehane grade 3 in five and grade 4 in two patients were observed and Bougie guided intubation was needed in seven patients. As nasal intubation is contraindicated in mucormycosis, oral fibre optic intubation, retrograde guide wire guided intubation and tracheostomy was needed in one patient each. Extensive rhino-orbito-cerebral mucormycosis and diabetes mellitus have increased incidence of difficult airway. Hence, preparedness for difficult airway scenario is must and if available a video laryngoscope may be used.

An ultrasonography guided CVC and arterial cannulation was done in 16 (39.02%) and 17 (41.46%) patients respectively for various indications. They were CKD, acute kidney injury (AKI), severe hypovolemia, uncontrolled hypertension, labile hemodynamic status, need for vasopressors, inotropic and bicarbonate therapy, serial ABG sampling, electrolytes monitoring and unavailability of peripheral intravenous access. Difficulty was faced in establishment of peripheral intravenous access in most patients due to prolonged hospital stay and Amphotericin B induced thrombophlebitis.

Several studies have cited respiratory complications in COVID due to reactive airway, increased secretions and active inflammatory process in acute stage and restrictive or obstructive lung disease, pulmonary fibrosis, decreased pulmonary compliance as post-COVID-19 illness pulmonary sequelae. Higher mean airway pressures were observed in most patients (28-38 cm H<sub>2</sub>O). These patients were initially ventilated on volume control mode but due



**Figure 4: Perioperative Events**

to persistently raised airway pressures were changed to PCV-VG mode to maintain a tidal volume of 6 ml/kg. Few patients were observed to have persistently raised EtCO<sub>2</sub> (>35 mm Hg) and decreased tolerance for apnea during laryngoscopy, intubation and endotracheal suction despite supplemental apneic oxygenation. Bronchospasm was seen 21.95% of the study population and desaturation (SpO<sub>2</sub> 90%) was seen in 12%. Perioperative steroids, bronchodilator nebulization, and supplemental apneic oxygenation were used in these patients. Anticipating respiratory complications in COVID lung, use of steroid supplementation, bronchodilator nebulization, supplemental apneic oxygenation and monitoring airway pressures and use of appropriate mode for optimum ventilation for better outcome is recommended. Immediate post-operative ICU care was needed in 10 (24.39%) patients for continued hemodynamic and ventilatory support. Dedicated ICU/HDU for perioperative care of CAM is necessary in the current scenario.

Preoperatively most patients presented with hypertension and tachycardia which persisted in spite of anxiolysis and hydration. Intraoperative labile hemodynamic parameters were observed with hypotension and tachycardia commonly in patients with uncontrolled HT and intra-operative vasopressor support was required in eight (19.5%) patients and was continued in two patients in the post-operative period. Cardiac complications in form of ECG changes were seen in 20 (48.8%) patients. They were ST-T changes seen in three patients, cardiac arrhythmias in 12 patients in form of ventricular premature complexes, atrial premature complexes and atrial fibrillation and hypokalemia induced ECG changes in five patients. Anti-arrhythmic drugs such as lidocaine, amiodarone, diltiazem, and beta-blockers (metoprolol) for rate control were used for respective arrhythmias. Possible causes of perioperative labile hemodynamic parameters, hypotension, and arrhythmias could be pre-existing cardiac diseases, COVID induced myocardial dysfunction, post-COVID and steroid induced

adrenal suppression, multiorgan dysfunction due to sepsis, and amphotericin which have been reported. 2-D Echocardiography could be available only in few patients due to emergency. Blood loss during the surgery was within the acceptable limit ranging from 250 ml to 400ml. Blood transfusion was required in six patients due to pre-existing severe anemia. Furthermore, intraoperative hyperglycemia, acidosis, and hypokalemia were observed in most of the patients and titrated infusions of insulin, bicarbonate and potassium were used when indicated. Hence, it is essential to maintain adequate mean arterial pressure, cardiac output and normovolemia guided by invasive monitoring and timely measurement and correction of BS, blood gas, pH, and electrolyte abnormalities and for better perioperative outcome and prevent postoperative complications.

Occurrence of perioperative events and complications were clinically highly observed in patients of age >60 years, multiple comorbidities, hyperglycemia (BS >140), severe COVID, CORAD >10, high inflammatory markers (Ferritin, C-reactive protein), RT-PCR positive status, preoperative acidosis, hypokalemia and extensive, invasive rhino-orbito-cerebral, and mucormycosis. Although, statistical significance was proved in patients with the presence of more than one co-morbidity, severe COVID 19, and HRCT score >10. All these factors can be used to predict perioperative outcome in CAM and can be used to devise a scoring system in addition to ASA for perioperative risk stratification and predicting occurrence of perioperative events and complications. If complications can be predicted using above factors and score, better preparedness and prompt management will help to reduce perioperative morbidity and mortality. As the current study has limitations due to observational, retrospective and single center study, further randomized controlled studies would help to validate these factors.

Few unique cases presented with multiple challenges deserve mention. Acute febrile illness and highly raised

total leukocyte counts and inflammatory markers at the time of surgery, multiorgan dysfunction with sepsis presented with severe hemodynamic instability. Multiple uncontrolled comorbidities, extensive disease involving orbit, maxilla, and face with severely restricted mouth opening was present in one of the patients and required tracheostomy. A patient with extensive cerebral mucormycosis uncontrolled seizures required extensive surgery and prolonged ICU stay. Pulmonary thromboembolism and intractable atrial fibrillation were observed and required intensive prolonged management for the same. Two patients were renal transplant recipients and one of them was in graft rejection phase with oliguria, deranged renal function tests, dyselectrolytemia and anemia required hemodialysis preoperatively. One patient who had severe COVID pneumonia (CT score 22/25), obstructive sleep apnea, and obesity (body mass index 35 kg/m<sup>2</sup>) required post-operative mechanical ventilation and further prolonged CPAP support. Five out of 41 patients (12.2%) came for recurrent surgeries and each time presented with additional challenges. Teamwork among various specialties to manage this prolonged and recurrent disease is essential to reduce overall morbidity and mortality. There was no mortality in the immediate postoperative period. At the end of one week from the day of surgery four patients (9.8%) died due to multiorgan failure in extensive, invasive mucormycosis. Reported mortality in mucormycosis and CAM varies between 50% and 80% in various studies.

We conclude that CAM present as emergency procedures providing insufficient time for preoperative optimization for uncontrolled hypertension, hyperglycemia, acidosis, hypokalemia, AKI, etc. Anesthesia technique of choice is standard balanced GA or MAC in few select cases. Common intraoperative challenges were difficult airway, unstable hemodynamic status, ECG changes (arrhythmia, ischemia etc.), respiratory complications in COVID lung and metabolic and electrolyte derangements. Invasive monitoring, central venous and arterial cannulation, vasopressors, veno-dilators, anti-arrhythmic and post-operative ICU care may be required and should be promptly available. Patients with presence multiple co-morbidity, severe COVID 19, and HRCT score >10 are at higher risk for perioperative complications. All these factors can be used to predict perioperative outcome and can be used as a scoring system in addition to ASA for perioperative risk stratification. Further large randomized controlled studies would help to validate these factors.

Thus, from the experiences of this study we may recommend high watchful expectancy and preparedness for anticipated and unanticipated adverse events. Comprehensive preparedness for difficult airway management, invasive

monitoring, unstable hemodynamic, ischemia, arrhythmia, and metabolic derangements is vital. High vigilance for respiratory complications in COVID lung and use of apneic oxygenation, steroids, bronchodilator nebulization, monitoring airway pressures and use of appropriate mode for optimum ventilation may help for better outcome. Risk estimation to predict perioperative complications and outcome should be inclusive of ASA-PS, COVID severity and lung involvement, degree of invasion by mucormycosis, multiorgan involvement and acute biochemical and metabolic derangements. Peri-operative dedicated ICU care should be ensured. Anticipation, meticulous preparation and vigilant monitoring for prompt detection and management of complications in susceptible patients is crucial to reduce perioperative morbidity and mortality.<sup>[5-10]</sup>

## CONCLUSION

CAM are emergency procedures providing insufficient time for pre-operative optimization. Anesthesia technique of choice is GA and MAC in select cases. Thorough preparedness for difficult airway management, invasive monitoring, vasopressors, ionotropic, venodilators, and antiarrhythmic drugs is vital. Common intraoperative challenges were unstable hemodynamics, ECG changes (arrhythmia, ischemia etc.), and respiratory complications in COVID lung. High vigilance for prompt management of complications in susceptible patients is crucial to reduce morbidity and mortality.

## ACKNOWLEDGMENT

We would like to acknowledge all the members of Department of Anaesthesia, Medicine, ENT and all allied surgical and medical branches for working as a team to manage this epidemic and pandemic.

## REFERENCES

1. Werthman-Ehrenreich A. Mucormycosis with orbital compartment syndrome in a patient with COVID-19. *Am J Emerg Med* 2021;42:264.e5-8.
2. Chamilos G, Lewis RE, Kontoyiannis DP. Delaying amphotericin B-based frontline therapy significantly increases mortality among patients with hematologic malignancy who have zygomycosis. *Clin Infect Dis* 2008;47:503-9.
3. Hanley B, Naresh KN, Roufousse C, Nicholson AG, Weir J, Cooke GS, *et al.* Histopathological findings and viral tropism in UK patients with severe fatal COVID-19: A post-mortem study. *Lancet Microbe* 2020;1:e245-53.
4. Mitra S, Janweja M, Sengupta A. Post-COVID-19 rhino-orbito-cerebral mucormycosis: A new addition to challenges in pandemic control. *Eur Arch Otorhinolaryngol* 2021;279:1-6.
5. Pippal SK, Kumar D, Ukawat L. Management challenge of rhino-orbito-cerebral mucormycosis in Covid 19 Era: A prospective observational study. *Indian J Otolaryng Head Neck Surg* 2021;23:1-7.

6. Bhardwaj R, Sharma A, Parasher A, Gupta H, Sahu S, Pal S. Rhino-Orbito-Cerebral mucormycosis during the second wave of Covid-19: The Indian scenario. *Indian J Otolaryng Head Neck Surg* 2021;1-6.
7. Diwakar J, Samaddar A, Konar SK, Bhat MD, Manuel E, Veenakumari HB, *et al.* First report of COVID-19-associated rhino-orbito-cerebral mucormycosis in pediatric patients with type 1 diabetes mellitus. *J Mycol Med* 2021;31:101203.
8. Malhotra HS, Gupta P, Mehrotra D, Dandu H, Kohli N, Verma V, *et al.* COVID-19 associated mucormycosis: Staging and management recommendations (Report of a multi-disciplinary expert committee). *J Oral Bio Craniofac Res* 2021;11:569-80.
9. Kumari A, Rao NP, Patnaik U, Malik V, Tevatia MS, Thakur S, *et al.* Management outcomes of mucormycosis in COVID-19 patients: A preliminary report from a tertiary care hospital. *Med J Armed Forces India* 2021;77:S289-95.
10. Bilgic A, Kodjikian L, Sudhalkar A, Dwivedi S, Vasavada V, Shah A, *et al.* Risk factors for COVID-19 associated mucormycosis: The ophthalmologist's perspective. *J Fungi* 2022;8:271.

**How to cite this article:** Harde M, Devaraj N, Zile V, Dighe P. Anesthetic and Peri-operative Challenges of COVID-19 Associated Rhino-Orbito-Cerebral Mucormycosis. *Int J Sci Stud* 2022;9(12):90-96.

**Source of Support:** Nil, **Conflicts of Interest:** None declared.