Indian Journal of Clinical Anaesthesia 2023;10(1):89–97

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Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Case Series

Anaesthetic challenges of coronavirus disease (COVID-19) associated mucormycosis: A case series

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ARTICLE INFO

Article history:
Received 29-11-2022
Accepted 15-12-2022
Available online 09-03-2023

Keywords:
Insulin
Surgical debridement
Amphotericin- b
Personal protective equipment
Diabetes
Steroid
Rhno- orbito-cerebral
Difficult airway
Mucormycosis
COVID- 19

ABSTRACT

Introduction: During the second wave of COVID -19 Indian subcontinent suffered another pandemic of covid associated mucormycosis (CAM) which further burderned the already overexhausted health care infrastructure.

Objective: To share our experience of anaesthetic management of eighteen patients with covid associated mucormycosis who underwent surgical resection of necrotized tissues at a tertiary care hospital of North India.

Material and Methods: Eighteen patients with COVID-19 infection or previous history of COVID-19 infection based on RT-PCR and histopathologically proven rhino orbital mucormycosis, presented for endoscopic and open surgeries during May and June 2021. According to institutional protocol, institutional ethical committee clearance was not required for a case series. Data regarding the demographic details, clinical manifestations, COVID-19 course, laboratory parameters, imaging reports, pre-operative evaluation, airway management, intraoperative and postoperative management, and complications were collected.

Results: Out of eighteen patients 12(66.7%) were male and six (33.33%) were female, with a median age of 51 years. Six patients (33.33%) had a past history of COVID-19, twelve patients had concurrent COVID-19 (66.66%). Most of the patients presented with unilateral facial swelling, retro-orbital pain, ptosis and headache. Fifteen (83.33%) patients had high blood sugars, seven (46.66%) were known type 2 diabetics and eight (53.33%) developed new-onset diabetes after taking prolong systemic corticosteroids. All eighteen patients received antifungal treatment,eight (44.44%)patients had derranged renal function tests with raised serum creatininine (2.4-2.8) and normal blood urea nitrogen. Eight (44.44%) of them had difficult airway because of swelling on face and limited mouth opening, two patients were reoperated (n=2/18). Three (27.27%) patients deveoped arrythmias and ST changes intraoperatively, two(n=2/18) patients were extubated next day after surgery, one patient was tracheostomised in view of preoperative difficult airway and extensive surgery. One fiftyfive year old covid positive female patient died on fifth postoperative day.

Discussion: In our case series, all 18 patients had covid associated rhino-orbital mucormycosis, most of them had diabetes and hypertension, cerebrovascular accident, coronary artery disease, asthma and post KTP status. Twelve patients were covid positive and 6 had recent history of covid. One patient developed hemiparesis and one patient died because of intracranial extension of mucormycosis. Disseminated or cerebral mucormycosis, severe covid, elderly age group, associated comorbidities like uncontrolled diabetes and renal failure have been found to increases mortality in CAM patients.

Conclusion: Physicians caring for covid associated mucormycosis patients must be aware of the severity of the covid-19 as well as mucormycosis, associated comorbidities and various side effects of the medications used for treatment. Early diagnosis and timely medical and surgical management are necessary to improve outcome in covid associated mucormycosis.

https://doi.org/10.18231/j.ijca.2023.016

1. Introduction

An unprecedented surge of invasive mucormycosis was noticed among coronavirus disease (COVID-19) patients.[1–3] It is a diabetes-defining illness as hyperglycemia not only impairs polymorphonuclear function, chemotaxis, and altered intracellular killing by elevating the expression of GRP78 in endothelium but also increases free serum iron, an essential element for the mucormycosis growth. Mucormycosis primarily manifest as rhino-orbital-cerebral or pulmonary, with high morbidity and mortality.[4] In the absence of definitive treatment for the current COVID-19 pandemic, systemic corticosteroids have been widely used worldwide for modulating the inflammatory lung injury and preventing respiratory failure.[5] Secondary bacterial and fungal infections due to steroid-induced impairment of the neutrophil functioning, and hyperglycemia is a serious concern.[6] India being the diabetic capital of the world with approximately 47% population indifferent to glycemic status bears 40% of the global mucor mycosis burden.[7]

The mainstay management of COVID-19 associated mucormycosis (CAM) is surgical debridement under general anesthesia through either functional endoscopic sinus procedures or orbital exenteration, maxillectomy, palatal debridement, etc. depending upon severity along with intravenous amphotericin B (AmB). Along with the multi-organ impact of COVID-19, hyperglycemia, systemic effects of AmB and often the distorted anatomy of airway caused by mucormycosis poses unique challenges for the anaesthetist.[8] However, literature regarding anaesthetic concerns for CAM is sparse. We are sharing our experience and challenges of providing anaesthesia in a case series of eighteen patients of CAM who underwent surgery for rhinorbital mucormycosis, at a tertiary care center of north India.

2. Materials and Methods

Eighteen patients with COVID-19 infection or previous history of COVID-19 infection based on RT-PCR and histopathologically proven rhino orbital mucormycosis, presented for endoscopic and open surgeries during May and June 2021. According to institutional protocol, institutional ethical committee clearance was not required for a case series. Data regarding the demographic details, clinical manifestations, COVID-19 status, comorbidities, medical and surgical management were noted.

Laboratory parameters, imaging reports, pre-operative evaluation, airway management, intraoperative and postoperative management, and complications were noted. Our hospital established a dedicated ward for covid negative mucormycosis patients with facility for monitoring,oxygen and ventilation.

All health care personnel followed covid protocol and donned level 3 personnel protective equipment (PPE) kit during surgery of covid positive patients. COVID-19 positive patients were shifted via a dedicated lift and from a separate corridor to the covid operation theatre (OT). COVID positive patients were operated in a dedicated negative pressure COVID OT and shifted to COVID positive intensive care unit (ICU) or ward according to the postoperative course.

Apart from other routine OTs, a dedicated OT was kept for covid negative mucormycosis patients. In covid positive patients, preoperative evaluation was done by anaesthesiologist posted in covid positive ward. The anaesthesia informed consent was signed by the patient or relative before surgery.

Routine monitoring (electrocardiograph, and pulse oximetry, continuous non-invasive blood pressure) was performed after the patient entered the OT. Intravenous (IV) cannula was already in situ in most of the patients. Preoxygenation was done for 3 minutes with 100% oxygen. Intravenous induction was done with propofol, fentanyl and atracurium. Succinylcholine was used in patients with suspected difficult airway. Maintenance of anaesthesia was done with mixture of oxygen, air and isoflurane. Oral endotracheal intubation was done in all patients and tube was fixed to right or left angle of mouth according to surgical requirement. Throat packing was done in all patients, which was removed at the end of surgery. Peak airway pressure and end tidal carbon di oxide (etCO2) monitored after intubation. Blood sugar monitoring was done every hourly in diabetic patients. Perioperative nephrotoxic drugs were avoided in all patients and pain management was done with morphine, fentanyl and intravenous paracetamol. Crystalloids and blood was used, colloids were avoided. At the end of the surgery, neuromuscular blockade was reversed with intravenous neostigmine and glycopyrrolate.

2.1. Statistical analysis

The data was managed in the MS Excel spreadsheet. The quantitative variable was reported as Mean (SD) and the categorical by frequency (%). The boxplot (Figure 1) was drawn for the laboratory based investigation, depicting the median (midline) of the plot, the first quartile and second quartile respectively the bottom and top of the box.

3. Results

The characteristics and perioperative course of the studied participants is illustrated by Table 1.

Out of eighteen patients 12(66.7%) were male and six(33.33%) were female with a median age of 51 years. Six patients (33.33%) had a recent history of COVID-19,

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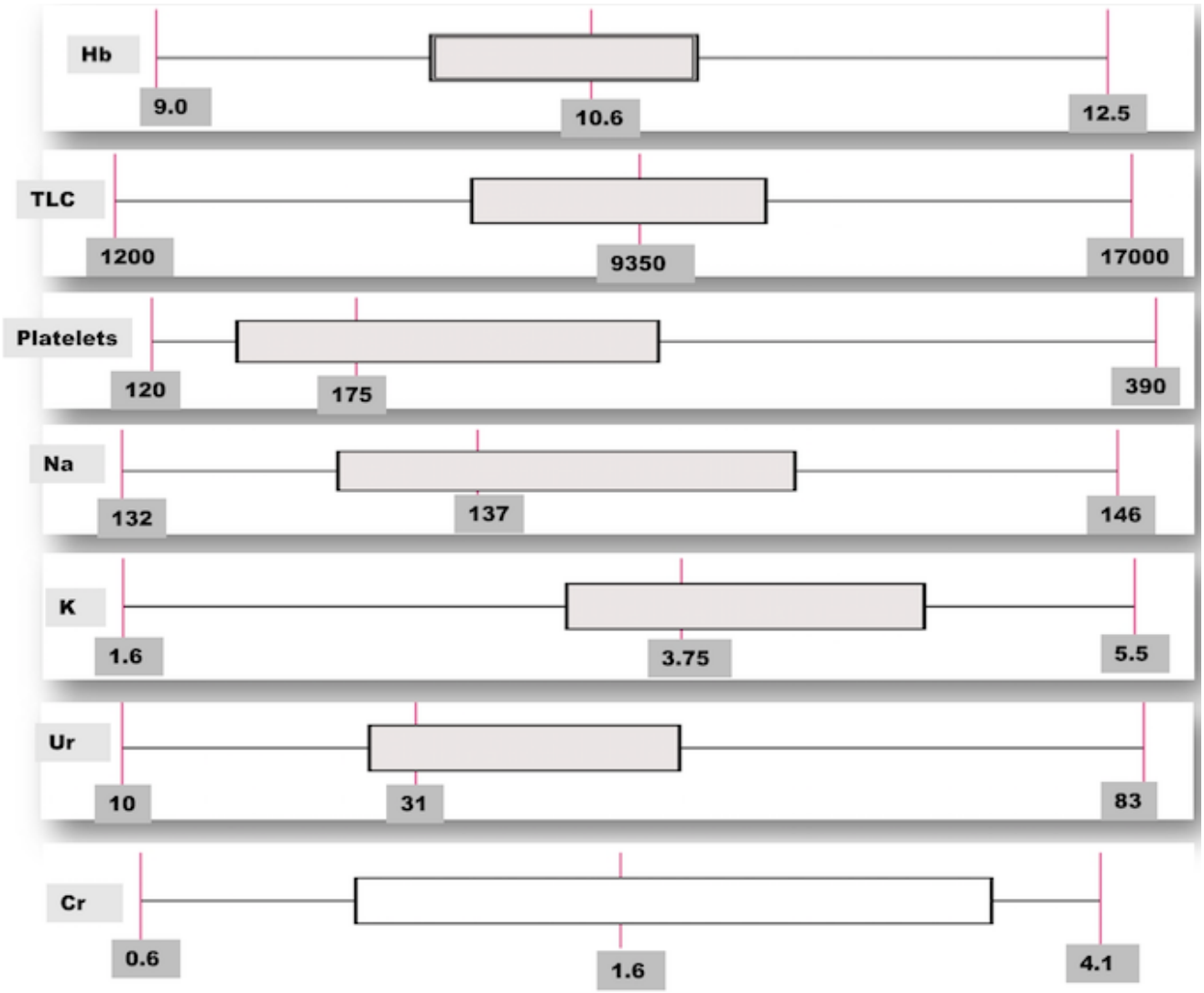

Fig. 1:

twelve patients had concurrent COVID-19 (66.66%). One patient developed symptoms of mucormycosis first and after nine days presented to our hospital and was found covid positive, surgery was done next day. All covid negative cases presented for surgery developed mucormycosis when they were covid positive except one who developed symptoms of mucor after 10 days of recovery from covid. One of the patients become positive again within period of 10 days but mucor surgery was done when finally declared covid negative.

Most of the patients presented with unilateral facial swelling, retro-orbital pain, ptosis and headache. The most common clinical presentation was diminution of vision and ophthalmoplegia. The most common imaging findings were orbital cellulitis and pansinusitis (Figure 2). Diabetes was most common comorbidity. Fifteen (83.33%) patients had high blood sugars, seven(46.66%) were known type 2 diabetics and eight (53.33%) developed new-onset diabetes after taking prolong systemic coricosteroids during long term ICU stay as a post covid sequelae. Three patients with diabetes were on insulin, rest of them were on oral hypoglycemic agents.

Eight(44.44%) patients had hypertension along with diabetes, one (n=1/8) of them was post kidney transplant (KTP), one(n=1/8) had hypertension with diabetes and cerebrovascular disease (CVD) with left hemiparesis. One patient (n=1/8) had diabetes on irregular treatment with triple vessel coronary artery disease and hypoglossal nerve palsy. One (n=1/8) had diabetes, hypertension and asthma.

Steroids were used in thirteen patients (72.22%), six patients received it for 5-7 days, six patients received it for 15-31 days, post KTP patient was on steroids for 13 years. Perioperative steroid was supplemented in five patients in view of the long term use of steroids for more than 3 weeks.

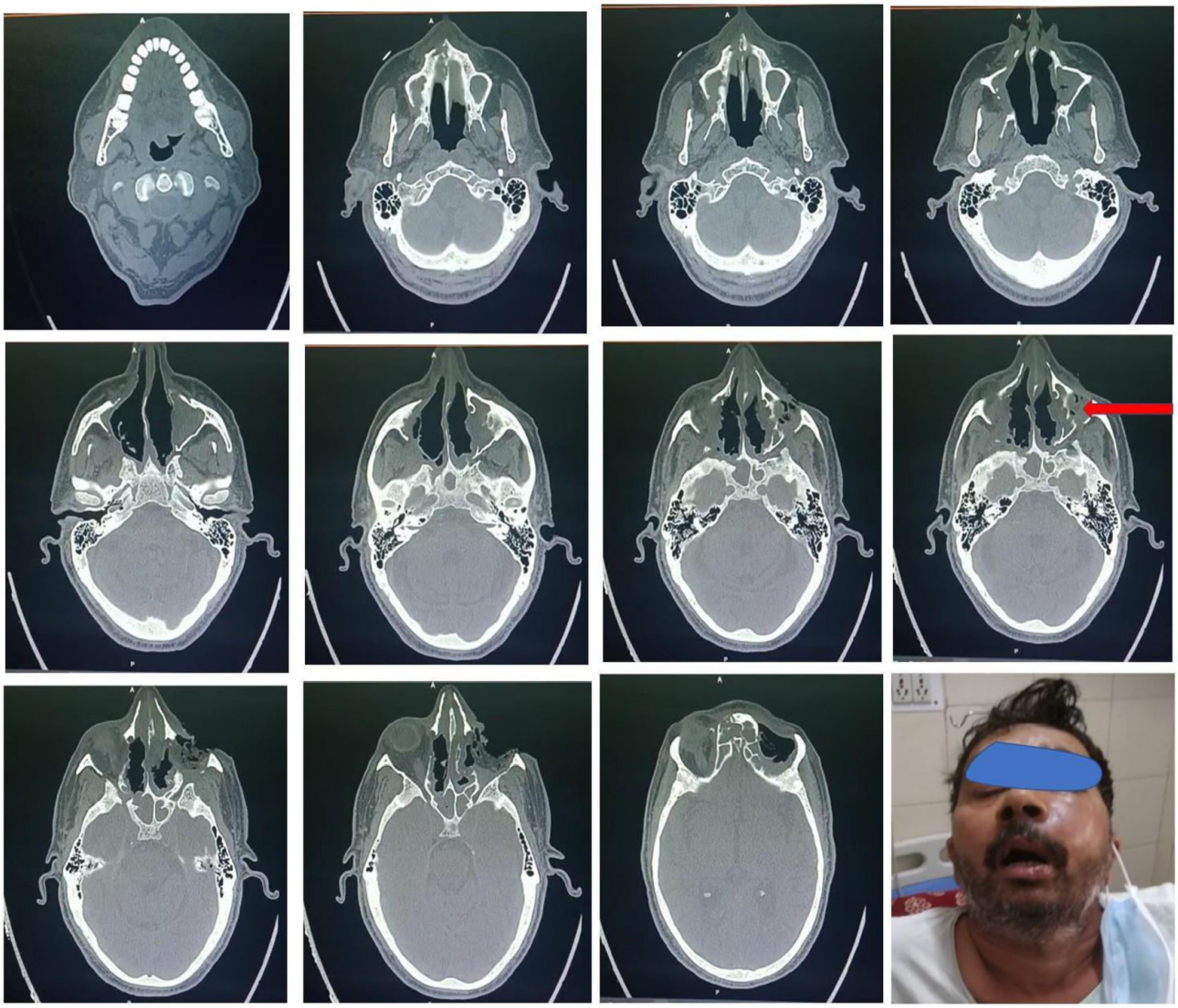

Fig. 2: NCCT head, red arrow indicating affected maxillary sinus & clinical appearance of one of the follow up COVID-19 patients, affected with mucormycosis

Seven(38.88%) patients required oxygen and only one (n=1/7) of the patient was on oxygen before surgery. Eleven (61.11%) patients were on room air and did not require oxygen.

At the time of surgery, and their saturation on room air ranged from 93-98% and breath holding time (BHT) 15-25 seconds. Four patients had chest x-ray changes, first with left lower lobe consolidation, second had bilateral ground glass opacities and chest CT score 12/25, third had bilateral middle and upper zone opacities chest CT score 20/25, fourth with bilateral ground glass opacities and chest CT score 15/25. Before covid, all patients had good effort tolerance more than 4 METS except one patient.

All eighteen patients received antifungal treatment, six patients received liposomal amphotericin B and one(n=1/6) of them had severe anaphylactic reaction to amphotericin B which was managed by stoppping the drug immediately, intravenous fluids and hydrocortisone, eleven patients received liposomal amphotericin B and posaconazole both, out of this one (1/11) patient also received intraorbital amphotericin along with liposomal intravenous amphotericin B and posaconazole, one post KTP patient received only posaconazole.

Eight (44.44%) patients had derranged renal function tests with raised serum creatininine (2.4-2.8) and normal blood urea nitrogen.

Eight (44.44%) of them had difficult airway because of swelling on face and limited mouth opening, succinylcholine was used in five patients and avoided in two patients with hyperkalemia. Videolaryngoscope was

Table 1: Characteristics of the studied participants (n=18)

Parameters	Categories	Statistic!
Age		46(13) 51 (35,53)
Past COVID History	Yes	12 (66.7)
	No	6 (33.3)
Treatment	Home	5 (27.8)
	Shifted to hospital after initial home treatment	2 (11.1)
	Outside Hospital then shifted to AIIMS	5 (27.8)
	AIIMS, Delhi	6 (33.3)
Average duration from COVID (+) to Mucormycosis symptoms*	Patients with concurrent COVID	15
	Patients with Past History of COVID	22
Average duration from COVID (+) to Mucormycosis symptoms to day of surgery*	Patients with Concurrent COVID	13
	Patients with Past History of COVID	21
Comorbidities	Absent	3 (16.7)
	Diabetes Mellitus	15 (83.3)
	Type 2^	7 (46.7)
	Steroid Induced^	8 (53.3)
	Hypertension with Diabetes^	8 (53.3)
Oxygen Therapy	Room Air	11 (61.1)
	Nasal prongs	3 (16.7)
	Volume	4 (22.2)
Antifungal Treatment	Liposomal Amphotericin B(LampB)	6 (33.3)
	LampB+Posaconazole	11 (61.1)
	Posaconazole	1 (5.6)
Deranged Renal function	Yes	8 (44.4)
	No	10 (55.6)
Deranged Electrolytes	No	13 (72.2)
	Hypokalemia$	3 (60.0)
	Hyperkalemia$	2 (40.0)
Difficult Airway	No	10 (55.6)
	Yes	8 (44.4)
	Use of videolaryngoscope#	6 (75.0)
	Use of bougie#	2 (25.0)
Use of Succinylcholine	No	13 (72.2)
	Yes	5 (27.8)

! Mean (SD, Median (Interquartile Range) for continuous variable, and n(%) for categorical variables, *days, ^denominator-15, $denominator-5, #demoninator-8

used in 6 patients, bougie was used in two patients in view of cormack lehan grade 3b,and four patients were intubated in second attempt Endoscopic surgery was done in fourteen patients, four patients underwent open surgery (Table 2).

Table 3 illustrates perioperative complications. Two patients were reoperated (n=2/18). One male patient underwent surgery three times at interval of 15 days bilateral endoscopic denker's debridement, orbital exentation and revision endoscopic debridement. He became hemiplegic on 3rd day after lastsurgery because of mucormycosis, contrast enhanced CT finding revealed hypodensity in post limb of internal capsule and acute ischaemic infarct. He was sent home with nasogastric tube for feeding, ecospirin 75mg, and atorvastatin 80 mg.

Three (3/18) patients deveoped arrythmias and ST changes intraoperatively. One patient developed significant ST depression and bigemini, second patient developed multiple ectopics both were succesfully treated with intravenous (IV) lignocaine. Third patient developed significant tachycardia and ST depression and treated with dexmedetomidine infusion.

Blood loss ranged from 100-800 ml, three (3/18)patients required blood transfusion, two had preoperative anaemia with haemoglobin 7.9 and other had 800 ml blood loss. Invasive blood pressure monitoring was done in three patients with radial artery canulation.

Two(2/18) patients had metabolic acidosis intraoperatively which was corrected with sodiumbicarbonate, one had high blood sugar and decreased potassium levels required insulin and potassium intraoperatively.

Three (3/18) patients deveoped arrythmias and ST changes intraoperatively which was repaired during surgery and antimeningitis prophylaxis given..

Two(n=2/18) patients were extubated next day after surgery, one 75 year old female patient with diabetes, hypertension, old cerebro vascular accident (CVA)with left side residual hemiparesis and preoperative CT score of 20/25 underwent endoscopic debridement of right sinonasal cavity. Second patient was fiftyfive year old male, operated first time for right suprastructural maxillectomy and right orbital exentration bleed on sixth day reoperated and kept on ventilator overnight.

One(1/180 patient was tracheostomised in view of preoperative difficult airway and extensive surgery which involved maxillectomy, debridement and right side hard palate removal, neuromuscular blockade reversed, and he was successfully decanulated within a week.

Time of awakening after stopping of inhalational agents ranged from (5-15 minutes). All patients shifted on oxygen, one patient shifted to recovery on room air but desaturated as soon as he arrived in recovery and oxygen was immediately applied with face mask and saturation improved gradually.

One(1/18) fiftyfive year old covid positive female patient died on fifth postoperative day. She wasadmitted after ten days of onset of mucormycosis, had recent onset diabetes and a known hypertensive well controlled on medication. MRI was done from outside before admission to our hospital and it revealed maxillary,ethmoid,frontal sphenoid sinus with intraorbital extension. Next day she underwent right side endoscopic debridement and orbital exentration. Her intraoperative course remained uneventful extubated safely but became drowsy on postoperative day(POD)one. MRI revealed infarct in right middle cerebral artery and on POD 2 her GCS became 3, she was intubated and repeat MRI showed intracranial extension of mucormycosis, developed acute kidney injury, shock, external ventricular drain inserted under local anaesthesia, decompressive craniotomy planned but could not be done because of massive brain bulge after craniotomy.

Table 2: Types of surgeries

Type of surgeries	Number of patients (n=18)	Percentage
Endoscopic Sinus Debridement(ESD)	14	77.77
Open Surgeries		
Bilateral ethmoidotomy, Maxillary debridement, Orbital floor exploration	4	22.22
Open debridement of maxillary sinus		
Maxillectomy Right side hard palate removal		
Right suprastructural maxillectomy+ right orbital exentration		

Table 3: Perioperative complications

Perioperative Complications	Number of Patients (n=18)
Reoperated	2
Arrythmias and ST changes	3
Required Blood Transfusion	3
Metabolic acidosis	2
Hyperglycemia with hypokalemia	1
Developed CSF leak	1
Extubated next day of surgery	2
Tracheostomised	1
Death	1

4. Discussion

The entire world is facing the wrath of COVID-19 pandemic since December 2019. Situation became really worsened especially in Indian subcontinent during second wave of COVID-19 when covid associated mucormycosis emerged as an epidemic with 14,872 cases by 28 May 2021.[9] Severity of COVID-19 infection was much higher in the second wave and 45% of the world cases were from India with a mortality of 34%. Mucormycosis is associated with high mortality rate of around 46% with a significant case fatality rate of 68% in disseminated mucormycosis and 31% in those with cutaneous disease.[10]

Mucormycosis is a rapidly progressive opportunistic fungal infection, causes angioinvasion leading to vessel thrombosis and tissue necrosis, penetrate through endothelial cells lining of blood vessels and ultimately causes hematogenous dissemination from the original site of infection to other target organ. CAM is difficult to treat in view of evolving knowledge of COVID-19, its multiorgan effects and different presentations with each new wave along with highly lethal mucormycosis. Fungal infection can occur while patient is having covid infection or few weeks or months after patient has become covid negative. Treatment of CAM requires care of covid and mucor related multiorgan effects as well as intravenous antifungal thearpy, surgical excision and debridement of fungus invaded area.

Anaesthesiologists are frequently involved in care of covid patients at various levels inside ICUs, covid wards and operation theatres. Covid positive patient may be asymptomatic or may have a moderate to severe covid disease at the time of diagnosis of CAM. Surgery for CAM is an urgent surgery due to its angioinvasive nature and delay in surgery will increase morbidity and mortality.

Preoperative evaluation should take into account the multiorgan effects of COVID-19, angioinvasive and destructive effects of mucormycosis, commonly associated comorbidities like diabetes, treatment and medications i.e. steroids, immunomodulator drugs, antifungal drugs and side effects of these drugs.

COVID-19 virus binds angiotensin converting enzyme 2 (ACE 2 receptors) present in vascular endothelial cells, lungs, heart, brain, kidneys, liver, intestine, pharynx and other tissues. Respiratory system is most commonly affected, renal failure, myocardial ischaemia, stroke, perforation peritonitis, deep vein thrombosis, diabetes are the known effects of COVID-19. Cytokines released by white blood cells in some patients may be in an uncontrolled manner leading to cytokine storm which may further cause multiorgan injury and systemic inflammatory response. Fever and inflammation cause hypercoagulability and impaired fibrinolysis.

Pulmonary effects of COVID-19 includes diffuse alveolar damage, pneumonia, alveolar and interstitial edema which after hyalinization and fibrosis develop into irreversible stage of acute respiratory distress syndrome (ARDS).[11] In our case series, four patients had chest x ray changes at the time of surgery and no patient was on oxygen therapy (room air SpO2 96-98%) and BHT was 15-

25 seconds. Seventy one year old COVID positive female patient with CT score 20/25 had poor respiratory efforts after surgery and shifted to ICU for mechanical ventilation. Her trachea was extubated a day after surgery.

Baseline oxygen saturation, need for supplemental oxygen, various routes, doses and delivery methods should be assessed before taking up the patient for surgery. COVID-19 positive patient those who are on room air or minimal oxygen support, BHT and other bedside PFTs may be done to plan postoperative course and need for mechanical ventilation. Patients with recent history of covid pulmonary function tests may be done in PFT labs as few studies have suggested deranged PFTs and restrictive lung disease in the post covid patients.

These patients should be shifted on oxygen from OT to recovery room or ward as one of our covidnegative patient desaturated while shifting. Various studies have shown high incidence of postoperative pulmonary complications and worsening of covid after surgery especially after general anaesthesia.[12,13] Postoperatively these patients must be observed on monitored beds with provision of oxygen as there covid status may worsen.

We faced intubation difficulties in six patients and used videolaryngoscopes, bougie and succinylcholine, two patients had hyperkalemia, succinylcholine was avoided in these patients. In view of preoperative difficult airway and extensive surgery, one patient was tracheostomised at the end of surgery. Airway management may be difficult in these patients as covid causes airway edema and laryngeal edema and rhinoorbital mucormycosis causes swelling in eye, facial edema, palatal perforation, painful mouth opening, epiglottitis, supraglottitis associated with fungal debris.[14] All these factors predispose to difficult airway situation with difficult mask ventilation, difficult supraglottic airway insertion and difficult intubation. Succinylcholine should be used cautiously as these patients may have hyperkalemia due to deranged renal functions or covid associated critical illness myopathy. Tracheostomy may be required preoperatively in view of difficult airway or postoperatively due to extensive surgery.[15]

In some patients with palatal perforation, a removable prosthesis is used to cover it, this may cause airway obstruction, inability to pass endotracheal tube due to dislodgement of prosthesis, and limitation of the space for a laryngoscope causing traumatic intubation. It is advisable to remove this prosthesis before intubation and cover it with a gauge before intubation.[16]

In our case series, 46.66% were known diabetics and 53.33% developed newly onset diabetes as a post covid sequelae. Perioperative sugars were controlled with insulin in three patients, two patients had metabolic acidosis intraoperatively which was corrected, one patient required intraoperative insulin and potassium infusion.

Pathophysiology of CAM is complex and knitted around diabetes, as diabetic patients are more prone for severe COVID-19 infection, COVID-19 per se worsens hyperglycemia, causes metabolic derangements and mucormycosis has strong association with diabetes.

Furthermore results of recovery trial lead to unscruplous use of steroid in COVID-19 patientswhich precipitates hyperglycemia. Risk of metabolic derrangements because of hyperglycaemia is much higher in patients with COVID-19 as these patients develop ketoacidosis even with type 2 diabetes mellitus (T2DM).[17] In a systematic review 77% of COVID-19 positive patients with T2 DM develop ketoacidosis.[18]

Intraoperatively blood sugars must be monitored hourly and corrected if required as it may further cause metabolic derangements. Apart from controlling blood sugars, usage of insulin in COVID-19 reduces IL-6 and D-dimer levels and improve severity in patients with or without diabetes mellitus.[17] Insulin causes intracellular movement of potassium and use of amphotericin B in these patients may aggravate hypokalemia, serum potassium measurements should be considered perioperatively and supplemented if required.

For medical treatment of mucormycosis, AmB is the primary thearpy and posaconazole is used as a combination therapy.[19] AmB causes nephrotoxicity, hypokalemia, hypomagnesemia, fever, anaphylaxis, shivering, dyspnea and hypotension.[14] Liposomal AmB has lesser side effects, we used liposomal AmB alone in 6 patients; 11 patients received posaconazole along with AmB and post KTP patient received only posaconazole. Three of our patients had derranged renal function tests and one patient develpoed severe anaphylactic reaction to AmB which was managed successfully.

Patients with CAM frequently have renal dysfunction. Incidence of acute kidney injury(AKI) is quite high in critically ill COVID-19 patients, various factors like history of chronic kidney disease, tissue hypoxia, hypotension, hypovolemia and nephrotoxic drugs (vancomycin, aminoglycosides, colistin) or antivirals (remdesivir, ritonavir)) are potentially associated with it. AKI is associated with high rate of mortality in covid positive patients and kidney function did not recover in one third of the patients.[20] AmB and preexisting diabetes related renal injury further put these patients at a very high risk of perioperative renal failure and some of these patients require dialysis.

Perioperatively maintain adequate intravascular volume, blood or crystalloids should be used colloids must be avoided as it impairs renal dysfunction and causes coagulation disturbances. Atracurium or cisatracurium are preferred as they are not excreted by kidneys. NSAIDSs and nephrotoxic drugs must be avoided and in long surgeries hourly urine output must be measured.

Three of our patients developed arrythmias and ST changes intraoperatively which were managed successfully. COVID-19 patients are at risk of developing, myocarditis, myocardial injury, elevated cardiac enzymes, various arrythmias, ventricular tachycardia, ventricular fibrililation and even sudden cardiac arrest.[21] Cardiac injury may be due to hypoxia, worsening of coronary perfusion, microthrombi, direct tissue damage, hyperacute systemic inflammatory response syndrome and medications for COVID-19. Interaction of SARS-CoV-2 with the renin-angiotensin-aldosterone system can cause hypokalemia and increases vulnerability to arrhythmias.

Most of our patients (81.8%) received steroids mostly methylprednisolone and 44% of them received perioperative steroids. Steroids was supplemented in some patients as these patients may have suppressed hypothalamic pituitary axis after tapering of steroids and may have haemodynamic instability.

In our case series, all 18 patients had covid associated rhinoorbital mucormycosis, most of them had diabetes and hypertension, had history of steroid use, age of the patients ranged from (25 -71) years with CVA, CAD, and asthma and post KTP status. Twelve patients were covid positive and 6 had recent history of covid. One patient developed hemiparesis and one patient died because of intracranial extension of mucormycosis. Disseminated or cerebral mucormycosis, severe covid, elderly age group, associated comorbidities like uncontrolled diabetes and renal failure have been found to increases mortality in CAM patients.[22,23]

The favorable outcome in the current case series was probably because of the better glycemic control in- hospital, timely initiation of liposomal amphotericin B and surgical intervention as an adjunct to antifungal therapy and a good and meticulous perioperative care as well as a strong administrative will power to provide resources for the rapidly changing scenarios in COVID-19 pandemic.

5. Limitations

Our case series is single center, retrospective case series with a small sample size and is based on the analysis of anesthesia and hospital records.

6. Conclusions

Anaesthetic management must take into consideration difficult airway which becomes more difficult in PPE kit, the urgency or the semi emergency nature of the procedure, optimization of the associated comorbidities due to COVID-19 and mucormycosis in the limited time period, side effects of antifungal drugs, steroids and immune modulator drugs, perioperative steroid supplementation, post-operative ventilation, oxygen therapy and monitoring due to the risk of comorbidities and high probability of worsening of COVID-19 after surgery.

A good communication with the surgeon is also very important to know the extent of surgery so that intraoperative monitoring and postoperative care can be planned appropriately.

In summary, physicians caring for critically ill COVID-19 patients must be aware of the course of the disease, various comorbidities and side effects of the medications. Early diagnosis and timely medical and surgical management are necessary to improve outcome in covid associated mucormycosis.

7. Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue.

8. Conflicts of Interest

In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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Cite this article: Lalwani P, Sinha R, Sarkar S, Subramaniam R, Mishra AK. Anaesthetic challenges of coronavirus disease (COVID-19) associated mucormycosis: A case series. *Indian J Clin Anaesth* 2023;10(1):89-97.