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Management of pediatric facial fractures during COVID-19 pandemic

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Objective. The coronavirus disease 2019 (COVID-19) pandemic caused delays in medical and surgical interventions in most health care systems worldwide. Oral and maxillofacial surgeons (OMSs) delayed operations to protect themselves, patients, and staff. This article (1) presents one institution's experience in the management of pediatric craniomaxillofacial trauma during the COVID-19 pandemic and (2) suggests recommendations to decrease transmission.

Methods. This was a retrospective review of children aged 18 years or younger who underwent surgery at Children's Healthcare of Atlanta in Atlanta, GA, between March and August 2020. Patients (1) were aged 18 years old or younger, (2) had one or more maxillofacial fractures, and (3) underwent surgery performed by an OMS, otolaryngologist, or plastic surgeon. Medical records were reviewed regarding (1) fracture location, (2) COVID-19 status, (3) timing, (4) personal protective equipment, and (5) infection status. Descriptive statistics were computed.

Results. Fifty-eight children met the inclusion criteria. The most commonly injured maxillofacial location was the nose. Operations were performed 50.9 hours after admission. Specific prevention perioperative guidelines were used with all patients, with no transmission occurring from a patient to a health care worker.

Conclusions. With application of our recommendations, there was no transmission to health care workers. We hope that these guidelines will assist OMSs during the COVID-19 pandemic. (Oral Surg Oral Med Oral Pathol Oral Radiol 2021;132:e169–e174)

During December 2019, a series of unexplained pneumonia cases were reported in Wuhan, China. The causative organism was found to be severe acute respiratory syndrome coronavirus 2. In February 2020, the World Health Organization officially named the disease "coronavirus disease 2019" (COVID-19).^{1,2} The virus causes mild symptoms (e.g., mild rhinorrhea,

cough)³⁻⁵ that can rapidly progress to acute respiratory distress syndrome, need for ventilator support, and potentially death.⁶ Some children develop multisystem inflammatory syndrome, but most children are unaffected.⁷ The mechanism for resilience is unknown. Therefore, children have the potential to be asymptomatic carriers and may contribute to virus transmission in the community.

Human-to-human transmission occurs^{9,10} via symptomatic and asymptomatic carriers.^{11,12} Transmission is thought to occur mainly through respiratory droplets.¹³ Droplets can be detectable in aerosols for up to 3 hours. Contaminated surfaces also transmit the virus (e.g., copper, 4 hours; cardboard, 24 hours; plastic/glass/stainless steel, 2-3 days).¹⁴ Other similar viruses (e.g., severe acute respiratory syndrome coronavirus, Middle East respiratory syndrome coronavirus, or endemic human coronaviruses) have been shown to persist on fomites for up to 9 days.¹³⁻¹⁵ Viral RNA has been found in stool samples from infected patients.^{8,16}

The structure of this virus consists of a lipid envelope, which is disrupted by specific disinfectants within

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Statement of Clinical Relevance

The coronavirus disease 2019 pandemic brought unprecedented challenges to oral and maxillofacial surgeons. Some operations were modified to protect patients and staff. In this article, we present our center's guidelines and recommendations for treating children with craniomaxillofacial trauma during a pandemic.

1 minute (e.g., 60% ethanol, 0.5% hydrogen peroxide, 0.1% sodium hypochlorite).^{17,18} Other biocidal agents, such as 0.05%-0.2% benzalkonium chloride or 0.02% chlorhexidine digluconate, are less effective. The ultimate disinfectant has not yet been discovered.

The COVID-19 pandemic has posed unprecedented challenges for the global medical community. To decrease the impact and mitigate the number of COVID-19 cases, national and local government agencies instituted social distancing guidelines, limited social gatherings, and encouraged appropriate hand hygiene. Many states, counties, and cities declared a state of emergency with orders to close all nonessential businesses and shelter in place. The potential for domestic violence, physical altercations, unsupervised children, burglary, and crimes was expected to surge. Therefore, pediatric craniomaxillofacial (CMF) trauma continued to occur.

Guidelines for the diagnosis and treatment of COVID-19 have been constantly changing since the pandemic arrived in the United States.^{19,20} Uniform guidelines for surgical interventions in a child with CMF trauma do not exist. The purpose of this article is to (1) present our institution's experience in the management of pediatric CMF trauma during the COVID-19 pandemic and (2) suggest guidelines and recommendations to decrease COVID-19 transmission.

METHODS

This study was approved by the Children's Healthcare of Atlanta (CHOA) Institutional Review Board (17-039). A retrospective chart review was conducted of children aged 18 years or younger who presented to CHOA between March and August 2020. Patients were identified by reviewing the operating room (OR) case logs. Patients were included if they (1) were aged 18 years old or younger; (2) were diagnosed with one or more maxillofacial fractures; and (3) had undergone an operative intervention by oral and maxillofacial surgery, otolaryngology, or plastic surgery services. Exclusion criteria were patients (1) receiving nonoperative treatment (i.e., bridle wire, diet modifications), (2) with isolated dental trauma, (3) with isolated odontogenic infection, and (4) with incomplete medical records. Medical records were reviewed for (1) fracture location, (2) patient COVID-19 status, (3) timing of repair, (4) use of personal protective equipment (PPE), and (5) conversion/infection status (i.e., positive patient infecting staff). Descriptive statistics were computed to summarize findings and transmission rate according to our newly developed guidelines.

RESULTS

A total of 9423 patients underwent a surgical intervention in an OR at CHOA during the period from March

to August 2020 (first 6 months of the COVID-19 pandemic in the United States). Of these patients, 58 met the inclusion criteria. Injury locations were the nose (n = 24 [41.4%]), mandible (n = 16 [27.6%]), soft tissue (n = 8 [13.8%]), zygomatic complex (n = 4 [6.9%]), orbit (n = 3 [5.2%]), or complex involving more than one operative site (n = 3 [5.2%]). Surgical interventions took place 50.9 hours after admission (range, 4 hours to 11 days). PPE was used with all patients. Strict COVID-19 prevention guidelines (described later in this article) were used with all patients. Following these guidelines, there was no transmission from a patient to a health care worker.

DISCUSSION

Definitions

Every child with CMF trauma requiring admission was screened for COVID-19 infection. Suspicion for COVID-19 was based on recent travel, sick contacts, and symptoms. Each child was placed in an appropriate category on the basis of COVID-19 status: unknown status (before investigation), patient under investigation, COVID-19–positive patient (as a result of a positive test), or COVID-19–negative patient (as a result of a negative test). Providers treated all patients (even COVID-19–negative patients) with the same precautions.

Preoperative testing

Procedures involving the upper airway mucosa (intubation, tracheostomy, oropharyngeal procedures) were considered high risk because of aerosolization of the virus, which is known to be in high concentration in these areas.^{1,22} When viral particles become aerosolized, they stay until complete air exchange or settling (1-3 hours).^{1,2}

We recommend obtaining a preoperative COVID-19 status for all patients when operating in and around the face as close as possible to the time of the operation. Instrumenting potentially infected mucosal tissue for the purposes of fracture fixation is equivalent to the powered microdebriders/shavers used in sinus surgery. This process would likely lead to increased risk of transmission and droplet diffusion throughout the OR.^{22,23} At CHOA, when a patient is admitted with CMF trauma, he or she undergoes rapid COVID-19 testing in preparation for potential surgical intervention. However, because of the potential for a false-negative result, health care providers should assume that all patients have a positive status and should maintain appropriate precautions.

Treatment indications

The available literature presents various indications for surgical treatment of pediatric facial fractures. In

children, surgeons achieve accurate bone reduction and stable fixation to permit bone healing and avoid disturbing future skeletal growth and dental development. Thus, fracture management in younger patients can sometimes be nonsurgical. As the facial skeleton matures, more conventional and “adult-like” surgical approaches become appropriate (Lorenz 24). Children can often follow a soft diet as they slowly return to normal function. During the COVID-19 pandemic, this process allowed some patients to receive appropriate treatment without additional risk of exposure to COVID-19 in the OR.

Timing of surgical intervention

During the first 3 months of the COVID-19 pandemic, most health care systems nationwide canceled all elective operations. Surgeons continued to provide care in emergent and urgent situations.²¹ In general, pediatric facial fractures that require surgical intervention should receive definitive care as soon as it is safe or within 7 to 10 days. If the repair of a facial fracture is delayed longer, compromised functional and/or cosmetic outcomes may occur. These secondary deformities (e.g., temporomandibular joint ankylosis, enophthalmos, facial deformity) are typically difficult to correct secondarily. Accordingly, in our cohort, CMF trauma that required operative intervention occurred within 50.9 hours after admission.

We recommend dividing all operations into 4 categories: emergent, urgent, time sensitive, and elective (Table I). Emergent cases consist of fractures resulting in uncontrolled bleeding or causing airway compromise and those resulting in uncontrolled bleeding from facial structures caused by other conditions (e.g., pseudo aneurysm, anterior/posterior nasal bleeding) that would lead to airway compromise. Urgent cases cannot be treated at the bedside, and surgical intervention should be completed within 12 hours (e.g., orbital blowout fracture with muscle entrapment, extensive facial lacerations, ear avulsion, unstable dentoalveolar fracture). Time-sensitive cases should be treated within 5 to 7 days, but sooner if possible. Examples are displaced nasal bone/septum fracture with airway obstruction; displaced naso-orbito-ethmoid; Le Fort I, II, or III fracture; displaced zygomaticomaxillary complex fracture; orbital wall fracture without muscle entrapment; and/or mandible fracture (with malocclusion/deformity requiring open reduction and internal fixation [ORIF]). In addition, any surgical repair of CMF trauma that would expedite discharge from the hospital should occur as soon as possible. Elective cases do not interfere with daily form and function and should take place only when it is safe to do so. In our cohort, all fractures were in the time-sensitive category. This suggestion

Table I. Timing of surgical intervention

	Timing to completion	Examples
Elective	Can be postponed >4 wk	<ul style="list-style-type: none"> • Revisions • Bone/cartilage grafts
Time sensitive	Completed within 1-2 wk	<ul style="list-style-type: none"> • Displaced nasal bone/septum fracture causing nasal airway obstruction • NOE (Markowitz type 2 or 3) • Le Fort fracture (I, II, III) • Displaced ZMC fractures • Orbital wall fracture without evidence of muscle entrapment • Mandible fracture • Repair of CMF trauma that will expedite discharge from hospital
Urgent	Completed within 24 h	<ul style="list-style-type: none"> • Orbital blowout fracture with muscle entrapment • Extensive facial lacerations • Ear avulsion • Unstable dentoalveolar fracture
Emergent	Completed immediately	<ul style="list-style-type: none"> • Fracture resulting in uncontrolled bleeding or causing airway compromise • Uncontrolled bleeding from facial structures that resulted from other conditions (e.g., aneurysm, anterior/posterior nasal bleeding) that would lead to airway compromise

CMF, craniomaxillofacial; NOE, naso-orbito-ethmoid; ZMC, zygomaticomaxillary complex.

provided adequate time to obtain COVID-19 results and prepare the OR and equipment.

A tracheostomy is sometimes performed as part of complex CMF repair. Tracheostomy has a high risk of transmission via inhalation, contact with infected respiratory secretions, close proximity, and positive pressure ventilation.²² In order to decrease viral transmission, we recommend avoiding tracheostomy if at all possible. Instead, surgeons should consider submental intubation or dividing a prolonged operation into multiple shorter ones in order to decrease the potential need for prolonged intubation and/or a tracheostomy. In our cohort of patients, none required a tracheostomy.

Table II. US Food and Drug Administration—approved personal protective equipment

Equipment	Protection
Fit-tested N95 mask	Against inhalation of virus
Disposable surgical mask	Protects N95 mask
Head/neck cover	Decreases skin/hair exposure
Goggles	Eyes, decreases conjunctival exposure
Face shield	Skin not covered by above
Fluid-resistant gown	Clothes, skin
Double gloves	Hands, wrists
Shoe covers	Protects shoes

PPE equipment

Universal precautions consist of a high level of PPE and enhanced vigilance to appropriate fitting of PPE (Table II). Health care workers must be trained in putting on PPE (i.e., donning), performing clinical duties with PPE, and removing PPE (i.e., doffing) in the context of their current and potential duties.²⁴ Training material should be easy to understand and available in the appropriate language and literacy level for all workers.^{25,26} It is important to note that a recent Cochrane review found low to very low certainty of evidence that covering more parts of the body leads to better protection but usually at the cost of more difficult donning or doffing and less user comfort, and it may therefore lead to even more contamination. More breathable types of PPE may lead to similar contamination but may have greater user satisfaction.²⁷ Powered air-purifying respirators have certain limitations (e.g., emission of unfiltered air flow) and may not be safe for members of a surgical team not using a powered air-purifying respirators, may lack disposable parts or ability to be sterilized, and may have inability to accommodate a headlight, and so forth.²⁸

We recommend using the most effective PPE possible that allows completion of an operation without compromising surgical steps. We recommend the following head and neck protection: respirator or fit-tested N95 mask covered by a disposable surgical mask, head/neck cover, goggles, and face shield. We recommend a fluid-resistant gown, double gloves, and shoe covers²⁹ (Table II). Doffing should consist of a one-step glove and gown removal and extensive hand washing after all PPE is removed.²⁴ We also recommend donning and doffing with a partner, discussing the process, and providing real-time feedback. PPE should be discarded in a dedicated and labeled COVID-19 container. Nondisposable equipment, such as goggles and face shields, should be cleaned according to individual institutional guidelines.

OR equipment

Typically, every institution has separate guidelines with some similarities between hospitals. All ORs

maintain positive pressure for surgical infection control. ORs are kept at 20 air changes per hour. Our institution designated one specific OR as the COVID-19 OR. When a surgical procedure took place in a patient positive for COVID-19, that OR was used for subsequent operations in patients with COVID-19. All non-essential equipment and supplies were removed from that room and from the path to the room. In general, the anesthesia ventilators have appropriate filtration to prevent aerosolization. In case a patient requires a hand mask/bag, high-efficiency particulate air filters are in place. If a patient positive for COVID-19 remains intubated postoperatively, transportation should occur on a ventilator to a specified COVID-19 room in the intensive care unit (ICU). Handoff will occur at the bedside in the COVID-19 ICU with both the OR and ICU teams present. None of our patients required prolonged intubation and/or transport on a ventilator.

Our institution developed a specific protocol for cleaning the OR and recovery room after the presence of a patient with COVID-19. After aerosolizing procedures, we recommend closing and taping the OR doors for 15 minutes without allowing entry to anyone. Then, a terminal clean should be completed via ultraviolet protocol.²⁵

OR staff

The OR staff consisted of 3 teams (anesthesia, surgery, staff) with 2 members on each team (attending and resident/fellow or circulator and surgical tech), except in extenuating circumstances. Many institutions suspended clinical rotations by medical students, including participation in operations. All personnel in the room should wear N95 masks and similar PPE secondary to the high risk of aerosolization. Only anesthesia staff should be in the room during induction. When indicated, the OR team can assign an additional outside circulator/runner.

CMF treatment modifications

The purpose of modifications in the treatment of pediatric CMF trauma is to decrease the length of operating time, which decreases overall exposure to the virus among the surgeon and OR staff.^{30,31} When appropriate, nonsurgical interventions (i.e., dietary modifications) are preferred (e.g., a child with primary dentition). We present the following specific strategies that we have been following which resulted in a zero transmission rate during the COVID-19 pandemic:

1. The oral cavity should be irrigated with 0.5% peroxide for 60 seconds before the procedure to decrease viral load.
2. Electrocautery and bipolar electrocautery should be used at the lowest voltage possible to minimize plume.

3. All attempts should be made to treat fractures with closed reduction (i.e., maxillomandibular fixation).
4. When performing closed reduction, if possible and appropriate, all attempts should be made to use hybrid arch bars, intermaxillary fixation screws, ivy loops, and so forth instead of traditional arch bars. This is done in an effort to decrease time in the OR.
5. For ORIF, choose a transcutaneous approach instead of an intraoral approach when possible and appropriate.
6. During ORIF, use self-drilling screws when possible.
7. Consider removal of maxillomandibular fixation appliances at the end of the case if appropriate. This will likely decrease the possibility of the need to return to the OR for removal.
8. If possible, resorbable sutures should be used.
9. Follow-up care:
 - a. Inpatient visit provided by only one member of the surgical team
 - b. In-person postoperative visit 5 to 7 days after the operation only if absolutely necessary; this decreased patient traffic in the hospital/outpatient clinic
 - c. Telemedicine should be used if possible and for additional postoperative visits, if appropriate.³²
 - d. During the postoperative visit, only one surgeon should enter the patient's room.

CONCLUSIONS

Oral and maxillofacial surgeons have never faced challenges similar to the COVID-19 pandemic. The sudden arrival of the pandemic did not decrease the need for surgical interventions of CMF trauma in children. Following our specific recommendations, we have had no transmission to health care workers. Therefore, it is our hope that the guidelines presented in this article will assist oral and maxillofacial surgeons when providing treatment to children with CMF trauma during the COVID-19 pandemic.

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