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Changes in the trends of orthopedic services due to the COVID-19 pandemic: A Review

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Abstract

As of June 10, 2022, the World Health Organization has recorded over 532 million documented Coronavirus Disease 2019 (COVID-19) [(Coronavirus) Sars-COV-2] cases and almost 6.3 million deaths worldwide, which has caused strain on medical specialties globally. The aim of this review is to explore the impact that Covid-19 has had on orthopedic practices. Providers observed a rapid decline in the number of orthopedic patients' admission due to cancellation of elective procedures, however, emergent cases still required treatment. Various observational studies, case reports, and clinical trials were collected through a PubMed database search. Additional sources were found through Google. The search was refined to publications in English and between the years of 2019 and 2021. The keywords used were "COVID-19" and/or "Orthopedic Injuries". Thirty-seven studies were retained. The pandemic brought on significant changes to the mechanism of injury, number of admissions, type of injuries and patient outcomes. Mortality rates significantly increased particularly amongst patients with hip fractures and COVID-19. Road traffic injuries remained a common cause of injury and domestic injuries became more prevalent with lockdown. Social isolation negatively affected mental health resulting in several orthopedic injuries. Telehealth services and separation for COVID-positive and COVID-negative patients benefited both patients and providers.

While hospitals and medical facilities are still facing COVID-19 case surges, it is important to understand how this pandemic has impacted preparation, care, and opportunities for prevention education and ongoing care.

Key Words: Orthopedics; Surgery; Lockdown; Mental health; Telehealth; COVID-19

Core Tip: Previous and impending surges of Coronavirus 2019 (COVID-19) have caused a disruption in orthopedic specialties in elective procedures and changed the causation and outcomes of emergent cases. The pandemic has also impacted patient care and short-term and long-term outcomes.

INTRODUCTION

Now entering the third year of the Coronavirus 2019 (COVID-19) [Coronavirus (SARS-CoV-2)] pandemic, the number of globally reported cases continues to increase at a rapid rate despite the introduction of authorized vaccines. As of June 10, 2022, there have been almost 532 million cases and over 6.3 million deaths worldwide[1]. Hospitals continue to be overwhelmed with positive cases as new variants emerge. Hospital protocols in patient care have been changing to keep health care workers and patients safe and to keep resources on hand[2]. Non-emergent procedures were delayed in stages to reduce the burden on healthcare services. The long-term effects of these delays have not yet been fully understood as the pandemic continues. These delays occurred across all specialties. In particular, many orthopedic surgeries were postponed being one of the most common specialties to oversee elective procedures.

The lockdown brought on by the pandemic presented many challenges; routine procedures became more complex, patients were forced to seek medical care later than anticipated due to fear of contracting the disease or an overload in medical care facilities, and unavailability of rehabilitation centers post-operatively due to COVID-19 restrictions. Furthermore, limited mobility in certain age groups may have impacted bone and joint health. The focus of this review is to assess the overall impact COVID-19 has

had on patient care in the orthopedic service and evaluate new management methods for future implementation.

CLINICAL PRESENTATIONS

The PubMed database was searched for relevant studies. The search was refined to publications in English and between the years 2019 and 2021. The keywords used were "COVID-19" and/or "Orthopedic Injuries". Observational studies, clinical trials, and case reports were included in the selection process. Reviews, meta-analyses, and systematic reviews were excluded. Articles that were related to spinal injuries or oncology were also excluded due to the complex nature of these cases. This review was performed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Additional resources were found using a Google web search. The Baishideng Publishing Group Reference Citation Analysis (RCA) tool was used to create and verify citations according to the journal's guidelines. The RCA tool also provided the Impact Index for articles.

Lower extremity fractures

Campbell *et al*[3] utilized a prospective and retrospective study to compare the management of Open Lower Limb Fractures (oLLF) pre- and peri-COVID pandemic period. Open Lower Limb Fractures comprised of open fractures of long bones, and hind or mid foot. A 64% reduction in ED attendances 25264 pre-COVID compared to 9042 peri-COVID and 18% reduction in oLLF has been observed. Despite a decrease of almost 50% in traffic, road traffic accidents (RTA) were still the most common cause of injury in this COVID period. There was a rise in incidents of oLLFs following a fall from a height. Mostly seen in relatively young patients due to increased incidence of suicide. Despite reassignments of junior surgical staff, some senior level surgical staff remained committed to provide emergency orthopedic surgery care that resulted in timely intervention of open long bone fractures.

Hip Fractures & outcomes

Egol *et al*[4] researched the mortality and major complications in hip fracture care during the pandemic across seven musculoskeletal care centers across New York. The study focused on the health care system's response to the essential care of its hip fracture patients and its effects on patient outcomes. This prospective study was employed from February 1, 2020 through April 15, 2020, to compare 138 recent and 115 pre-COVID hip fracture patients. Patients with recent hip fractures were grouped into three classes: COVID-positive, suspected COVID and COVID-negative groups. The COVID-negative patients underwent surgery immediately whereas COVID-positive patients' surgery was delayed. The approach to surgery for hip fractures was the same regardless of COVID status. The majority of patients received general anesthesia and a proportion of patients underwent spinal anesthesia. As expected, higher mortality was found in COVID-positive patients compared to suspected or COVID-negative patients: 35.3%, 7.1% and 0.9% respectively.

Ojeda-Thies *et al*[5] retrospectively studied patients treated for hip fractures during COVID-19 pandemic from March 1, 2020 through May 1, 2020. This center divided 64 patients into three cohorts: pre-cohort of 17 patients, COVID-positive of 14 patients and COVID-negative of 33 patient groups. More than 90% of patients received spinal anesthesia. There was a higher incidence of COVID positivity (23.5%) rate after the patients were discharged from the hospital following hip surgery and 50% of those patients died. That resulted in separating the anesthesia circuit for COVID-positive and COVID-negative patients. The study revealed that separate circuits for COVID-19 and non-COVID-19 patients allows adequate hip fracture care, despite delayed surgery in patients with severe respiratory illness from COVID. Separating patients that were not infected from those that were, helped with the efficiency of treating fractures amongst COVID-negative patients and significantly reduced the 30-d mortality and the conversion rates.

Tyas *et al*[6] studied the effect of COVID-19 on Best Practice Tariff of Hip fracture in 40000 patients collected from the National Hip Fracture Database (NHFD) from

England, Wales, and Northern Ireland. Best Practice Tariff was used to optimize care for patients, incentivize providers, and yield better outcome. Quality metrics such as timely surgery, post-operative delirium, 30-d mortality, hospital length of stay, and timely orthogeriatric review were assessed. Researchers concluded that COVID-19 Led to a significant reduction in best practice tariff. Prompt geriatric review dropped over the review period. Significant changes in bone health assessments, reduction in falls assessments, and post-op delirium were also observed. Mortality rates peaked at 13.7%. Therefore, it is important to maintain the quality care and assessment of geriatric hip fractures and management in next pandemic.

Gao *et al*[7] piloted a study at a hospital in China for tracking hip fracture patients post operatively and providing rehabilitation guidance using a chat software called WeChat. The study selected 80 patients and divided them into two equal groups of observation and control. The control group was given traditional discharge instructions and the observation group received additional instructions that provided continuous instruction of physical therapy exercises through WeChat apps. This study was done at the peak season of COVID 19 infection between February 1, 2020 to April 30, 2020. Complications and mortality were significantly higher in the control group. Complications observed include urinary tract infections (UTIs), deep vein thrombosis, dislocation or fracture around prosthesis, surgical site infection, and pneumonia. It was recommended that during the COVID-19 pandemic, it was helpful to use WeChat or another similar chat software to guide the rehabilitation of hip fractures to minimize post-operative complications.

LeBrun *et al*[8] studied 59 hip fracture patients in New York City over a five-week period, from March 20, 2020 to April 25, 2020 during the COVID-19 pandemic. Centralized care was established for emergency hip fracture management. Patients were separated into COVID-positive and COVID-negative groups based on infection status. The study showed that hospital mortality was significantly increased in the COVID-positive patients (56%) compared to COVID-negative patients (4%). All deaths in COVID-

positive patients were related to COVID. COVID-positive patients were also at higher risk for complications such as pneumonia or hyperinflammation.

Hall *et al*[9] assessed the effects of COVID-19 on 30-day mortality for 317 patients with hip fractures in a multicenter retrospective study. The effects of social lockdown on the epidemiology of hip fractures were also assessed. Results showed that COVID-19 was independently related with an increased risk of 30-day mortality in hip fracture patients.

Crozier-Shaw *et al*[10] studied hip fracture care pre-COVID (45 hip fractures) and peri-COVID (36 hip fractures). A 20% reduction in hip fracture presentation was noted however, the 30-day mortality was increased from 2.2% to 8.3%. Despite improved quality indicators that were observed in hip fracture management during COVID-19 period, there was 3-fold increase in mortality. Although, 4 patients tested positive on swab test for COVID 19, 2 of them died. Therefore, COVID-19 infection was associated with increased mortality in hip fracture patients that were positive and undergoing surgery. Researchers found that these findings will be important to apply to orthogeriatric care during future COVID-19 waves.

Galivanche *et al*[11] collected 42002 patients through claims data that had undergone hip fracture surgical repair between April and December 2020. Of these, 678 were COVID-positive and while there were no significant differences in age, sex or procedure type between the patients who were tested positive or negative for COVID-19, however, COVID-positive patients did present with a higher incidence of comorbidities. Propensity score matching was used to balance the two groups (COVID-positive *vs* COVID-negative). After matching, the COVID-19 positive group had a higher incidence of adverse events perioperatively such as venous thromboembolism (6.64% compared to 3.43%) and pneumonia (11.21% compared to 4.56%).

Catellani *et al*[12] studied 16 patients with femoral neck fractures that were COVID-positive with active infection and were receiving protocolized treatment for COVID-19 during the pandemic in northern Italy. Three patients died before surgery because of complications from COVID. After surgery, four patients died of respiratory failure. The overall mortality of hip fracture with active COVID-19 infection was 43.7%. Surgical

mortality of hip fracture in patients with active COVID-19 infection was 30.77%. Patient who underwent surgery in the face of active infection had to pass strict criteria. Most patients received spinal anesthesia. A stabilization of respiratory parameters was observed in COVID-positive patients after the surgery. It was suggested that surgery may have contributed to the overall respiratory stability of patients, mobilization, comfort, and improvement in physiological ventilation in COVID-19 positive patients with proximal femoral fragility fractures.

Mitkovic *et al*[13] investigated the frequency and distribution of orthopedic fractures during the stay-at-home lockdown in Serbia. Researchers examined how the lockdown influenced the frequency of different fracture types. Staying at home for 54 d decreased the total number of fractures by 18.9% and females were more likely to suffer from femoral neck fractures during this time. However, femoral neck fractures occurred more frequently in the state of lockdown than during the same period in a non-emergency state in 2019. Mitkovic type method of external fixation was assumed to be an alternative method of tibial fracture fixation during the lockdown. That methodology presumed to be a reducing factor of intraoperative COVID transmission among medical staff and hospitalization time.

Orfanos *et al*[14] performed a retrospective study on geriatric patients aged 60 years and above who sustained hip fracture after a fall in the United Kingdom. Of the 199 patients, 102 patients were included from the COVID-19 pandemic period and was compared to 97 patients from the same period in 2019. Approximately 11% of patients tested positive for COVID during the observation period. A higher proportion of female patients suffered hip fracture from a fall. However, mortality was found to be higher amongst males between the two groups ($P = 0.005$). There was no significant difference between the groups regarding 30-d all-cause mortality and morbidity. Early surgical intervention along with sufficient optimization prior to surgery of a COVID-positive patient's treatment were both critical for a patient's survival. Patients were also moved rapidly to rehabilitation facilities which aided in recovery.

Brayda-Bruno *et al*[15] studied 498 fracture patients in Italy during the COVID-19 pandemic to assess how the pandemic has changed traumatology and the hospital setting. It was assessed that unspecified femoral fractures were much more common in this time period than the previous time period (181/352 compared to 57/146). The average age of orthopedic patients prior to the pandemic was 61 years of age compared to during the pandemic which was 69 years of age. This institution required COVID-19 testing which expedited orthopedic services by separating COVID-negative and COVID-positive patients. Patients that were admitted as COVID-negative remained COVID-negative during admission. Ten patients died in the pandemic group compared to zero deaths in the control group. Out of ten, three patients died due to comorbidities and seven patients died due to thromboembolic events related to COVID-19. Time between diagnoses and discharge was significantly lower (P = 0.03) despite an increase in orthopedic cases. The difference was attributed to early operative intervention in the pandemic group.

Zagra *et al*[16] conducted a retrospective multicenter study in patients with periprosthetic fractures (PPF) during COVID-19 pandemic in northern Italy. Out of 1390 patients, 38 patients were found to be suffered from PPF. Most of the patients had femoral PPF. There was no difference in the incidence of PPF during pandemic when compared with the earlier year prior to pandemic. Routine screening for COVID-19 was performed and found around 10% or more with COVID-19 positivity because of positive test or the positive symptoms and imaging findings. Standard operative care was performed in PPF patients during the pandemic. Hip fracture was associated with increased 30-day mortality in COVID-positive patients compared to COVID negative patients. Approximately 60% of PPF patients developed complications.

In a letter to the editor, Muse *et al*[17] used a retrospective case series of five COVID-19 orthopedic patients who sustained hip fractures, one femoral neck fracture and four intertrochanteric fracture, that underwent surgery at Montefiore Medical Center, New York. As per recommendation, hip fracture should be repaired within 48 h of admission to reduce mortality and morbidity, but only three out of five patients underwent surgery

within the 48 h timeframe and two had surgeries after 72 h of admission. While regional anesthesia is safe for COVID-positive patients, spinal anesthesia was used to prevent viral aerosolization on four patients. Only one patient received general anesthesia. None of the patients died. The most common complication was the need for packed red blood cell transfusion. Providers suggested that surgical treatment plans can be delayed if necessary.

Foot and ankle

Shah *et al*[18] evaluated the impact of the pandemic on foot and ankle services in a single trauma center in the UK using a retrospective cohort study. A total of 206 patients were evaluated from admission to discharge to compare pre-lockdown and lockdown phases and stable and unstable fractures. Of 100 patients with a stable ankle fractures, 35 (35%) were discharged from the emergency department without a planned follow up. A majority of patients who presented unstable fractures required some form of interventions. Some of the patients were sent home with cast, advised elevation, non-weight bearing, and to follow up for definite treatment. In another group partial fixations were employed to reduce intraoperative time and avert the need for invasive surgeries. Most of the operated patients were followed up with in two weeks' time for a wound check. Patients were advised on pain and plaster management to avoid face-to-face interactions with providers. Telemedicine reduced the patient-physician contact and reduced the burden of follow up.

Kuliński *et al*[19] researched the effect of the COVID-19 pandemic on both elective and emergency foot surgeries on 145 orthopedic patients in Poland. The data showed reduction in the total number of orthopedic admissions by 55% during the pandemic. Elective orthopedic interventions declined by 72% and emergency orthopedic interventions increased by 27% during the pandemic as compared to pre-pandemic era. Length of hospital stay decreased by 2.5 days in adults and 1.7 days in children. There was a decline of 32% in the number of patients coming to ED for injuries. The pandemic did not affect the average age of patients and the male to female ratio. It is suggested that

the COVID-19 pandemic has affected the epidemiology and prevalence of foot surgeries in children and adults.

Al-Humadi *et al*[20] conducted a retrospective case series of 11 patients to investigate outcomes of lower extremity trauma surgery in COVID-19 positive patients. Most of the patients had hip fractures and rest sustained femur and tibia and fibular fractures. Orthopedic operations in COVID-19 positive patients were successfully done with patient anticoagulation, hematologic and pulmonary management. These three were optimized prior to surgery to reduce venous thromboembolic event and avoid blood transfusion. Complications such as DVT, acute renal failure, and pneumonia, still occurred and two patients died postoperatively. The patients who died were more than 50 years old and had prior history of more than one comorbid condition.

Upper extremity fractures

Dunkerley *et al*[21] noted that the pandemic has decreased operative intervention of unspecified upper extremity fractures and increased the use of telemedicine clinics. In this prospective study which was performed at the peak of the COVID-19 outbreak from April 14 through April 28, 2020. Of the 154 patients that were analyzed, 51% were managed as in a normal circumstance, whereas, 49% management were impacted by the pandemic. Of those affected, 12% were discharged at diagnosis with potentially unstable upper extremities fractures, this had the danger of mal-union. Additionally, 29% were discharged from the orthopedic virtual clinic as opposed to having in person clinical or radiological follow up. Nurses on the trauma team would virtually request patient care instructions from physicians working remotely. Discharged patients were fixated with removable immobilization. Follow-up surveys given to patients who were treated by the virtual clinic showed very high satisfaction rate of 4.8/5. While telemedicine played a vital role in orthopedic management as well as being economical and efficient to both patients and providers, there is a potential risk of poor outcomes such as mal-union, requiring corrective treatments in the future.

Diamond *et al*[22] conducted a multi-center study from two level I trauma centers in Pennsylvania and California. Researchers studied the occurrence of emergency upper extremity operations during the COVID-19 pandemic specifically during shelter-on-place orders. Injuries included trauma to the forearm, hand, wrist and finger emergency surgeries. It was found that there was a 40% increase in volume attributed to high-risk behavior which was defined as lawlessness, assault, and high-speed auto accidents. Additionally, it was found that home improvement projects, lack of social and physical resources, delay of treatment due to avoidance of treatment facilities are also impacting the high volume of upper extremity injuries.

Fyllos *et al*[23] compared the turnout of patients with orthopedic, upper extremity, and hand and wrist emergencies during pre-pandemic and peri-pandemic periods. During the pandemic, it was found that the numbers of patients with orthopedic, upper extremity, and hand and wrist problems (*e.g.*, arthritis, tendinopathy, *etc.*) were significantly reduced by 57.09%, 49.77% and 49.95% respectively compared to a patient population in 2019. However, upper extremity injury emergencies (*e.g.*, fractures, dislocations, *etc.*) increased from 37.17% to 43.32% and hand and wrist injury emergencies increased from 25.07% to 29.15%. Although other causes of injury have decreased, it is suggested the increase of domestic accidents from new hobbies during the lockdown have been the probable cause of the surge.

Gumina *et al*[24] evaluated 404 patients under the age of 18 that were treated at the trauma center for shoulder and elbow injuries before and during the pandemic (from March 8, 2020 through April 8, 2020). Young people typically incur high-energy injuries from social activities, school activities, sports, parks, and clubs. Due to the prohibition of these events, injuries caused by these activities were almost eliminated. There were no cases of contusions, physeal fractures, other fractures, or dislocations of the elbow. The shoulder and elbow injuries seen at this center were mainly caused by falls in the home, offering an opportunity for education.

Other injuries

Donovan *et al*[25] performed a retrospective case-controlled study at a Level 1 trauma center in the UK. Factors such as anatomical area of injury, cause of injury, operative procedure, type of anesthesia, total operating time, complications, and 30-day mortality were analyzed against a dataset of 248 patients. The 248-patient dataset was comprised of 142 patients that required 165 operations pre-pandemic and 106 peri-pandemic patients that underwent 124 operations. During the COVID period, the results showed a 30% decrease in overall orthopedic injuries due to reduced number of road traffic accidents and sporting injuries. Also, the number of hip fractures and low impact injuries remain the same. Operative time increased by 14 minutes due to the new PPE requirements. During COVID, a higher number of patients received spinal anesthesia and fewer patients received general anesthesia. Complications and mortality rates did not change. The incidence of COVID in the patients tested in the hospital and COVID in the general population at the time of the study was the same at 8.5%.

Maniscalco *et al*[26] conducted a study on the impact of COVID-19 on orthopedic traumas presenting to the emergency orthopedic departments in Parma and Piacenza Hospital, Italy evaluating patients admitted with proximal femur fractures. The study collected data for patients between February 22, 2020 to April 18, 2020 and was compared with 2019 data. The results showed a decrease in orthopedic cases at the ER by 26.8%. Regular mechanisms of injury vastly changed where 19.1% increase of the traumas occurring in the home, sports injuries decreasing by 75.3%, work injuries decreasing by 42.2% and school traumas reduced to 0%. A decrease in femur fractures from 38.9% to 33.5% was also observed during the pandemic. A higher mortality was reported during the pandemic in elderly patients with femur fracture due to COVID.

Druel *et al*[27] studied the effects of COVID-19 containment measures on 888 orthopedic trauma surgery during the pandemic at a trauma center in France. Participants were divided into three cohorts: reference, pre-containment, and containment groups. The occurrence of domestic accidents increased from 51.6% to 64.8% whereas work-related accidents, altercations, and RTA decreased. The decreased in number of cases (from 6.7% to 4.0%) could be due to fear of going to medical facilities,

fear of containment rules, or minimizing the seriousness of symptoms. Overall, the results showed a decrease of 28.7% in the number of patients undergoing trauma surgery services during the containment period.

Elbardesy *et al*[28] investigated the impact of COVID-19 pandemic on trauma and orthopedic center in Ireland among 505 patients. The study was conducted between March 1, 2020 and the April 14, 2020 and compared patients from 2019 on the same time period. The total number of trauma and orthopedic surgeries performed decreased by 10.5%. Likewise, the number of pediatric orthopedic procedures decreased by 40.32%. Adult distal radius and pediatric elbow fractures increased by 88% and 13% respectively while hip fractures remained the most common trauma. Overall, the COVID-19 pandemic led to a decrease in the total number of trauma surgeries. Notably fractures directly related to solo outdoor activities such as falls, running, cycling like ankle, radius, elbow and hand fractures increased.

Andreozzi *et al*[29] performed a retrospective comparative study of the impact of COVID-19 on orthopedic trauma in Italy. They analyzed the impact of the lockdown on acute orthopedic trauma. The overall number of admissions in the pre COVID era was 995 as compared to 204 during COVID-19 outbreak. Average age of patients (51.9 years old) was significantly higher during the pandemic as compared to pre-pandemic (41.4 years old). Most injuries (65.7%) occurred at home during the pandemic as compared to 32.3% pre-pandemic. The most injured extremity during pandemic was the hand (14.2%) compared to before the pandemic which was polytrauma (22.8%). While overall rates of acute traumas have decreased, incidence of hip fractures remained high indicating a need for focus on orthogeriatric care.

Kalem *et al*[30] studied the effect of COVID-19 pandemic on the prevalence and epidemiology on 361 orthopedic trauma patients in Turkey. The study examined the fractures distribution in three age categories (≤ 20 years, 21-64 years and ≥ 65 years). The overall number of admissions decreased by 50.9% and upper extremity injuries decreased by 65%. The type of trauma and the mechanism of injury changed with a significant increase in low energy trauma and the upper extremities more affected during the

pandemic (49.9% *vs* 30.5% peri-pandemic and pre-pandemic respectively). However, there was no difference in occurrence of fractures in geriatric patients. It is suggested that the decrease in admissions was parallel with a 40% decrease in overall human movement.

Elective surgeries

Clough *et al*[31] examined the risk of contracting COVID-19 in patients undergoing orthopedic surgery. The data was collected for March 2020 to June 2020. The 225 orthopedic trauma surgery patients were separated into three surgery sites to minimize the perioperative spread of COVID infection. At the acute site that had both COVID-positive and COVID-negative patients undergoing surgery for upper and lower limb fractures, the incidence of post-surgical COVID infection was 6.5% with a 50% mortality rate. While seven of the 84 patients (8.3%) who underwent surgeries for femoral neck fractures became positive, five died (71%). On the other hand, the patients who had surgeries in the hospital that only performed elective cases, only 0.9% patients developed COVID-19 without any mortality.

Practice pattern

Kale *et al*[32] analyzed the effects of COVID-19 on orthopedic practices. A survey study was conducted with orthopedic surgeons by Louisiana Orthopaedic Association (LOA) at the peak of the pandemic. The response rate of the survey was 33%. The survey found that most surgeons delayed their elective surgeries. The decrease of patients in offices resulted in substantial loss of revenue. Furthermore, there was an increase in pain and deformities in patients due to the delay in elective procedures. Researchers found that many surgeons increased their revenue with the use of telehealth. This adaptation opens a new era of medicine.

Meng *et al*[33] used a case series study at Beijing Chaoyang Hospital. Researchers aimed to analyze clinical outcomes of patients that were required to undergo orthopedic surgery. Fracture types included clavicle, scapular, vertebral compression, and upper and lower extremity fractures. Results showed an increase in average wait time from

injury to surgery of 8.7 ± 3.4 d in March and April 2020 from 4.6 ± 2.6 d in the same period in 2019, almost doubling waiting time for surgeries in the pandemic. A higher percentage of patients in pandemic developed complications such as pneumonia, fever, venous thromboembolism, and cardiovascular complications. This led to introduction of a novel clinical pathway for preoperative screening of COVID-19 in traumatic orthopedic patients thereby reducing waiting time from injury to surgery.

Patel *et al*[34] conducted a retrospective study on orthopedic patients in the UK during pre-COVID-19 (328 patients) and peri-COVID-19 (178 patients) eras. The sample included patients with periprosthetic, pelvis, spine, upper and lower extremity or multiple fractures. There was a reduction in orthopedic patients during the peri-COVID period and that restructuring of orthopedic services in response to the COVID-19 pandemic was associated with a delay in surgery (4.91 d compared to 2.94 d) and increased in severity of post-operative complications such as nausea, vomiting, superficial phlebitis. Complications, however, were not associated with COVID-19 status. Fast-track emergency operative orthopedic services during the pandemic were recommended.

Gupta *et al*[35] performed a retrospective study to compare the surgical management of upper and lower extremity open fractures during the pre-COVID (89 patients) and peri-COVID (52 patients) eras. The results showed that despite the decrease in total trauma cases, there were delays in presentation to the ED. Due to this interruption, there was a delay in administration of first dose of antibiotics, however, there was no significant delay in presentation to surgery. There was a trend of higher infection rate perhaps due to delay in antibiotics administration.

Saini *et al*[36] performed a retrospective study on 488 upper and lower limb fracture patients in India to explore the consequences of neglected and delayed care during and after the lockdown. It was discovered that the average delay in surgical time and hospital stay was significantly increased during each period. During lockdown, the average delay was 8.23 ± 6.1 days and after lockdown the average delay was 21.38 ± 26.14 days. Complications such as blood loss, stay in the ICU, surgical time, and requirement for

bone grafts was greatly increased after the lockdown period was over though not statistically significant. Out of 45 patients who developed non-union or malunion, 42 patients required corrective procedures.

Miscellaneous

Balakumar *et al*[37] researched the risk of operating on a variety of urgent orthopedic cases during the COVID-19 pandemic first lock down, between March 26, 2020 through May 20, 2020, for clinical decision making and efficiency of medical resource utilization. Researchers included 433 patients in the study. The average age of the patients was 65 years and a majority were involved in low energy mechanism and with femoral neck fracture being the dominant orthopedic injury. Of all patients, 72% were treated at an elective surgery site (ESS) and 23% were treated at major trauma centers (MTC). The overall mortality in femoral neck fracture was identified at 15.9%. Higher mortality was observed at the ESS (13.7%) compared to the MTC (7.7%). The higher mortality at the ESS was observed in patients who were tested positive for COVID (40.1% *vs* 20%). The main outcome was mortality risk considering orthopedic patients were being treated at the MTC which admitted both COVID-positive and COVID-negative patients. It was suggested that there was an 11% rate of contracting COVID-19 peri-operatively due to being admitted to the hospital. However, using a site not designated for treating COVID-19 patients for orthopedic surgery and performing surgery at an ESS did not improve the outcome of mortality, risk of infection or length of stay.

Paul *et al*[38] studied the effect of COVID-19 on ulnar collateral ligament repair (UCLR) in 106 major league baseball (MLB) players. The study observed at all pitchers of the MLB who underwent UCLR repair and found no difference in overall UCLR repair from baseball seasons 2017 through 2020, (n = 16, 20, 16 and 18). However, when the repair was examined with the number of games played pre-pandemic compared to pandemic season, it was found that pitchers were about three times more likely to undergo UCLR repair after the COVID-19 Lockdown. The higher rate of UCLR was most likely due to the lack of preseason activity during lockdown periods.

Yu *et al*[39] compared patterns and management of fracture patients pre-COVID and peri-COVID eras (January 24, 2020 through March 9, 2020) in China. Fracture types included upper and lower extremities and vertebra. Researchers found a 42% decrease in the number of orthopedic patients during the COVID pandemic. Time of injury to hospitalization of the patients did not change, however, time of injury to operation significantly increased during the pandemic 4.5 days ± 4.1 *vs* 2.0 days ± 1.5, ($P < 0.001$) when compared with 2019 data. Similarly, length of stay of patients after surgery was longer in pandemic when compared to 2019 data. Mandatory screenings delayed surgery by more than 48 h. It was recommended that screening of emergency patients should be a priority to minimize risk of infection among other patients and hospital staff.

CONCLUSION

The presentation of coronavirus, while not entirely mysterious, was bound to have unprecedented effects on healthcare workers, regulations in medical specialties, and the patients. Orthopedic specialties globally observed numerous changes over the evolution of the pandemic. Orthopedic cases varied in severity. Medical facilities were forced to create alternative treatment plans for emergent and elective orthopedic procedures, and the data presented showed the impact of COVID on orthopedic injury. Some of the changes implemented during this time showed to be beneficial and could be potential long-term solutions for optimizing medical orthopedic management.

Hip replacements are generally the most common elective procedure, but elective procedures were halted therefore most institutions did not perform them. Hip fractures have still been very common during this time[4,25,28] however, the pandemic has increased the mortality and complication rate particularly amongst COVID-positive patients[5,8,11,16,38]. The importance of early treatment and proper rehabilitation was strongly emphasized in order to ensure prompt recovery[14].

Mechanism of injury also changed during the pandemic. COVID-19 impacted the number of RTAs significantly as well as sporting injuries due to lockdowns and cancellation of group gatherings[3,25,27]. Work injuries also decreased a significant amount

due to lockdowns and remote work[26,28]. School traumas reduced to as students engaged in online learning[24,26]. With the vast population sheltering at home, there was a dramatic increase in domestic injuries that included home improvement projects, running, falls, cycling[22,28,29]. There was also a rise from 18% to 35% in oLLFs in patients with mental health conditions, implying that social isolation even if necessary, negatively impacts mental health[3,22]. A 40% increase in upper extremity injuries due to high-risk behaviors was observed during this time which could also be a consequence of social isolation[22].

The use of telehealth services was introduced in several facilities to alleviate the burden on healthcare facilities as well as limit exposure of both patients and providers to COVID. Virtual patient care proved to have a positive impact on the rehabilitation on patients post-operatively, lowering the rate of complications[7]. The use of telehealth services, while beneficial, did have adverse effects in patients that required more hands-on treatment[21]. These patients will be required to seek care or corrective treatment for the injury in the future[21]. To take full advantage of the benefits of telehealth, the screening for the patients that can be seen virtually should be stringent in order to ensure quality care.

From the management changes that were seen during this period, there were some takeaways that should be emphasized in current standards of practice. Early intervention was and should be a priority. This is essential for patients with hip fractures or other severe fractures to minimize the risk of mal-union. Telehealth was a service to bridge the gap in healthcare for those that were COVID-positive and needed treatment or even for facilities that weren't allowing any patients to be seen in person[7]. This is a service that in the future would be valuable to patients that are immobile, are ill, or have transportation issues[40]. Since appropriate PPE (personal protective equipment) allows for healthcare providers to treat COVID patients with minimal exposure, separating COVID-positive and COVID-negative patients allowed for timely injury management and COVID management. Knowing that COVID will continue to be prevalent, separating COVID-positive and negative patients can help expedite treatment for both groups of

patients. This literature review emphasized the necessity of being prepared to perform routine but emergent procedures even in unprecedented crises.

There were some limitations in this study. The previous and current literature does not allow us to explore how new approaches in orthopedic management would impact patient care and long term. Also, being as we are still facing COVID surges, the data to support an outcomes study is not yet available. Further research should be conducted to examine how orthopedic injury management has changed when COVID is at its nadir.

To summarize, while hospitals and medical facilities are still facing COVID-19 case surges, it is important to understand how this pandemic has impacted the various specialties of healthcare. Significant changes were noted in orthopedic practices since the start of the COVID-19 pandemic including different mechanisms of injury, higher mortality rates, and injury to different areas of the body. Changes that positively impacted patient outcomes should be made standards of practice and practices that negatively impacted patient outcomes should be actively evaluated to not only be avoided in regular care but also in times of crises.

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