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SPECIAL TOPIC

Facial Surgery in the Era of SARS-CoV-2 and Beyond: Challenges, Considerations, and Initiatives

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Summary: The SARS-CoV-2 pandemic resulted in the implementation of healthcare practice regulations and restrictions across the United States. To facilitate safe patient management practices for facial plastic and reconstructive surgeons, appropriate guidelines and recommendations should be followed. Guidelines and recommendations should include a synthesis of the best evidence available from public health authorities and respected members in the surgery community. This review contains evidence-based suggestions that prioritize the safety of healthcare professionals and patients to help guide facial and reconstructive surgeons toward safe patient management. *(Plast Reconstr Surg Glob Open 2020;8:e3301; doi: 10.1097/GOX.0000000000003301; Published online 25 November 2020.)*

INTRODUCTION

The rapid international spread of severe acute respiratory distress syndrome coronavirus 2 (SARS-CoV-2; COVID-19) has had an unprecedented impact on economic and healthcare infrastructure across the world.[1] As of August 19, 2020, there are 22,262,946 confirmed cases internationally and 5,525,235 confirmed cases in the United States.[2] Healthcare systems have taken drastic measures to preserve personal protective equipment (PPE) and appropriately allocate supplies and human resources in ways that have never been seen previously.[3–7]

In addition to COVID-specific hospital precautions recommended by the Centers for Disease Control (CDC), clear guidelines and strategies should be adhered to for case management and resource allocation. Developing specialty-specific guidelines and strategies would help streamline patient care, prevent unnecessary exposure, and assign case management responsibilities. Regarding the care of facial surgery patients, it is important to develop and improve systems that streamline the triage and diagnostic processes to efficiently determine the need to operate.[8] Additionally, it is important to pursue novel strategies to safely deliver care to patients in preparation for changes in practice in the aftermath of the pandemic.

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Received for publication August 31, 2020; accepted October 21, 2020.

DOI: 10.1097/GOX.0000000000003301

In this review, we comprehensively discuss preoperative, intraoperative, and postoperative considerations for facial plastic surgeons and facial surgery patients during and after the coronavirus-19 (COVID-19) pandemic. We synthesize evidence from the guidelines presented by the Organizations of Craniomaxillofacial Surgery (AO CMF), the American College of Surgeons (ACS), the American Society of Plastic Surgeons (ASPS), CDC, and World Health Organization (WHO), while also contributing our own commentary to add to the evolving standard of care. Additionally, we describe opportunities for the facial surgery community to evolve and improve as a result of the changes induced by the pandemic. We hope this review can be used to facilitate a successful return to practice and guide facial plastic surgeons toward safe patient care during and after the pandemic.

PREOPERATIVE EVALUATION

In March 2020, ACS and ASPS recommended postponing all urgent and elective surgeries. Since then, many states have resumed non-emergent procedures. This has typically occurred on a state-by-state basis as case load has begun to fall in certain regions. Regardless of case load, many patients will still require medical consultation to avoid negative health consequences. Hence, it is important to consider strategies to ensure safe delivery of medical consultations and surgical care when indicated. This includes remote consultations via telemedicine and COVID-19 testing for all patients when surgery is indicated.

Federal and state legislators have eased restrictions for telemedicine practice, which have allowed providers to broaden the scope of their practice remotely.[9,10] With the passing of the CARES act, Medicare patients can more easily access care directly from their homes through

Disclosure: *The authors have no financial interests to disclose. No funding was received for this article.*

telemedicine.[10] Furthermore, new reimbursement codes were created, allowing providers to bill telemedicine consults as if they were standard, in-person consultations. Providers would receive the benefit of a full specialist consultation without the possibility of exposing either themselves or their patients to the virus.[10,11] Additional changes include more relaxed Health Insurance Portability and Accountability Act regulations and flexibility to consult with patients across state lines.[10] Statements from the Department of Health and Human Services and the CDC acknowledged the rapid adoption of telemedicine by patients and providers.[8,11,12]Members of ASPS also agree with this sentiment. A survey released in June comprising over 350 members showed that 68% of respondents were taking virtual consultations.[12] In accordance with the Department of Health and Human Services and the CDC, ACS and ASPS have recommended remote telemedicine consultations for preoperative evaluation and postoperative follow-up in regions with high viral case-loads.[12–14]

Multiple studies have shown utility for telemedicine in the realm of surgery, including early-stage management of burns, mild facial trauma, tumors, postoperative follow-up, and cosmetic consults.[15–17] One study demonstrated that with digital imaging, providers were able to diagnose burn injuries and recommend next steps with 97% accuracy using telemedicine.[18] A second study suggested that telemedicine can be used as a way to improve acute diagnosis and triage processes in trauma cases, thereby expediting the initiation of appropriate interventions and curtailing inappropriate ones.[19] This can be applied specifically to facial trauma cases as well. In one study, a trauma team set up a telemedicine consult service with several nearby tertiary care centers. By consulting maxillofacial specialists at tertiary care facilities, expensive and unnecessary transfers of maxillofacial patients were significantly reduced.[20] During and after the pandemic, the utilization of a telemedicine consultation program between emergency department providers and maxillofacial specialists may help reduce unnecessary interventions, freeing up specialists to focus on higher acuity cases.[15,18,19,21,22]

Although the benefits of telemedicine are evident, there are limitations in performing consultations and follow-up appointments with patients via telemedicine. The most obvious is the inability to perform an in-person examination of the patient, which may result in the loss of important data that are normally used by facial surgeons to make decisions. For example, an accurate report on physical examination of the face, including a cranial nerve examination, is significantly more challenging to obtain over telemedicine than in-person. In addition, some healthcare facilities have inadequate bandwidth to accommodate an immediate, full transition to telemedicine, leading to low-fidelity consultations with patients. Considering these limitations, telemedicine consultation makes the most sense for low-risk facial surgery cases at this time. It is very possible that telemedicine will become increasingly relevant in the practice of facial surgery even when COVID-19 caseloads have declined substantially. Efforts to improve telemedicine connectivity and accuracy of the telemedicine physical examination should be explored.

In the wake of the pandemic and the resumption of non-emergent facial surgery practice, preoperative testing for COVID-19 should be performed whenever possible.[23,24] This includes cases in which there is no risk of harm to the patient if surgical intervention is not immediately performed. Viral nucleic acid testing protocol recommended by the CDC should be followed.[25,26] The Stanford University protocol originally recommended 48 hours of preoperative testing, which includes 2 SARS-CoV-2 tests 24 hours apart.[27,28] As non-emergent procedures have resumed across the country, the ACS has recommended one preoperative test 48 hours before surgery. Our recommendations are in concordance with the most updated recommendations proposed by the ACS.[29]

The surgery community has adjusted to the CDC and ACS recommendations appropriately; preoperative testing is now a standardized protocol for all surgery patients and we envision that this will remain the case for the foreseeable future. With such testing protocol in place, it is important to understand the reliability and capabilities of COVID tests. Currently, the gold standard test for diagnosing COVID-19 is the reverse transcription polymerase chain reaction (RT-PCR) molecular test, which detects viral RNA via samples obtained from bronchial aspirate or nasal swab.[30,31] In fact, several studies have deemed the sputum RT-PCR test to be the most sensitive, with a sensitivity of roughly 97%.[30,32,33] The method of sample collection also seems to be important, as RT-PCR tests applied to other samples (blood,[32,34–36] urine,[33,34] and stool and rectal swabs[37]) were significantly less sensitive and specific.[30] Furthermore, the timing of COVID-19 testing relative to viral exposure seems to be important when assessing testing accuracy as roughly 67% of patients test negative 4 days after exposure to the virus,[38,39] and 38% will test negative on their first day of symptoms.[38–42] Preoperative testing protocol may change as new data become available, and surgeons are encouraged to stay in touch with novel literature as well as recommendations from the CDC, AO-CMF, ASPS, and ACS.

OPERATING ROOM PRECAUTIONS AND CONCERNS

Standard precautions for patient care set forth by the CDC and WHO are necessary to prevent the spread of SARS-CoV-2 within a hospital setting. These precautions act as a starting point, but due to differing settings of practice between specialties and individual facilities, additional precautions should be undertaken based on the unique challenges faced by each surgical discipline. Established general recommendations include specific guidelines for all healthcare workers to minimize the risk of airborne, droplet, and contact transmission within the hospital setting.[43] Both organizations suggest that healthcare providers performing aerosol-generating procedures (AGP) are at the highest risk of contracting COVID-19.[43]

Facial surgeons often perform procedures of the nares, oral cavity, and aerodigestive tract, many of which may be aerosolizing. The nature of these procedures

may put the operator at a higher risk of contracting and spreading COVID-19.[44–46] In reports from China, COVID-19 was detected in 72% of sputum samples, 63% of nasal swabs, 46% of bronchoscope brush biopsies, and 32% of pharyngeal swabs.[47] The virus was detected in asymptomatic patients who later tested positive,[47] which may suggest a benefit to creating a list of procedures that may expose facial surgeons to a higher risk of infection. This includes AGPs as well as an expanded list of procedures involving the nares, oral cavity, nasopharynx, and bronchial tree. Facial surgeons often use drills or saws in facial fracture reconstructions or orthognathic cases, which may carry an increased risk of aerosolization of COVID-19.[48,49] Examples of routinely performed AGPs and additional high-risk procedures include endotracheal intubation, sputum induction, nebulizer treatment, tracheostomy, chest physiotherapy, high-frequency ventilation, positive pressure ventilation (BiPAP and CPAP), airway suction, cardiopulmonary resuscitation, turning the patient to the prone position, and surgeries involving the oral cavity, nasopharynx, aerodigestive tract, or craniofacial region.[50,51]

In alignment with recommendations from the CDC and ACS, all surgeries involving suspected COVID-19 positive patients should be performed in negative pressure rooms.[52,53] The ventilation systems in most U.S. hospital operating rooms are designed to provide positive pressure.[53] Therefore, the transition to a negative pressure operating room may be difficult for some hospital institutions, especially those with limited access to resources. One cost-effective way around this is to add a portable, high-efficiency, particulate air filtration system to the existing system. This filtration system creates a negative pressure environment that is consistent with OSHA and CDC recommendations.[54] During and between operations, traffic into and out of the operating room should be kept at minimum.[55] The surgery team should enter after intubation with the appropriate PPE, to reduce the risk of aerosolized transmission.[56]

Standard OR PPE includes a standard surgical mask, double gloves, shoe covers, surgical cap, and waterproof gown. Current recommendations by the CDC include additional eye protection as well as the use of an N95 mask or powered-air-purified respirator (PAPR) when performing AGPs. Additional eye protection may include a full face shield, safety goggles with extensions to cover the sides of the eyes, and disposable prescription eyewear shields for those who wear prescribed glasses.[53]

Evidence suggests that there are advantages and disadvantages to using either the PAPR or N95 masks to protect providers from aerosolizing infections during surgery. The University of Minnesota created guidelines for extreme and enhanced airborne precautions based on the Stanford University protocol. These guidelines recommend that surgeons operating on high-risk cases follow extreme airborne precautions, which includes a PAPR, fluid-resistant gown, and surgical gloves.[57] Examples of high-risk cases that would call for extreme precautions include facial fractures wherein morbidity/mortality is significant without emergent intervention, situations where the clinical history cannot be obtained, and confirmed COVID-19-positive patients. Regarding facial fracture reconstruction and orthognathic procedures, a battery-powered low-speed drill is recommended whenever possible due to the highly-aerosolizing nature of high-speed drills.[57] Enhanced airborne precautions were recommended in patients who tested negative for COVID-19 in situations where PAPRs were not available. Enhanced airborne precauttions include an N95 mask, face shield protection, fluid resistant gown, and surgical gloves.[57] Similarly, the AO CMF released their own recommendations in June, which were nearly identical to the recommendations proposed by the University of Minnesota.[23] Two other studies suggested that PAPRs may be superior to N95 masks regarding filtration of airborne particles, but require advanced training to use.[58,59] The CDC, ACS, and AO CMF recommend appropriate PPE for droplet precautions, which can include PAPRs or N95 masks, and recommends against the use of standard surgical masks due to their ineffectiveness at protecting the user. The decision to use PAPR or N95 during surgery should depend on the risk of aerosolization during the procedure, the COVID-19 infection status of the patient, and the level of training present at the surgery center. If the patient tests positive for COVID-19 and the surgery center is equipped with PPARs, we recommend proceeding with extreme airborne precautions outlined above. If the patient tests negative, we recommend proceeding with enhanced airborne precautions.

RISK CLASSIFICATION SYSTEM AND RECOMMENDATIONS

Non-emergent surgeries are resuming in certain areas of the world, and it is important to consider approaches for safe integration back into standard surgical practice. This includes testing for all patients, preoperative telemedicine consultation when appropriate, and a timeline for resuming non-emergent procedures based on the recommendations of local public health authorities. These challenges underscore the importance of creating a streamlined risk classification and patient management system.[60] This system was created using recommendations from the CDC, ACS, ASPS, WHO, AO CMF, and suggestions from maxillofacial surgeons and ENT physician groups.[16,23,57,60–65] All recommendations prioritize patient and provider safety. **Table 1** summarizes our risk classification system and provides recommendations for emergent, urgent, and low-risk case management, which are in alignment with ACS and AO CMF recommendations.[23,24]

LOW-RISK

In our classification system, Low Risk cases are managed in an elective setting and never require same-day intervention. At the beginning of the pandemic, it was recommended that management of these cases occur remotely until safe management strategies have been identified. In the United States, state-specific protocols are needed, as factors such as case-load, access to PPE, population density, and local government rulings differ between states. The ASPS and ACS describe several criteria for resumption of low-risk cases. This includes a 14-day trend of declining cases in the

Table 1. Risk Classification and Recommendations in Maxillofacial Surgery during SARS-CoV-2

Risk Classification	Condition	Recommendation	Rationale
Low Risk	**Orthognathic**		The CDC, ACS, and ASPS recommend postponing all elective procedures and in-person clinic appointments until further notice. In the meantime, telemedicine consultation can be used to track patient compliance, give advice, and determine next steps.
		Telemedicine consultation between the patient and physician to ensure no immediate risk and to determine operation timeframe.	
	Congenital Craniomaxillofacial		
	Cleft lip/palate Craniosynostosis Craniofacial syndromes	Telemedicine consultation between the patient and physician to ensure no immediate risk and to determine operation timeframe.	
	Cosmetic		
	Facelift Rhinoplasty Other cosmetic procedures	Telemedicine consultation between the patient and physician. Postpone until after pandemic.	
	Postoperative Follow-up		
	Any low-risk follow-up	Telemedicine consultation between the patient and physician to determine postoperative progression.	
Intermediate Risk	**Oncologic**		Telemedicine consultation will allow appropriate visual examination of facial and intraoral lesions to determine timeframe of safe operation, while minimizing the risk of infection exposure.
	Benign/slow-growing facial tumors Benign/slow-growing intraoral tumors	Telemedicine consultation between the patient and physician for appropriate evaluation. Deferral of surgical intervention for 2 wk or until pandemic is under control.	
	Trauma		Conservative management in the ED minimizes foot traffic and risk of infection spread, while also allowing surgeons to focus on higher risk cases.
	Intraoral lacerations Closed fracture—little functional impairment	Presenting to ED: conservative management in the ED with appropriate PPE and avoidance of AGP.	
	Uncomplicated nasal fractures Dentoalveolar fractures Cystic lesions	Telemedicine consult: use images and history to determine immediate risk and next steps.	Telemedicine consultation will allow appropriate visual examination of facial and intraoral lesions to determine next steps in management, while minimizing risk of infection exposure.
High Risk	**Oncologic**		Prompt surgical removal of malignant lesions minimizes the riskof metastasis.
	Malignant tumors of face Malignant intraoral tumors	Maintain scheduled surgery. Operate with adherence to guidelines recommended by the CDC. If no surgery is scheduled, consult via telemedicine. Proceed with urgent surgery, if necessary.	
	Trauma		If there is no immediate threat to the patient, and the patient remains stable, urgent management is not associated with poorer outcomes when compared with urgent management of facial trauma. Immediate risk is determined by hemodynamic instability, loss of patent airway, or risk of nerve damage.
	Facial burns	Manage in ED if no immediate risk. Consider follow-up with burn center.	
	Nerve entrapment or damage	Manage in ED if no immediate risk. If patient develops the risk of impending nerve damage, manage emergently.	
	Orbital fractures	Manage in ED if no immediate risk. If patient develops the risk of impending vision loss or nerve damage, manage emergently.	
	Eyelid and lacrimal injuries	Manage in ED if no immediate risk. If globe inspection necessitates surgery, proceed urgently.	
	Complicated nasal fractures	Manage in the ED if no immediate risk. If hematoma evacuation is required, proceed urgently.	
	Open fractures Zygomatic fractures Maxillary fractures Mandible fractures	Manage in the ED if no immediate risk. Proceed with surgery urgently if necessary.	
	Infectious		
	Severe head and neck infections without risk of sepsis or airway compromise	Manage in ED and proceed to surgery urgently.	
Life Threatening	**Trauma**		Emergent surgical management of patients at risk of hemodynamic instability and/or airway compromise improves outcomes. Resuscitation, airway control, and surgery should occur immediately.
	Severe hemorrhage Airway compromise Expanding hematoma Penetrating facial injury	Manage with resuscitation and airway stabilization. Proceed to surgery emergently. For penetrating facial trauma, consider appropriate management to minimize risk of permanent facial damage.	
	Infectious		
	Severe head and neck infections with risk of sepsis or airway compromise	Resuscitate, stabilize, and initiate prophylactic infection control. Proceed to surgery emergently.	

state, authorization by local health authorities, the presence of appropriate medical supplies, and the presence of an adequate number of educated staff.[29,66] For the foreseeable future, all patients undergoing low-risk surgery should be tested for COVID-19 beforehand.[23,29,67] Examples of low-risk cases include cosmetic cases, injections, implants, and postoperative follow-up.

INTERMEDIATE-RISK AND HIGH-RISK

Intermediate risk and high-risk patients present in stable condition but have injuries or underlying medical issues that will likely require intervention. Initial evaluation will determine if these patients require surgery. These cases are not immediately life threatening. If indicated, intervention for high-risk cases should occur within 24 hours, while intervention for intermediate-risk cases can occur within 2 weeks. All patients should undergo preoperative testing for COVID-19. Examples of high-risk cases include certain malignant tumors, certain open fractures, and traumatic injuries with the possibility of long-term sequelae if not addressed expeditiously. Examples of intermediate-risk cases include benign tumors, cystic lesions, intraoral lacerations, and uncomplicated fractures.

LIFE-THREATENING

Life-Threatening cases are those that present an immediate threat to life, limb, or vision. These patients should be treated immediately, usually with surgical intervention. This includes patients presenting with severe hemorrhage, expanding hematoma of the neck or orbital region, or airway compromise. Preoperative testing may not be possible in this situation.

POSTOPERATIVE CONSIDERATIONS

Proper postoperative care is crucial to prevent adverse outcomes and ensuring the health and safety of the patient, staff, and healthcare team. Additionally, some conditions may predispose the patient to a greater risk of postoperative complications and lengthened hospital stay, potentially increasing risk of infection.[68,69] It is the surgeon's responsibility to ensure thorough interdisciplinary postoperative patient management involving accessory staff as well as provide education on signs, symptoms, and sequelae of COVID-19. This is particularly relevant in emergent surgical situations, in which time constraints and patient risk prevented preoperative testing.

Evidence suggests that patients infected with COVID-19 can present with "cytokine storm syndrome" in addition to fever and acute respiratory failure.[70] This specific "cytokine storm syndrome" manifests as significant hypotension, high fever, and dyspnea. In emergent situations where preoperative testing was not performed, patients presenting with these symptoms should be evaluated for SARS-CoV-2 infection using viral PCR testing and treated supportively.[53] In the event of a positive test, patients should be transferred to a negative-pressure isolation room in the designated SARS-CoV-2 ward, and standard treatment protocol for SARS-CoV-2 should be employed.[53]

Emerging evidence suggests that SARS-CoV-2 patients are prone to coagulopathic complications similar to disseminated intravascular coagulopathy (DIC) as a result of inflammation induced by the infection. Additionally, hypoxia can initiate thrombosis through increased blood viscosity as well as a hypoxia-inducible transcription factor dependent pathway.[71] The hallmark findings of SARS-CoV-2-induced coagulopathy are elevations in fibrinogen and D-dimer levels.[72] This pattern is distinct from the classic presentation seen in DIC from trauma or sepsis.[71,72] In SARS-CoV-2-induced DIC, aPTT elevation is almost always less than PT elevation, microangiopathy is absent, and only a mild thrombocytopenia is seen.[53,72] Many postoperative patients are prone to deep vein thrombosis at baseline due to their relative lack of mobility. Thromboprophylaxis with low-molecular-weight-heparin should be initiated in all hospitalized patients with SARS-CoV-2 infection, and abnormal an PT/aPTT test is not a contraindication.[72] The American Society of Hematology and the International Society of Thrombosis and Hemostasis recommends monitoring platelet count, PT/aPTT, D-dimer, and fibrinogen.[72] Importantly, elevated D-dimer has been suggested to be a prognostic indicator of DIC in SARS-CoV-2 patients, and recent studies have suggested that therapeutic anticoagulation should be initiated using aspirin and LMWH.[73–75]

Other specific complications related to SARS-CoV-2 may affect postoperative management of patients undergoing emergency surgery. Acute respiratory distress syndrome has been described extensively as a common cause of morbidity and mortality in SARS-CoV-2-positive patients.[76,77] Additionally, one study noted that patients who developed SARS-CoV-2 pneumonia often developed renal failure, which presented with proteinuria, hematuria, and acute kidney injury. While most patients who developed renal failure recovered within 3 weeks of onset, renal failure was associated with a higher rate of mortality in SARS-CoV-2 patients.[78] Other studies report evidence of patients suffering from acute liver failure, acute cardiovascular failure, and secondary infection. Each of these complications should be considered by surgeons during the postoperative care period when caring for patients who have undergone emergency surgery or for patients who have previously tested positive for SARS-CoV-2.[78–80]

LIMITATIONS

Several limitations of this review should be acknowledged. First and foremost, the COVID-19 pandemic is a rapidly evolving situation and new literature is published daily. Guidelines proposed by public health authorities are constantly being updated and may evolve from the current sources on which we base our recommendations.

CONCLUSIONS

The SARS-CoV-2 pandemic has put pressure on the healthcare system to adapt rapidly, and continue adapting as new guidelines and evidence emerge. Facial surgeons may be at a higher risk of contracting and transmitting

COVID-19, warranting additional protective precautions in the preoperative and intraoperative period until the pandemic has resolved or until public health authorities deem these precautions no longer necessary. Regarding postoperative considerations, our literature review, management suggestions, and risk-assessment model are consistent with the standard of care suggested by the CDC, WHO, ACS, and AO CMF. While the guidelines and recommendations outlined in this article are not exhaustive, our synthesis of available evidence may be used to help facial surgeons stratify risk and prioritize decision-making across the continuum of care.

Although these suggestions and considerations are of particular importance at this time, practice restrictions may be re-implemented in the event of a SARS-CoV-2 resurgence. Furthermore, as facial surgeons resume nonemergent procedures, telemedicine consultation and preoperative COVID-19 testing remain extremely important to the health and safety of patients and providers. We hope that this review may serve as a starting point for facial surgeons when considering ways to optimize efficiency and maintain continuity of care during and after the COVID-19 pandemic.

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