



Best Practice Guidelines for the Management of Acute Craniomaxillofacial Trauma During the COVID-19 Pandemic

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Abstract: Coronavirus disease 2019 (COVID-19) is an infectious disease that is caused by severe respiratory syndrome coronavirus 2. Although elective surgical procedures are being cancelled in many parts of the world during the COVID-19 pandemic, acute craniomaxillofacial (CMF) trauma will continue to occur and will need to be appropriately managed. Surgical procedures involving the nasal, oral, or pharyngeal mucosa carry a high risk of transmission due to aerosolization of the virus which is known to be in high concentration in these areas. Intraoperative exposure to high viral loads through aerosolization carries a very high risk of transmission, and the severity of the disease contracted in this manner is worse than that transmitted through regular community transmission. This places surgeons operating in the CMF region at particularly high risk during the pandemic. There is currently a paucity of information to delineate the best practice for the management of acute CMF trauma during the COVID-19 pandemic. In particular, a clear protocol describing optimal screening, timing of intervention and choice of personal protective equipment, is needed. The authors have proposed an algorithm for management of CMF trauma during the COVID-19 pandemic to ensure that urgent and emergent CMF injuries are addressed appropriately while optimizing the safety of surgeons and other healthcare providers. The algorithm is based on available evidence at the time of writing. As the COVID-19 pandemic continues to evolve and more evidence and better testing becomes available, the algorithm should be modified accordingly.

Key Words: Coronavirus, coronavirus disease 2019, craniofacial, maxillofacial, pandemic, trauma

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Human coronaviruses have been previously known to be mild pathogens, causing the common cold. In the 21st century,

however, 2 highly pathogenic human coronaviruses have emerged from animal reservoirs: severe acute respiratory syndrome coronavirus (SARS-CoV) and middle-east respiratory syndrome coronavirus.¹ Following reports of a cluster of pneumonia patients in Wuhan, China in December, 2019, coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 was ultimately determined to be the cause.² Since then it has become a global pandemic that continues to impact the provision of healthcare internationally. The World Health Organization (WHO) has estimated that over 2 million people have been infected by the virus resulting in greater than 125,000 deaths.³ The calculated fatality rate of the disease has been reported from 1% to 7% and ranges from 0.2% to 15% according to age groups.⁴ In addition, 3.8% of infected patients occur in healthcare providers as a result of direct exposure in the work environment.⁵

Despite all efforts, there continues to be an exponential increase in the number of patients reported internationally. Countries such as Italy, Spain, and the United States have become epicenters for COVID-19 with an unprecedented strain on healthcare systems. Flattening the curve through means such as social distancing have been proposed to limit the impact on healthcare systems by slowing the spread of COVID-19 across space and time.⁶ Some regions have gone as far as a complete lockdown to attempt to curb the spread of the virus.⁷

The COVID-19 is extremely contagious. The virus has been shown to be transmitted through aerosol/aerated solids or fluid from human secretions or discharges, as well as droplets from normal breathing, coughing, sneezing, and surface contact infected by symptomatic or asymptomatic carriers. During the Centers for Disease Control and Prevention investigation of the Diamond Princess cruise ship outbreak, 46.5% of infected individuals were asymptomatic at the time of testing, and 17.9% of those infected never developed symptoms.^{8–10} Furthermore, pediatric literature has shown that this disease may be asymptomatic in about 15% to 25% of children.^{11,12} Therefore, there is ample evidence that exposure of healthcare providers to asymptomatic patients is a real and imminent risk.

Surgical procedures involving the nasal, oral, or pharyngeal mucosa carry a high risk of transmission due to aerosolization of the virus which is known to be in high concentration in these areas when compared to the lower respiratory tract.¹³ Studies have shown that viral loads in the nasopharynx are over 1000 times higher for COVID-19 compared to SARS (SARS-CoV).¹⁴ Further it appears that if viral particles become aerosolized, they can stay in the air for over 3 hours.¹⁵ Experimental studies have consistently demonstrated that oral maxillofacial procedures generate significant amounts of aerosolized microbes, detected on surfaces up to 4 m away from the operator.^{16,17} This places healthcare providers in the operating room for craniomaxillofacial (CMF) trauma procedures at particularly high risk for contracting the disease, as they involve

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aerosol generating medical procedures (AGMP). Assuming up to 1 in 4 of those infected with COVID-19 are asymptomatic and the prevalence of COVID-19 in the population continues to rise, the potential risk of exposure to asymptomatic carriers presenting with CMF trauma will become an even greater concern.⁸ Moreover, healthcare providers infected during surgical procedures for CMF trauma, will experience much worse disease as compared to disease acquired through regular community transmission. This is speculated to be due to the high viral load generated during these highly aerosolizing procedures leading to aggravated cytokine release and more severe clinical manifestations.^{11,13}

Multiple professional bodies have advocated for healthcare providers working in high risk environments such as CMF trauma to wear a minimum of N95 masks even if the patient is asymptomatic or negative for COVID-19.¹⁸ If the patient is symptomatic or positive for COVID-19, then powered air-purifying respirators (PAPR) are recommended to halt potential transmission to medical personnel if surgery must proceed. So far there has been a significant mortality of otolaryngologists and ophthalmologists in the Wuhan region, thought to be related to exposure to aerosolized virus from the nasal and oral airway mucosa from high risk procedures such as CMF trauma and sinus operations and in some patients despite the use of N95 masks.^{19,20}

Given that the majority of CMF trauma procedures involve violation of the mucosa of the oral cavity and sinuses, these patients place the surgeons and the remainder of the operating room staff at high risk of exposure during the COVID-19 pandemic. All elective surgical procedures should be cancelled during the pandemic for a number of reasons. This includes preservation of resources (both healthcare personnel and personal protective equipment [PPE]) in addition to potential risk of COVID-19 transmission. However, unless a complete lockdown occurs, acute CMF trauma will continue to occur and will need to be appropriately managed. There is currently a paucity of information to delineate the best practice for the management of acute CMF trauma during the COVID-19 pandemic. In particular, a clear protocol describing optimal screening, timing of intervention, and choice of PPE, is needed.

The aim of this study is to develop a standardized operating procedure and algorithm to guide the management of acute CMF trauma during the COVID-19 pandemic.

METHODS

This is a scoping review of the literature and available guidelines published in regard to management of head and neck and CMF conditions during the COVID-19 pandemic. Furthermore, this review also reflects on international guidelines published by professional organizations such as the United Kingdom National Health Service,²¹ AO international task force for maxillofacial guidelines during COVID-19,¹⁹ British Society for Maxillofacial Surgery²² and Australian Society for Otolaryngology & Head and Neck Surgery.²³

Recommendations for Craniomaxillofacial Trauma

Screening and Indications

Given that a significant number of COVID-19 patients may be asymptomatic, the safest approach during the COVID-19 pandemic is to assume that all patients are infected and to treat accordingly unless they have had 2 negative COVID-19 polymerase chain reaction (PCR) tests separated by at least 24 hours. With a sensitivity of approximately 71%, a single PCR will miss some patients who are positive for COVID-19.²⁴ With 2 PCR tests performed at least 24 hours apart, this should decrease the number of false negative results.^{25,26} However, patients with CMF trauma may

occasionally require emergent surgery which precludes the ability to take these precautions. Currently at our institution, the time for PCR results is approximately 24 hours. Although rapid testing modalities are currently being developed, their sensitivity and specificity will need to be determined before implementation as a preoperative screening modality. Ideally, if a highly sensitive, rapid testing modality becomes available, then it should be used for all patients upon presentation. In most countries, testing of asymptomatic patients is currently not possible due to limited testing resources. Furthermore, a history to risk stratify patients may not be attainable in some trauma patients. These facts are the impetus for the development of an algorithmic approach to managing patients with CMF injuries.

Chest computed tomography (CT) is another screening modality that has been suggested for patients requiring emergency procedures in whom COVID-19 status is unknown. The sensitivity of chest CT for detecting COVID-19 was originally suggested to be up to 97% to 98% in early studies evaluating Chinese patients with symptomatology suspicious enough to warrant testing with both PCR and CT.^{24,27} However, more recent literature does raise the concern that sensitivity may be significantly lower.²⁴ Further literature has shown that even in patients with clinical symptomatology warranting both PCR and CT investigations, the negative predictive value of CT chest is only 63%.²⁸ This has led major radiology societies to recommend against the use of CT as a general screening for COVID-19.^{29–31}

The initial critical step in the treatment of patients with CMF trauma is the clinical decision as to whether the patient requires surgery or can be managed nonoperatively. To conserve resources at this time, nonoperative management should be considered in patients where operative and nonoperative outcomes are known to be comparable, or where operative management offers no proven advantage. For example, condylar fractures that are amenable to nonoperative management (no malocclusion) should be managed nonoperatively during the COVID-19 pandemic.

Patients requiring surgery fall into 2 groups:

- Group A: Emergent = requiring operative intervention within 24 hours or less
- Group B: Urgent = all other patients with traumatic CMF injuries requiring operative intervention

A swab for PCR testing should be sent upon presentation for all operative (groups A and B) patients. The justification for these groups are discussed in the following sections.

Group A

Emergent CMF injuries that should be treated within 24 hours are those that involve imminent compromise of vision, airway, or uncontrollable bleeding, combined intracranial/upper facial injuries necessitating craniotomy, as well as composite extensive soft tissue and bony injuries requiring urgent debridement, bony stabilization, and soft-tissue coverage to prevent infection.

For this group of patients, a swab should be taken upon presentation and sent for PCR analysis. Although these patients are likely to undergo surgery prior to obtaining PCR results, immediate testing should still be carried out in anticipation of some of them requiring subsequent procedures, in addition to the possibility of having to surgically treat acute complications (AGMP) that may arise in this cohort postoperatively. In addition to obtaining a presenting swab to send for PCR, patients who are asymptomatic or unable to provide a history of symptoms and require emergent CMF surgery should undergo a CT chest, assuming they are stable enough.

The simplest operation to resolve or temporize the situation should be done. If the nature of the injury requires extensive

multistage reconstruction (eg, gunshot wound to face), then a primary procedure to stabilize bone, soft tissue, and cover critical structures should be done initially while maintaining appropriate PPE precautions and minimizing operative techniques that are known to be aerosolizing. Definitive reconstruction should be deferred until after 2 negative PCR results are obtained.

Group B

Group B includes all CMF injuries that require an operative intervention on an urgent basis (but not emergently). Urgent patients include all facial fractures that require operative management in the acute setting to avoid a significant functional or cosmetic deformity but do not pose imminent compromise of vision, airway or uncontrollable bleeding, or involve combined intracranial/facial injury or extensive composite soft tissue and bony injuries.

In general, the determination of when these patients should undergo definitive operative treatment at the earliest, depends on reliable confirmation of a negative disease status. The determination of the length of time these patients can wait to undergo definitive treatment is generally (not accounting for COVID-19 status) dependent on time to union. Given that reliable testing can generally be carried out prior to the latter, all group B patients should undergo 2 PCR tests performed at least 24 hours apart, 1 on presentation and 1 as close to surgery as possible. If these patients are ambulatory, they should be on self-isolation at home the entire time they are awaiting surgery.

If either of the PCR results comes back positive or the patient becomes symptomatic, then the patient should be deferred to a time when the patient is confirmed to be disease free. Consideration for surgery can be made once the patient's symptoms have resolved and 2 negative PCR tests are obtained. These patients should also be cleared by hospital infection control. In group B patients who are COVID-19 positive, secondary correction of the deformity (eg, osteotomies) following resolution of the pandemic should be strongly considered, particularly in light of current resource shortages. In addition, although the median duration of viral shedding is 20 days, it can last up to 37 days suggesting that delay beyond bony union is the safest means of avoiding disease transmission.³² For this reason, we recommend secondary correction of malunited fractures in COVID-19 positive patients for those deformities that are more easily corrected (eg, most zygoma fractures, Lefort I fractures). For those that are difficult secondary corrections, which include displaced cranio-orbital fractures, orbital dystopia, naso-orbitoethmoid fractures, enophthalmic orbital floor fractures, and mandibular fractures requiring surgery, we would recommend proceeding with surgery following the acquisition of 2 negative PCRs and infection control and prevention clearance and prior to bony union.

Personal Protective Equipment

All OR staff except the anesthesia team should be outside the OR during the time of intubation and extubation and remain outside of the OR for a duration of time consistent with the laminar air flow design of the OR. At our institution, this has been calculated as 10 minutes following intubation and 10 minutes following extubation. The implementation of a barrier enclosure during endotracheal intubation has also been proposed as an adjunct to standard PPE during intubation to limit viral contamination.³³ During the surgical procedure, the number of healthcare personnel in the OR should be limited to the minimum required to achieve the care needed (no junior trainees and no observers).

In line with current evidence, WHO advocates for droplet and contact precautions for general healthcare workers caring for

COVID-19 patients. For those performing AGMPs such as CMF, head and neck, and dental surgeons, WHO recommends airborne and contact precautions.³⁴ The use of medical masks, eye protection, gloves, and gown are required for direct patient care; respirator masks are specifically required for AGMPs.^{3,35}

All CMF trauma patients should involve full PPE. This includes a respirator mask (minimum N95 mask), face shield, gloves, nonporous gown, and disposable hat regardless of the PCR status of the patient. Scrubs worn during the procedure should be changed immediately afterwards. A surgical headlight should not be worn in the OR unless it can be completely covered by the PPE or can be sterilized postoperatively. In any emergent patient where the patient is either symptomatic, has a positive PCR, demonstrates potential COVID-19 findings on chest CT or no history of symptoms is obtainable and status is therefore unknown, PAPR should be used if available.

At this time, the evidence is not yet available as to the efficacy of N95 masks compared to PAPR in the OR setting where COVID-19 viral particles are being aerosolized. The assigned protection factor for PAPR is 25 to 100 compared to 10 for N95.³⁶ Experience in Wuhan, China and Northern Italy has suggested that N95 masks were not enough and that PAPR was required to control transmission among medical personnel performing AGMPs, and in particular involving the upper respiratory tract mucosa.¹⁹ Therefore, until further evidence becomes available, a number of national and international societies have recommended that PAPR should be used for any AGMP in any region involving upper respiratory tract mucosa for a patient with a positive PCR, in patients where no history of symptoms is obtainable, or for any patient that has not yet had 2 negative PCRs.^{19,20,23} Although PAPR has been suggested to be used for the scenarios listed above, it may not be readily available. Therefore, chest CT in conjunction with basic screening for signs and symptoms including fever may have some utility in risk stratification for patients requiring emergent CMF surgery. Temporizing minimally invasive interventions should be utilized whenever possible (such as dressings for open wounds, temporary suture or staple closure, etc) as PAPR may not be readily available and other PPE may not be adequate or may be in short supply.

Modified Operative Technique

If proceeding with surgery, there are a number of technical considerations intraoperatively to limit potential aerosolization. These include substituting closed reduction for open if amenable, avoiding intraoral incisions if possible, using a scalpel rather than monopolar cautery for mucosal incisions, using bipolar cautery on the lowest power setting for hemostasis, avoiding repeated suctioning and irrigation, avoiding power instrumentation if possible (including drill, burr, saw, etc), preferentially using self-drilling screws, and if drilling is required, avoiding or limiting irrigation and using a low speed drill.¹⁹

In addition, we would suggest self-drilling maxillomandibular fixation (MMF) screws or Hybrid MMF (Stryker, Kalamazoo, MI) over traditional MMF with arch bars and wires to minimize the length of direct exposure to the upper respiratory tract in the OR as well as limit potential splashing of saliva onto the surgical team. Although closed reduction with MMF may avoid the need for intraoral incisions, it will require a minimum of one more AGMP for removal. The patient will likely also require several adjustments of elastics or wires in the clinic setting, which constitutes another instance of exposure. For this reason, when MMF is being used intraoperatively to guide open reduction and internal fixation of occlusal skeletal fractures (eg, mandibular fractures) but is not required to stabilize the fracture, we would recommend immediate removal of the MMF apparatus at the end of the initial procedure. If

the MMF apparatus is required as a stabilizing modality for closed reduction, for instance in a condylar neck fracture, the patient should once again be asymptomatic and have had 2 negative PCR tests >24 hours apart prior to MMF removal.

Intraoral incisions should be avoided if possible. In particular, using extra-oral incisions should be used for mandible fractures. Furthermore, if possible a fractured zygoma should be reduced and fixated without an intraoral incision, using a Carroll-Girard screw, for instance, and 2-point fixation at the lateral and/or inferior orbital rims.¹⁹ The mouth and nose should be covered with an occlusive dressing whenever possible unless they are required for surgical access.¹⁹ If working intraorally, a throat pack should be placed to minimize the risk of aerosolization if there is a cuff leak.

We would also recommend, in certain instances, a lower threshold for primary bone grafting. Although current technology enables anatomical reduction and fixation of highly comminuted fractures, this is a time-consuming, laborious process which necessitates extensive drilling and bone contouring. In proximity to sinuses, use of primary bone grafting may decrease the risk of exposure to aerosolized virus. Rather than attempting to piece together a number of small bony fragments and using a power drill in the vicinity of a sinus, bone graft is harvested from a clean surgical site, a spanning plate secured to the bone graft on the back table using a power drill during fixation. The bone graft and fixated spanning plate can then be brought back to facial bony defect and secured in place using self-drilling screws.

Algorithm

Although the current literature and guidelines provide a number of recommendations, some are not specific to CMF trauma, and an algorithmic approach for CMF trauma management is still needed. Therefore, based on the review of the literature as well as national and international society guidelines, we have created an algorithmic approach to best practice management of acute CMF trauma during the COVID-19 pandemic. The aim of this algorithm is to ensure that patients with CMF injuries are cared for while minimizing the transmission of COVID-19 to healthcare providers as well as from patient to patient. This algorithm assumes that all elective procedures will be deferred during the pandemic until there is complete resolution of the state of emergency (Fig. 1).

We understand that resources may be limited at this time and therefore, it may be a challenge to meet some of these recommendations. However, to determine the resources required to meet best practice standards, the first step is to outline the goals to be achieved. Ultimately this will help optimize safety for the healthcare providers coming into contact with these patients preoperatively, in the operating room and in the postoperative setting.

Part of the preoperative consent process should involve discussion with the patient and their family that their treatment process may be modified from the standard approach in light of the current COVID-19 pandemic.

CONCLUSION

This algorithm has been proposed to ensure that urgent and emergent CMF injuries are addressed appropriately while optimizing the safety of personnel and other patients. The algorithm is based on available evidence at the time of writing.

All routine, elective CMF procedures should be deferred until safe management strategies have been clearly identified. Ambulatory visits should be limited to those patients requiring urgent intervention or emergent follow-ups. Nonurgent visits should be replaced by a telephone conversation, or videoconference if local regulations permit and resources are available. Asymptomatic carriers are common and therefore reliance on history of symptoms

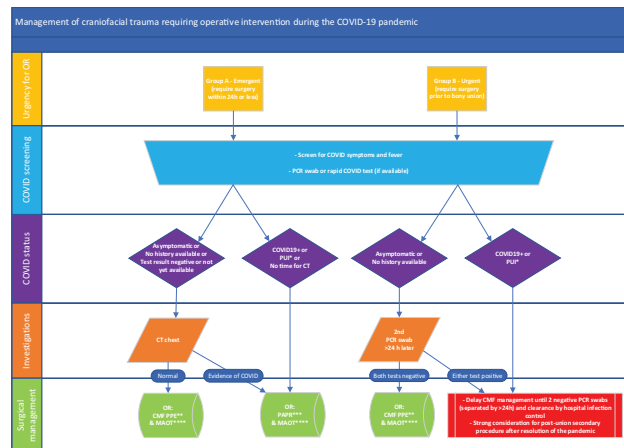


FIGURE 1. Proposed algorithm for management of craniomaxillofacial (CMF) trauma during the coronavirus disease 2019 (COVID-19) pandemic. *PUI: Person Under Investigation for COVID-19, **CMF PPE: includes N95 mask, face shield, gloves, nonporous gown and disposable hat, ***PAPR: Powered Air-Purifying Respirator, ****MAOT: Minimal Aerosolization Operative Technique as recommended by AO maxillofacial international task force¹⁹ which includes: consider closed reduction if amenable, avoid intraoral incisions if possible, scalpel over monopolar for mucosal incisions, bipolar cautery for hemostasis on lowest power setting, avoid repeated suctioning/irrigation, avoid power instrumentation if possible (including drill, burr, saw, etc), preferential use of self-drilling screws, if drilling is required, avoid or limit irrigation and use low speed drill. CT, computed tomography; PPE, personal protective equipment.

alone will not suffice for operative management of traumatic CMF injuries. Intraoperative exposure to high viral loads through aerosolization carries a very high risk of transmission, and the severity of the disease contracted in this manner is worse than that transmitted through regular community transmission. The proposed algorithm should be used as a guide for any surgeon managing CMF trauma during the COVID-19 pandemic. This has been created to ensure continued care for CMF trauma patients while attempting to minimize risk of exposure and transmission to surgeons and other healthcare providers. As the COVID-19 pandemic continues to evolve and more evidence and better testing becomes available, the algorithm should be modified accordingly.

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