

# Recommendations for Orthopedic Surgeons during the COVID-19 Pandemic

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## ABSTRACT

**Background:** Toward the end of 2019, the coronavirus disease-2019 (COVID-19) pandemic began to create turmoil for global health organizations. The illness, caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), spreads by droplets and fomites and can rapidly lead to life-threatening lung disease, especially for the old and those with health co-morbidities. Treating orthopedic patients, who presented with COVID-19 while avoiding nosocomial transmission, became of paramount importance.

**Objectives:** To present relevant methods for pandemic control and hospital accommodation with emphasis on orthopedic surgery.

**Methods:** We searched search PubMed and Google Scholar electronic databases using the following keywords: COVID-19, SARS-CoV-2, screening tools, personal protective equipment, and surgery triage.

**Results:** We included 25 records in our analysis. The recommendations from these records were divided into the following categories: COVID-19 disease, managing orthopedic surgery in the COVID-19 era, general institution precautions, triage of orthopedic surgeries, preoperative assessment, surgical room setting, personal protection equipment, anesthesia, orthopedic surgery technical precautions, and department stay and rehabilitation.

**Conclusions:** Special accommodations tailored for each medical facility, based on disease burden and available resources can improve patient and staff safety and reduce elective surgery cancellations. This article will assist orthopedic surgeons during the COVID-19 medical crisis, and possibly for future pandemics.

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**KEY WORDS:** coronavirus disease-2019 (COVID-19), personal protective equipment, screening tools, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), surgery triage

The coronavirus disease-2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is a global health crisis of pandemic proportions. Since the first case in December 2019 in Wuhan province, China, the virus has spread exponentially around the world. As of September 2021, there were more the 220 million confirmed cases and more the 4.6 million confirmed deaths worldwide [1]. As such, global health services were reformed to accommodate issues caused by the pandemic.

The challenge is complex. Lack of hospital beds due to opening of special corona departments, shortage of personal protective equipment (PPE) and screening kits, and lack of staff are just some of the difficulties that have been encountered. The current state of health systems in many places of the world has led to decrease of elective and semi-elective surgeries. Urgent and emergent challenges are treated with adequate safety measures [2]. Centers for Medicare and Medicaid Services (CMS), the American College of Surgeons (ACS), and the U.S. Surgeon General supported delaying elective surgeries during the first wave [3].

Our aim was to increase safety for both the orthopedic patient and the surgeon while minimizing morbidity by presenting relevant evidence, practicalities, and recommendations for pandemic control.

## PATIENTS AND METHODS

We conducted literature-based research from 1 December 2019 until 1 January 2021. Inclusion criteria included COVID-19 articles related to general and orthopedic surgery, pandemic guidelines and hospital and operating room recommendations. Exclusion criteria included literature not available in English and not relevant to orthopedic surgery or found to be biased by the reviewers. Search engines used were PubMed and Google Scholar. We used the following keywords: COVID-19, SARS-CoV-2, screening tools, personal protective equipment, and surgery triage. Data were reviewed by two orthopedic surgeons from two different hospitals.

## RESULTS

A total of 63 records were found. Following exclusion of irrelevant articles and duplications, a total of 25 records were analyzed [1-25]. Included records were analyzed for key recommendations and specific guidelines and divided into the following categories: COVID-19 disease, managing orthopedic surgery in the COVID-19 era, general institute precautions, triage of orthopedic surgeries, preoperative assessment, surgical room setting, personal protection equipment, anesthesia, orthopedic surgery technical precautions, and department stay and rehabilitation.

### COVID-19 DISEASE

COVID-19 disease is caused by the SARS-CoV-2 virus, which is a single-stranded RNA virus, from b-coronavirus 2b lineage. Transmission is made by aerosols, droplets caused by sneezing or coughing, and fomites. COVID-19 has a relatively low reproduction number of approximately two; thus each carrier transmits the disease to two more persons and can be transmitted by asymptomatic patients [4]. On average, symptoms appear 5 days after exposure and symptoms-to-death period is between 6 and 41 days, less among patients older than 70 and with decreased immunity, diabetes, or cardiovascular disease [5]. Symptoms usually include fever, fatigue, and cough, but may encompass fatigue, sore throat, headache, abdominal pain, and diarrhea. Complications that lead to death are usually acute respiratory distress syndrome (ARDS) with typical ground glass opacities on chest X-ray, pneumonia, and acute cardiac injury [6-8]. Mortality rates range between 4–5% [9].

Healthcare workers are exposed to this virus. While subspecialties like otorhinolaryngology and anesthesia are exposed to upper airway secretions more often, orthopedic surgeons are at risk as well. In a study conducted in Wuhan by Guo et al., up to 20 % of orthopedic surgeons were identified as COVID-19 positive [10].

### MANAGING ORTHOPEDIC SURGERY IN THE COVID-19 ERA

Orthopedic patients need medical attention either acutely, such as fracture stabilization and cauda equina or electively like arthroplasty or carpal tunnel release. In addition, patients need rehabilitation programs and follow-up visits.

### GENERAL INSTITUTE PRECAUTIONS

Screening is a vital tool. Beginning at the entrance to the facility, patients should have their temperature checked. Asking about common symptoms, such as rhinorrhea and fever can reduce hazardous exposure. If possible, all patients admitted to the hospital should have serologic testing for COVID-19. Two successive tests are sometimes required [11].

Reduction of intra-hospital spread is achieved with standard precautions for all patients and visitors. Examples of precautions include practicing social distancing of a minimum of 2

meters, hospitalizing fewer patients per room, and reducing the number of visitors to a minimum.

Staff planning is crucial, as shortages may be expected due to preventive quarantine or surge in the number of patients. In some institutes, personnel have been divided to organic shifts to halt spread.

Proper alert signs installation can reduce unnecessary exposure of visitors and staff to virus-designated areas. Primary engineering controls, such as proper ventilation of open spaces and wards and disinfection of contaminated surfaces distance, are proven steps to reducing viral distribution [12].

### TRIAGE OF ORTHOPEDIC SURGERIES

Following triage, fractures, vascular compromise, compartment syndrome, and infection should be treated without delay [11]. During the first wave in the United States, most elective orthopedic operations were rescheduled to save medical resources, such as PPE, and to free hospital beds and personnel for corona departments [13]. Unfortunately, postponement of some elective orthopedic operations can lead to unwanted results such as risk of myelopathy in delaying herniated cervical disk decompression.

There is no clear global consensus regarding which surgeries should not be delayed. During the first wave, the American College of Surgeons supported delaying of all elective surgeries and published a guide for the triage of orthopedic surgeries under the COVID-19 restriction. The recommendation for orthopedic surgeries is phase dependent [4,13,14]:

- Phase 1: Few COVID-19 patients and hospital resources, such as intensive care units (ICUs), ventilators, and staff are not exhausted
- Phase 2: Many COVID-19 patients with limited resources
- Phase 3: All hospital resources are routed to COVID-19 patients

A different approach of stratification of elective surgery was proposed by Stahel [2]. He divided elective surgery to essentials such as reconstructive surgery and discretionary, such as arthroplasty and sport surgery. In addition, the procedure is delayed if the patient is classified as at a high-risk of COVID-19, has increased American Society of Anesthesiologists classification, or is predicted to require blood products or intensive care treatment.

### PREOPERATIVE ASSESSMENT

Exposure can be reduced when performing an examination of patients. Extraction of data from electronic logs and past medical history should be conducted in a separate room. Physical examination be undertaken in a corona designated room and with full PPE [14].

Anamnesis is difficult as patients are unaccompanied and there may be difficulty understanding the speech while wearing a mask. Cast removal by oscillating saw can increase aerosols.

All orthopedic equipment required for cast removal or bandage removal should be sterilized.

In a retrospective study by Zhou et al. [15] in Wuhan, 54 of 191 patients with COVID-19 died in the hospital and were retrospectively assessed for risk factors: old age, high sequential organ failure assessment (SOFA) score, lymphopenia, diabetes, and D-dimer greater than 1 µg/ml were found to be indicators for poor prognosis. In these high-risk patients, orthopedic surgery should be avoided. An exception is proximal femoral fragility fractures. Catellani and colleagues [16] showed stabilization of respiratory parameters after reduction and fixation in COVID-19 positive patients.

**SURGICAL ROOM SETTING**

Operating rooms (OR) should be set to corona mode. Preferably, a whole OR complex would be allocated specifically for COVID-19 patients. Unnecessary equipment, such as a tourniquet in hip fracture reduction and internal fixation, should be removed from the room.

Ideally, the same staff should work on the parameter, preferably younger than 60 years of age. During the first wave, the areas in the United States that had the highest number of orthopedic surgeons older than 60 years old were overwhelmed by COVID-19 [17].

Maximum ventilation with high-efficiency particulate air (HEPA) filters should be installed and operated in negative pressure, unlike standard operating rooms with positive pressure aimed to reduce inflow of pathogens [18].

The entrance and exit to the OR should be kept with one-direction doors and buffered by anterooms to dress and undress and specific alerts and signs should be posted to reduce staff movement and exposure. Anesthesia should be performed outside the room as intubation can cause aerosols [19].

**PERSONAL PROTECTION EQUIPMENT**

When treating a positive or suspected COVID-19 patient, full PPE should be used. From head to toe, the following items are recommended [4]: hair covers, eye protection, protection from side exposure with side shields or goggles, and respiratory protection.

**RESPIRATORY PROTECTION INCLUDES**

- N95 respirators: The use of properly sealed N95 respirators is recommended by the U.S. National Institute for Occupational Safety and Health when treating COVID-19 patients. The pandemic has caused an increased demand and substantial shortage of PPE around the globe, especially respirators [20]. The U.S. Centers for Disease Control and Prevention made special exceptions regarding the N95 series mask and allowed the use of out of date respirators except during surgeries. The rationale is that expired respirators enable better protection than common surgical or improvised masks [21].
- Powered air purifying respirators with HEPA filters provide superior protection and can assist orthopedic surgeons by cre-

ating better visibility with less goggle condensation and reduction in the chances of dislodgement and seal loss while performing aggressive manipulations such as reduction of dislocated hip or caring for the polytrauma or agitated patient.

Additional equipment includes full face shield, fluid-resistant gown, worn over scrubs, gloves with long sleeve and taping, and impermeable surgical room shoes with single-use cover.

The use of orthopedic helmets, used often in arthroplasties, does not provide sufficient protection from microscopic viruses and should not replace the use of N95 ventilators [22]. The order of donning sterile PPE and scrubbing is subject to changes by state and medical institutes. For orthopedic surgery, we found the protocol presented by Rodrigues and co-authors [6] to be simple and helpful [Table 1].

**Table 1.** Scrubbing for COVID-19 positive patient: recommended order of actions

1. Feet covering or single use boots
2. Lead shield body and thyroid
3. Surgical suit
4. Surgical mask
5. Test mask seal
6. Face shield
7. Scrubbing.
8. Sterile gloves
9. Sterile surgical gown
10. Surgical sleeve
11. Entrance into operating room with patient already anesthetized

**ANESTHESIA**

General anesthesia with tracheal intubation has the potential to spread aerosols. Some experts recommend a 15 minute wait before entering the room after intubation [19,22]. As orthopedic surgeons, we can often convert general anesthesia to local anesthesia or use a block. Not only will this reduce the chance of spreading contagious aerosols, it will also reduce the general burden on our anesthesiologists and enable them to assist in other departments, such as the ICU. If intubation is required, the use of powered air-purifying respirators can be justified [18,22].

Intubation should be conducted in a different room and the surgeon should enter the OR after the patient is already intubated and properly draped.

**ORTHOPEDIC SURGERY TECHNICAL PRECAUTIONS**

As Winston Churchill said, “*failing to plan is planning to fail*”. This citation cannot be over-emphasized in the era of the COVID-19 pandemic.

Demanding impractical equipment and standby surgical kits will increase the risk and OR logistic burden. Predicting the

right measured nail or screw and considering the right approach will all reduce operative time and risk of exposure.

Last, electrocautery has been found to cause aerosols and therefore should be used with caution, accompanied with air suction [23].

We recommend closure of all wounds with absorbable sutures to avoid another outpatient procedure and to reduce the risk of exposure.

#### DEPARTMENT STAY AND REHABILITATION

As most orthopedic surgeries expected during this pandemic period will be acute in nature, there is a high probability they will be comprised of trauma, especially hip fractures and infections of various types. These situations will require a postoperative department stay and rehabilitation.

Some aspects of rehabilitation, such as daily physiotherapy exercise or occupational therapy exercises, can be conducted by video chat or a proper explanation prior to discharge. Patients can independently change bandages, thereby further reducing contact. The same is true of follow-up visits, many of which can be executed by telehealth or video chat. Special concern should be addressed to proper privacy issues, as not all applications are safe. Currently, Apple's Facetime and a special version of Zoom are approved by the U.S. Health Insurance Portability and Accountability (HIPAA). Video chats are an excellent tool to examine and guide the patients and to provide mental support and encouragement.

#### DISCUSSION

We created a one-stop-shop article for orthopedic surgeons in the COVID-19 pandemic era. As information is accumulating and experience is gathered, we hope this pathogen's mortality and morbidity will be reduced substantially.

We are all familiar with the concepts of damage control orthopedics (DCO) and we believe some of the concepts can be applied to COVID-19 orthopedic patients; for example, postponing unnecessary operations or installing a temporary external fixation reduce the cytokine storm which is common in both COVID-19 and polytrauma patients.

If this is a type of war, our most valuable weapon is PPE and protocols. Unfortunately, a global shortage of PPE has led to standard reductions such as incorporating outdated ventilators in daily practice. All efforts must be made to save this valuable tool.

The subject of halting elective surgeries has become the source of a great dispute. Saving hospital resources is crucial at this time but, according to a study by Zhang et al [24], more than 50% of all elective surgical cases have a potential to inflict significant harm on patients if cancelled or delayed.

The economic toll is enormous. The COVID-19 pandemic is threatening the viability of some hospitals, which are in imminent danger of bankruptcy [16]. Another important aspect is that orthopedic surgery accounts for 17% of all operating room procedures

in the United States [25] and, if elective surgery is not enabled soon, the crisis can reach an unprecedented medical recession.

#### CONCLUSIONS

Orthopedic surgeons should create clear guidelines in parallel with state or country protocols per their hospital or department, with detailed criteria indicating which patients are candidates for acute surgical treatment and which can be postponed. We should be ready for the post-corona era in which neglected patients will present with complications resulting from inappropriate care.

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**Capsule**

**Tumor immunology: a unique T cell subset in lung cancer**

Although some non-small-cell lung cancers (NSCLCs) are sensitive to immune checkpoint blockade (ICB), many patients with NSCLC do not respond to ICB, and this may be related to the lack of infiltration of CD8+ T cells. **Horton** and co-authors used mouse models of flank and lung tumors to show that CD8+ T cells from lung tumors, but not flank tumors, had a dysfunctional phenotype distinct from conventional T cell exhaustion that was

established in the draining lymph node and correlated to ICB resistance. Interleukin-2 and Interleukin-12 treatment rescued this phenotype, leading to control of lung tumors. These data suggest that cytokine therapy might be able to rescue a specific subset of dysfunctional T cells found in lung tumors.

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**Capsule**

**SARS-CoV-2 B.1.617.2 Delta variant replication and immune evasion**

The B.1.617.2 (Delta) variant of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was first identified in the state of Maharashtra in late 2020 and spread throughout India, outcompeting pre-existing lineages including B.1.617.1 (Kappa) and B.1.1.7 (Alpha). In vitro, B.1.617.2 is sixfold less sensitive to serum neutralizing antibodies from recovered individuals, and eightfold less sensitive to vaccine-elicited antibodies, compared with wild-type Wuhan-1 bearing D614G. Serum neutralizing titers against B.1.617.2 were lower in ChAdOx1 vaccinees than in BNT162b2 vaccinees. B.1.617.2 spike pseudotyped viruses exhibited compromised sensitivity to monoclonal antibodies to the receptor-binding domain and the amino-terminal domain. B.1.617.2 demonstrated higher replication efficiency than B.1.1.7 in both airway organoid and human airway epithelial systems, associated with B.1.617.2 spike being in a predominantly cleaved state compared with B.1.1.7 spike. The B.1.617.2 spike protein

was able to mediate highly efficient syncytium formation that was less sensitive to inhibition by neutralizing antibody, compared with that of wild-type spike. **Micochva** and colleagues also observed that B.1.617.2 had higher replication and spike-mediated entry than B.1.617.1, potentially explaining the B.1.617.2 dominance. In an analysis of more than 130 SARS-CoV-2-infected health care workers across three centers in India during a period of mixed lineage circulation, we observed reduced ChAdOx1 vaccine effectiveness against B.1.617.2 relative to non-B.1.617.2, with the caveat of possible residual confounding. Compromised vaccine efficacy against the highly fit and immune-evasive B.1.617.2 Delta variant warrants continued infection control measures in the post-vaccination era.

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