



The effect of COVID-19 on adult traumatic orthopedic injuries: a database study

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Abstract

Purpose This study compares orthopedic injuries, procedures, and hospital outcomes of patients presenting to trauma centers in Pennsylvania before and during the COVID-19 pandemic.

Methods A retrospective review of adult patients presenting to hospitals with Pennsylvania Trauma Systems Foundation (PTSF) designations was performed. All patients 18 years of age and older who presented with orthopedic injuries were included. Demographic information, injury and hospital stay details, and mortality were reviewed. Data were compared between the cohorts of patients presenting during April 2020 (COVID cohort) and April 2017, April 2018, and April 2019 (pre-COVID cohort).

Results Overall, 14,858 patients were reviewed, and 9427 patients were included in this study. There were fewer orthopedic injuries (4868 vs. 6603 yearly mean) in the COVID cohort which led to fewer procedures (1763 vs. 2329 yearly mean). The COVID cohort had a significantly shorter mean hospital length of stay compared to the pre-COVID cohort (4.7 days versus 5.2 days, $p=0.01$). A higher mortality rate was seen in the COVID cohort ($n=115$, 6.1%) compared to the pre-COVID cohort ($n=305$, 4.0%; $p<0.01$).

Conclusion The characteristics of orthopedic injuries sustained by patients presenting to trauma centers during the COVID pandemic were not different from prior to the pandemic. However, there were decreases in the number of orthopedic injuries and procedures accompanied by a 50% increase in mortality seen in these patients during the pandemic. Resources should be appropriately marshalled to prevent rises in-hospital mortality for patients with orthopedic trauma treated during a pandemic.

Level of evidence Level III.

Keywords COVID · Adult · Trauma · Pandemic

Introduction

The COVID-19 pandemic had brought about unparalleled changes in society. Since the first case of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was documented in Wuhan, China in December 2019, the infection

has spread at an alarming rate across the globe [1, 2]. In efforts to decrease the spread of transmission, stay-at-home orders and social distancing measures had been placed by the United States government [3, 4] and individual states [4] in the hopes of decreasing human contact and risk of contracting the infection. Because of these orders and the closure of many external businesses, restaurants, and communal gathering places, much of the American population was initially forced to spend more time at home, leaving their house only for essential tasks. This led to reported decreases in United States hospital trauma activations during this time [5], as well as decreases in the rates of traumatic injuries in non-orthopedic specialties [6, 7].

While multiply injured patients can have involvement of multiple organ systems, orthopedic injuries comprise a large portion of these patients' acute care needs. Studies from Europe and Asia have characterized the changes in

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orthopedic injury patterns during this pandemic, but the same has not been done in the United States as a whole, or in subsets of the population [8–13]. It is unknown if the stay-at-home order and change in population behaviors during this time has changed the type and characteristics of injuries seen at regional trauma centers in the United States. Understanding these concepts could allow for appropriate allocation of resources for treatment or creation of prevention strategies for orthopedic injuries during similar situations in the future.

The primary purpose of this study was to identify differences in the location at which and mechanism by which orthopedic injuries occurred prior to and during the COVID-19 pandemic. The secondary purposes of our study are to compare the incidences of orthopedic injuries types and procedures as well as hospital outcomes before and during the COVID-19 pandemic. Our primary hypothesis was that there was a shift away from higher energy injuries (e.g., motor vehicle collisions) outside the home towards low energy injuries (e.g., falls from standing) sustained at home. Our secondary hypotheses were that there were no differences in incidences of injuries or procedures based on anatomic location, decreases in open fractures during the pandemic, and higher intra-hospital mortality and longer lengths of stay.

Materials and methods

Study design

Approval for this study was obtained from our hospital's institutional review board (IRB). A retrospective review of patients in Pennsylvania presenting to hospitals with Pennsylvania Trauma Systems Foundation (PTSF) designations was performed using the PTSF Trauma Registry. This database includes data from its 39 member hospitals (37 in 2017, 38 in 2018 and 2019, and 39 in 2020) that treated adult traumatic injuries. Participating centers have 42 days after a patient is discharged to submit patient data to the registry, with each center submitting a minimum of 85% of their cases to maintain PTSF designation. The database was queried in October 2020 for patients presenting in the month of April 2020, determined to be the initial peak of COVID-19 in the United States and the height of the Pennsylvania state stay-at-home order, as well as April 2017, April 2018 and April 2019 to serve as controls. All patients 18 years of age and older who presented with orthopedic injuries were included. All patients younger than 18 years of age, those who did not incur orthopedic injuries, and those that did not have complete records were excluded (Fig. 1).

All injuries and procedures, as represented by ICD-9 and ICD-10 diagnosis codes in the database, were reviewed. All procedures noted by an ICD-9 or ICD-10 procedure code other than placing a peripheral intravenous line or dressing

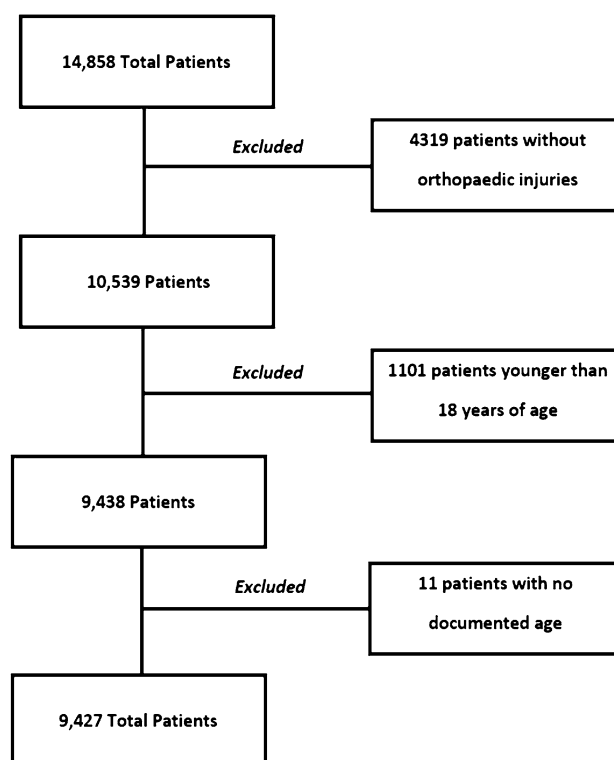


Fig. 1 Inclusion and exclusion criteria leading to final cohort

changes, regardless of whether they were done at bedside or in the operating room, were included, with there being a possibility of multiple procedures being completed in one setting (e.g., debridement and fixation of open fracture). Injuries and procedures were characterized by two of the authors based on anatomic location and type (bony or soft tissue). Bony injuries included fractures and dislocations, while soft tissue injuries included nerve, vascular, muscle, tendon, ligament, and skin injuries. All periarticular injuries were included in their respective joint (e.g., distal femur and proximal tibia fractures were classified as knee bony injuries). An intra-class correlation coefficient (ICC) analysis to confirm the precision of the two authors' coding (using 500 random codes) yielded a coefficient of 0.96.

Patient outcomes and statistical analysis

For each patient, demographic information, injury and hospital stay details, operative intervention, and mortality were recorded. Injuries occurring as a result of suicide, abuse, or assault were also noted. Data were compared between the COVID-19 cohort (April 2020) and the pre-COVID cohort (April 2017, April 2018, and April 2019) to identify any difference in injury patterns and outcomes. Demographic information, injury location, and mechanism of injury between the two cohorts were analyzed using Chi-squared

tests. Injury and procedure location incidences were analyzed using Chi-Squared analysis or Fischer Exact tests (if absolute count was less than 5) as appropriate. Alcohol levels and Glasgow Coma Scale (GCS) levels were analyzed using Mann–Whitney *U* testing. Finally, hospital outcomes were analyzed using Mann–Whitney *U* tests for continuous variables [length of stay (LOS) intensive care unit days, ventilator days, and complication rate] and Chi-Squared test for categorical variables (discharge location and mortality rate). Comparisons were made using IBM SPSS Version 23 Statistics for Windows (Armonk, NY: IBM Corp). For all analyses, $p \leq 0.05$ denoted significance.

Results

Demographics

Table 1 summarizes demographic characteristics of the two cohorts. There was a 24.7% decrease in patients presenting per year from the pre-COVID cohort (mean = 2512 per month) to the COVID (1891 patients). The demographics of the two cohorts differed with regards to their overall ethnicity, insurance status, average trauma code activation, rate of patients using anticoagulation therapy, with mental disorder, on current chemotherapy, and obesity.

Injury mechanism and location

Figure 2 displays the distribution of orthopedic injury location and mechanisms seen in both cohorts with no differences seen ($p = 0.11$ and $p = 0.40$, respectively). The location at which the highest proportion of orthopedic injuries were sustained was at home in both the pre-COVID ($n = 3733$, 49.5%) and COVID cohorts ($n = 989$, 52.3%). The most common mechanism by which orthopedic injuries occurred in both cohorts was after a ground level fall [pre-COVID ($n = 2758$, 35.8%) and COVID ($n = 736$, 38.9%)]. There was no difference in the proportion of patients presenting as a result of suicide attempts [mean 35 (1.4%) per year in pre-COVID cohort vs. 18 (1.0%) in COVID cohort, $p = 0.08$], assaults [194.3 (7.7%) yearly mean in pre-COVID cohort versus 145 (7.7%) in COVID cohort, $p = 0.33$], or abuse cases [9.3 yearly mean (1.1%) in pre-COVID cohort versus 3 (0.2%) in COVID cohort, $p = 0.30$] between cohorts.

Injuries and procedures

There were 19,808 orthopedic injuries in the pre-COVID cohort (yearly mean 6603) and 4868 in the COVID cohort representing a decrease of 26.3%. Five thousand, eight hundred and twenty-three (61.8%) patients sustained multiple orthopedic injuries, while 5621 (59.6%) patients sustained

polytraumatic injuries to multiple systems. There were 1961 burn injuries, 24 instances of compartment syndrome, 1573 (6.4%) open fractures (66 Type III open fractures), 151 (0.6%) nerve injuries, and 431 (1.7%) vascular injuries.

Figure 3 demonstrates the number and proportions of orthopedic injuries occurring within each cohort. There were no clinically meaningful differences between cohorts in the distribution of orthopedic injuries sustained. Importantly, there was no difference in the proportion of open fractures seen in each cohort ($n = 1277$, 6.4% vs. $n = 296$, 6.1%; $p = 0.35$). There was a 24.3% decrease in orthopedic procedures performed between the pre-COVID (yearly mean 2329) and COVID cohorts (1763) (Fig. 4). Despite the decrease in the total number of procedures performed during the pandemic, there were similar ratios of orthopedic procedures per injury (PPI) between cohorts (0.35 pre-COVID vs. 0.36 COVID) and procedures per patient (PPP) between cohorts (0.93 vs. 0.93). Despite a few small differences noted in the characteristics of the procedures performed in each cohort, these were not clinically meaningful.

Patients included in this study with orthopedic injuries also sustained 12,161 (9726 in pre-COVID and 2435 in COVID) non-orthopedic injuries. There was no difference in the proportion of patients that sustained non-orthopedic injuries between the COVID and pre-COVID cohorts (59.2% versus 59.7%, $p = 0.65$). Figure 5 shows that there were no differences between cohorts in non-orthopedic injury characteristics. There was a larger proportion of patients undergoing non-orthopedic procedures in the COVID ($n = 502$, 26.5%) cohort compared to the pre-COVID ($n = 1803$, 23.9%) cohort ($p = 0.02$).

On initial presentation, GCS levels (13.9 vs 14.0, $p = 0.01$) were lower in the COVID cohort and ISS scores were higher in the COVID cohort (10.6 versus 10.0, $p < 0.01$). Finally, there was a lower blood alcohol level in the COVID cohort on initial presentation ($n = 4845$, 0.03 versus 0.04, $p = 0.012$), but there was no difference in the proportion of patients with positive drug screens (21.5% versus 20.3%, $p = 0.24$).

Hospital outcomes

Hospital outcomes are summarized in Fig. 6. There were a similar number of reported hospital complications in the COVID-19 and pre-COVID cohorts ($n = 65$, 1.3% versus yearly mean $n = 96.3$, 1.5%, $p = 0.44$). A smaller percentage of patients were discharged home in April 2020 compared to the pre-COVID cohort (54.9% versus 60.0%, $p = 0.02$). Importantly, there was higher mortality rate in the COVID-19 cohort ($n = 115$, 6.1%) compared to the pre-COVID cohort ($n = 305$, 4.0%), a greater than 50% relative increase between the cohorts ($p < 0.01$). There were no differences in the demographics (e.g., medical co-morbidities, mean age,

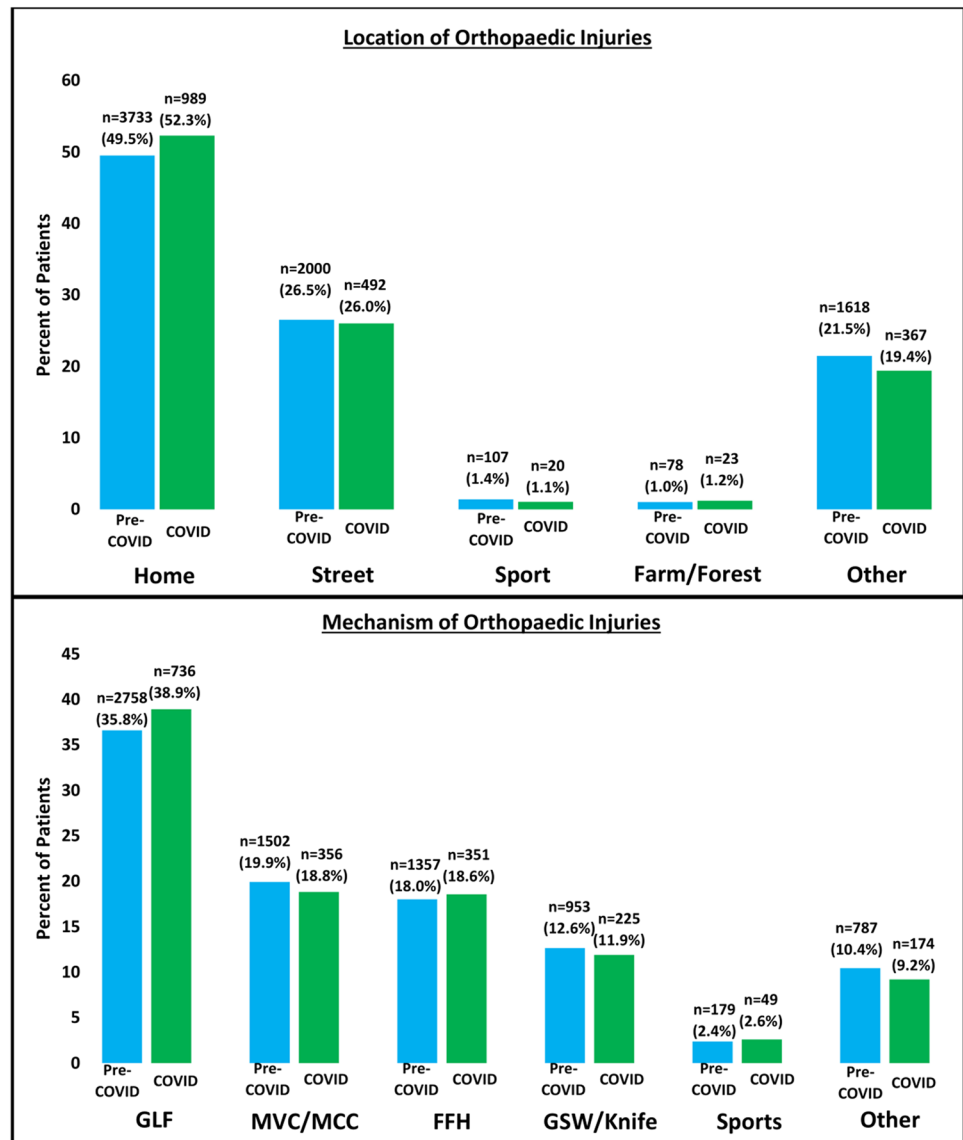
Table 1 Demographic information

	Pre-COVID cohort, <i>n</i> (%)	COVID cohort, <i>n</i> (%)	<i>p</i> value
Age			< 0.01
18–39 years	1747 (21.2%)	401 (21.2%)	
40–59 years	1698 (22.5%)	381 (20.1%)	
60–79 years	2231 (29.6%)	627 (32.9%)	
80+years	1856 (24.6%)	482 (25.5%)	
Gender			0.88
Male	4194 (55.7%)	1056 (55.8%)	
Female	3342 (44.3%)	835 (44.2%)	
Race			0.09
Caucasian	6067 (80.5%)	1495 (79.1%)	
Black	929 (12.3%)	268 (14.2%)	
Other/Unknown	540 (7.2%)	128 (6.8%)	
Ethnicity			< 0.01
Hispanic/Latino	376 (5.0%)	77 (4.1%)	
Non-Hispanic/Latino	7003 (92.9%)	1750 (92.5%)	
Unknown	157 (2.1%)	64 (3.4%)	
Insurance			< 0.01
Medicare/Medicaid	4989 (66.2%)	1283 (67.8%)	
Private Insurance	2225 (29.5%)	488 (25.8%)	
Self-pay	300 (4.0%)	101 (5.3%)	
Unknown	22 (0.3%)	19 (1.0%)	
Time to hospital presentation (minutes)	156.6 min	156.3 min	1.00
Average trauma activation (mean level)	1.64	1.72	< 0.01
COVID	0 (0.0%)	22 (1.2%)	< 0.01
CAD	308 (4.1%)	95 (5.0%)	0.07
CHF	743 (9.9%)	207 (10.9%)	0.16
DM	1375 (18.2%)	366 (19.4%)	0.27
AC	1230 (16.3%)	364 (19.2%)	< 0.01
Mental disorder	1779 (23.6%)	320 (16.9%)	< 0.01
HIV/AIDS	36 (0.5%)	11 (0.6%)	0.57
Transplant	16 (0.2%)	7 (0.4%)	0.21
Cirrhosis	110 (1.5%)	35 (1.9%)	0.22
Current chemotherapy	46 (0.6%)	24 (1.3%)	< 0.01
CVA	380 (5.0%)	83 (4.4%)	0.24
Dementia	562 (7.5%)	213 (11.3%)	< 0.01
Obesity	1373 (18.2%)	398 (21.0%)	< 0.01
COPD	769 (10.2%)	187 (9.9%)	0.68
High creatinine	214 (2.8%)	65 (3.4%)	0.17
Dialysis	62 (0.8%)	20 (1.1%)	0.33
Substance use disorder	469 (6.2%)	116 (6.1%)	0.89
Pregnancy	24 (0.3%)	6 (0.3%)	0.99
PAD	126 (1.7%)	44 (2.3%)	0.06
Current steroid use	112 (1.5%)	38 (2.0%)	0.10
Smoker	1623 (21.5%)	377 (19.9%)	0.13
Chronic alcohol use	422 (5.6%)	90 (4.8%)	0.15
Total [<i>n</i> (% of total)]	7536 (79.9%)	1891 (20.1%)	

COVID Severe acute respiratory syndrome coronavirus 2, CAD Coronary Artery Disease, CHF Congestive Heart Failure, DM Diabetes Mellitus, AC Current Anticoagulation Therapy, CVA Cardiovascular Accident, COPD Chronic Obstructive Pulmonary Disease, PAD Peripheral Artery Disease

Bold *p* values denote a significant difference between cohorts.

Fig. 2 Location of Injury (A) and Mechanism of Injury (B). There was no difference in location patterns ($p=0.11$) or injury mechanism ($p=0.40$) between the pre-COVID (April 2017–2019) cohort and COVID (April 2020) cohorts. *Home* Injury at home, *Street* Injury on street, sidewalk, or parking lot, *Sport* Injury at sporting event, playground, or swimming pool, *Farm/Forest* Injury at farm or forest, *Other* Injury at other location or unknown location, *GLF* Ground level fall, *MVC/MCC* Motor vehicle or motorcycle crash, *FFH* Fall from height, *GSW/Knife/Trauma* Gunshot wound, knife, trauma by another person, or trauma by another object, *Sports* Injury from playing in sporting event or playground



smoking status) of the patients who died in the pre-COVID and COVID cohorts ($p > 0.05$). Table 2 provides a comprehensive list of outcome measure differences between the two cohorts.

Discussion

The COVID-19 pandemic continues to be explored with regards to its effect on health care resource utilization and patient outcomes. While other studies have attempted to characterize the effect of COVID-19 on orthopaedic injuries outside of the United States [7, 11, 12], the present study provides an in-depth look at adult patients sustaining orthopaedic injuries and characteristics of the injuries themselves, subsequent procedures performed, and hospital outcomes during the height of the COVID pandemic in a subset of the

United States. This information can provide the necessary groundwork for improved outcomes and resource allocation during a pandemic.

Understanding differences in the population sustaining orthopaedic injuries during the pandemic compared with those presenting prior to the pandemic may allow for targeted prevention or treatment strategies. Patient demographics of the two cohorts differed in a variety of categories. We expected small differences between the demographics of our cohorts given that our study cohort is comprised of patients presenting only within a single month, and variability can naturally arise. However, we do not believe that the statistical differences seen in the comparison of these cohorts is clinically meaningful enough to impact our results or warrant targeting specific populations with prevention strategies. While patients with orthopaedic injuries were slightly older during COVID, the mean difference was only about

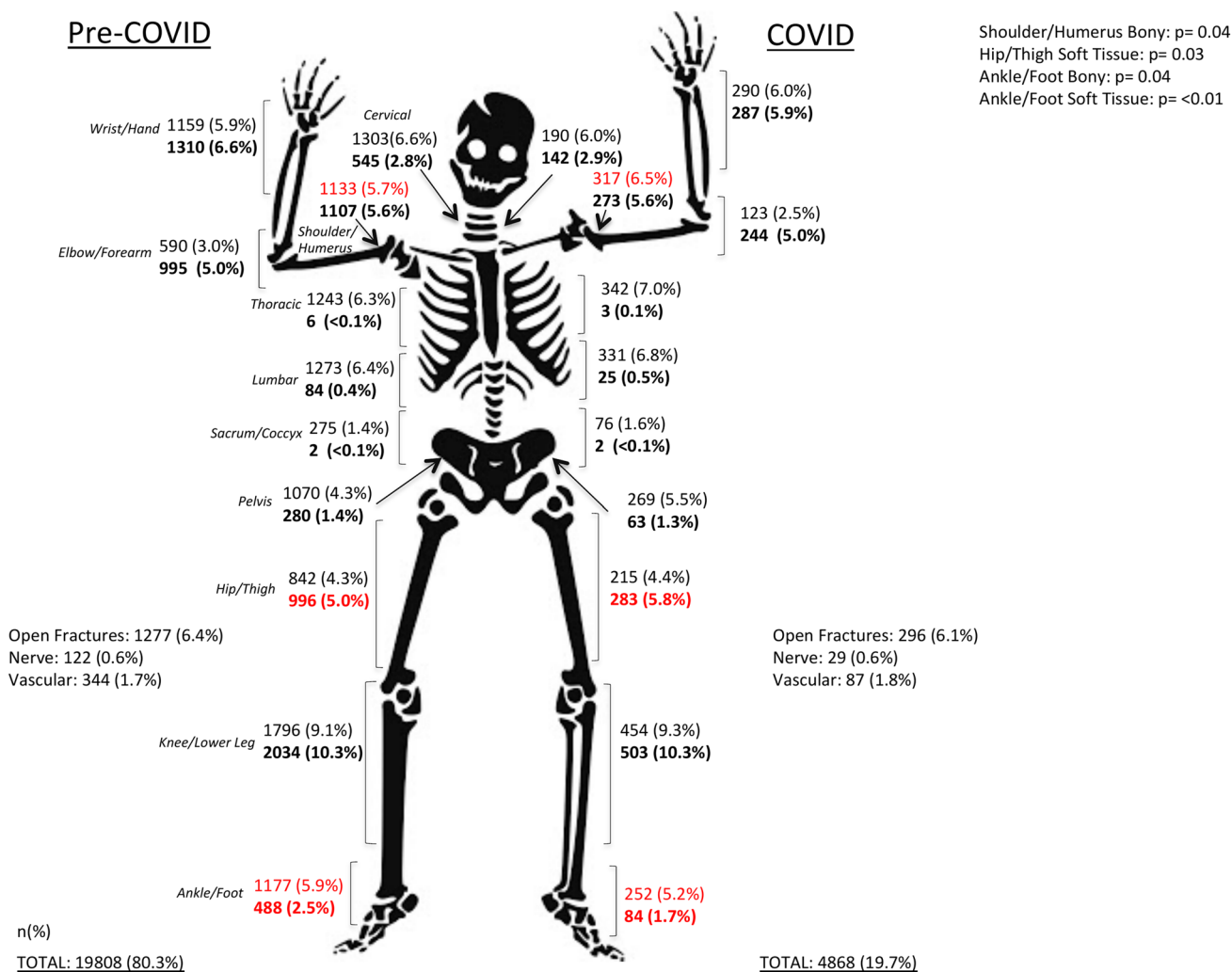


Fig. 3 Adult Orthopedic Injury Breakdown by Type and Cohort. All injury anatomic locations and types presented in absolute counts and percent of total injuries. Red values are significant. All bold values

represent soft tissue injuries in the corresponding anatomic location, and all non-bolded values represent bony injuries

2 years. The small decrease in patients who had private insurance and the increase in patients who were self-pay during COVID-19 is notable, as uninsured patients have disparate access to healthcare and may present to trauma centers with higher burdens of undiagnosed comorbid disease, thus possibly impacting mortality and other results of this study [14]. However, we do not know if the increase in self-pay patients corresponds to loss of healthcare coverage related to pandemic-related unemployment or other factors, or if the increase of about 1% of the population of self-pay patients is meaningful from an increased comorbidity standpoint. It is also difficult to determine how insurance coverage or many of these other demographic factors would greatly influence our other outcomes such as injury location, injury mechanism, or injury type.

We primarily hypothesized that the act of social distancing as well as the government-instituted lockdown in the

state of Pennsylvania would keep people at home, resulting in an increase in the proportion of injuries sustained in this location and with lower-energy mechanisms, a finding reported in other studies [11, 12]. However, our data suggest that orthopedic injuries occurred in a similar pattern during April 2020 as compared to previous months. While this may indicate that the changes in population behavior and social distancing had little effect on location or mechanism of injury, alternative conclusions may be drawn. For example, the National Highway Traffic Safety Administration had shown higher rates MVC-related mortality and injury during the pandemic which may suggest a greater chance of sustaining orthopedic injuries despite fewer people driving [15]. So, while the proportions of injury locations or mechanisms may not differ from pre-pandemic data, further investigation may show differing rates, rather than proportions, of injury locations and mechanisms. Our data differ from that in

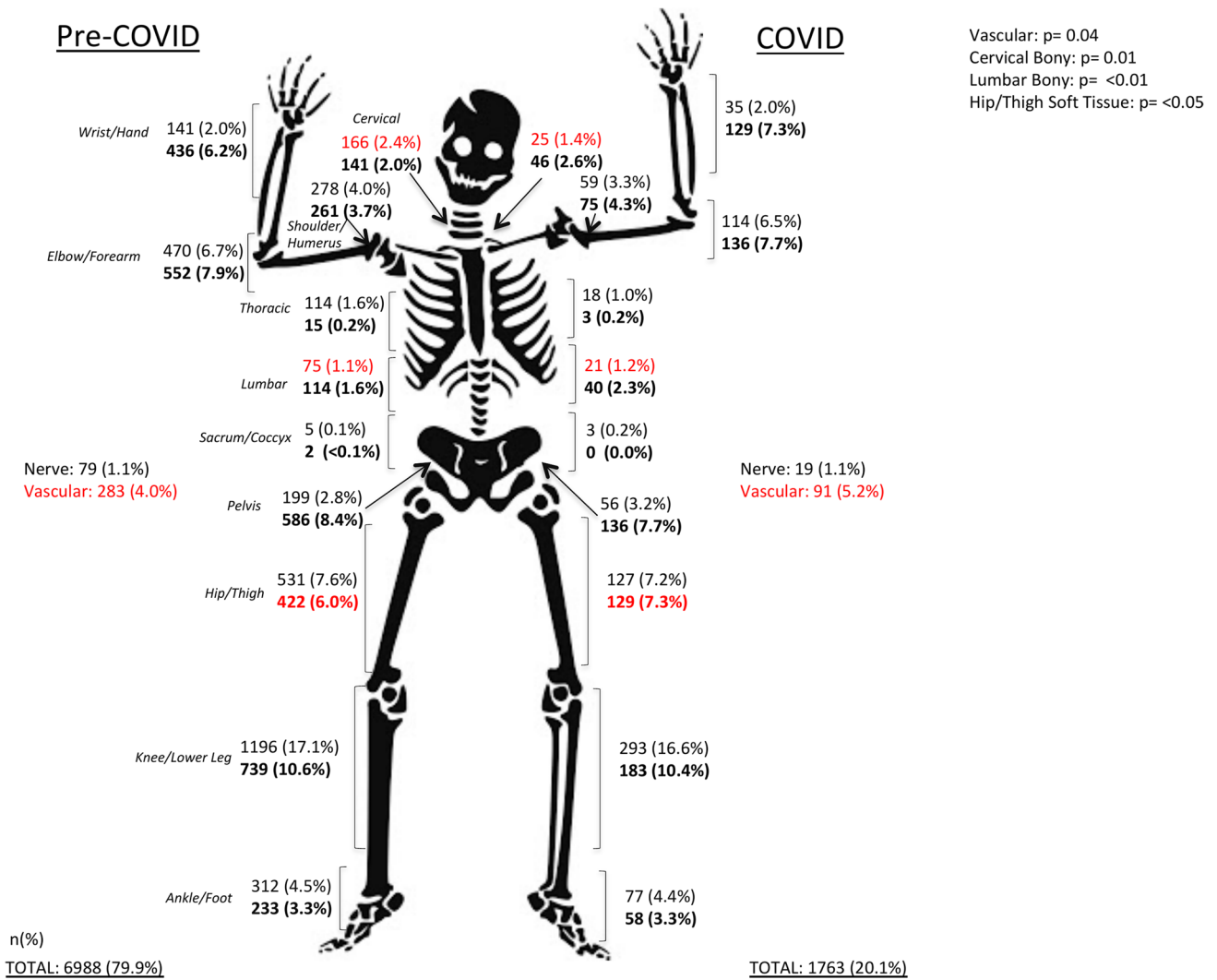
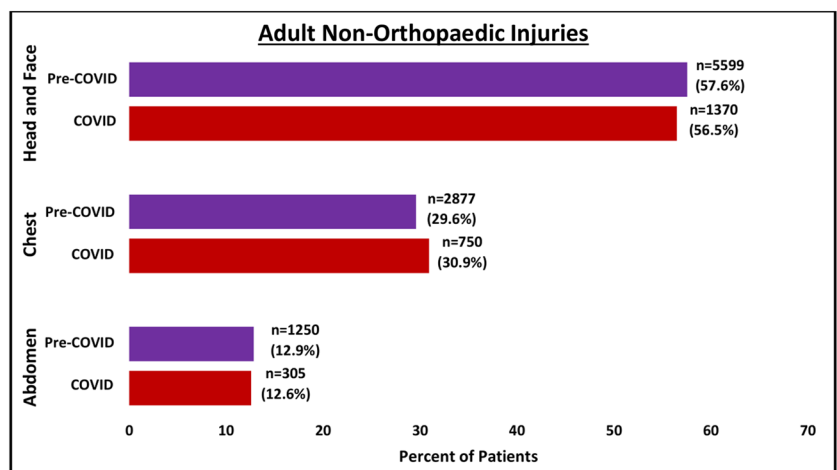


Fig. 4 Adult Orthopedic Procedure Breakdown by Type and Cohort. All procedure anatomic locations and types presented in absolute counts and percent of total procedures. Red values are statistically

significant. All bold values represent soft tissue procedures in the corresponding anatomic location, and all non-bolded values represent bony procedures

Fig. 5 Adult Non-orthopedic Injuries. All absolute counts include total bony and soft tissue injuries sustained in each month. All percentages presented of total injuries in corresponding location in the cohort. All percentages are calculated based on total number of non-orthopedic injuries in each cohort. All cohort comparisons showed $p > 0.05$



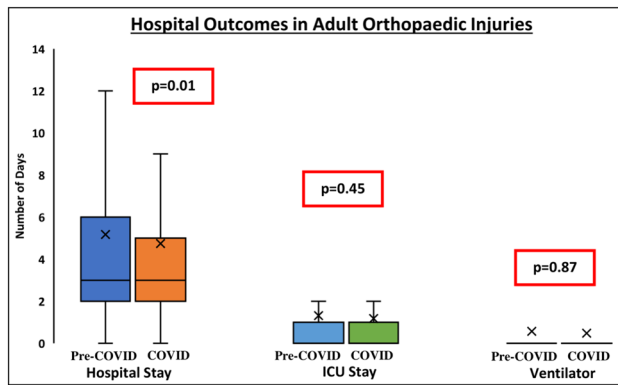


Fig. 6 Hospital Outcomes in Adult Orthopedic Injuries. There was a lower hospital length of stay in days ($p=0.01$) in April 2020 with no difference between the COVID and pre-COVID cohorts in ICU days ($p=0.45$) or days with ventilator needs ($p=0.87$). ICU Intensive Care Unit. The COVID-19 cohort had a shorter mean hospital LOS compared to the pre-COVID cohort (4.7 days versus 5.2 days, $p=0.01$). There was no difference between groups for ICU days (1.3 days versus 1.2 days, $p=0.45$) and days of ventilator needs (0.6 days versus 0.5 days, $p=0.87$)

studies by Hashmi, et al. in which there was a sharp decrease in MVC-related orthopedic trauma in Pakistan during the pandemic [12] and Lubbe, et al. in which the distribution of injury mechanisms changed [16]. These studies represented data from single tertiary institutions rather than statewide trauma networks representing hospitals of many different sizes and locations, thus likely underappreciating the injury characteristics outside of one geographic zone.

We found no difference in injury type between the pre-COVID and COVID cohorts. Overall, about 25% fewer patients sustained orthopedic injuries during the initial peak of the COVID-19 pandemic compared to previous years, including bony and soft tissue injuries. Furthermore, the authors believe that these specific differences are not as clinically relevant as the overall decrease in patients and injuries. Current literature studying the pandemic has variable reports on changes of injuries in specific anatomic locations and this could be due to a variety of factors that include location and type of government restrictions placed [8–13, 16]. Also counter to our hypothesis of there being a lower proportion of high-energy injuries during the pandemic, there was no difference in the proportion of open injuries, a surrogate marker of high-energy injuries.

The decrease in patients with orthopedic injuries was accompanied by a proportional decrease in number of injuries and procedures displayed by similar PPI and PPP ratios between cohorts. This again suggests limited differences between the cohorts, but with an impressive 1.5 higher odds of mortality in the COVID cohort, the implication is that the orthopedic injuries alone were not the cause. Given the slightly higher ISS scores and a greater proportion of

Table 2 Outcome measures compared between the pre-COVID and COVID cohorts

	Pre-COVID cohort	COVID cohort	<i>p</i> value
Location of injury			
Home	3733 (49.5%)	989 (52.3%)	0.11
Street	2000 (26.5%)	492 (26.0%)	
Sport	107 (1.4%)	20 (1.1%)	
Farm/Forest	78 (1.0%)	23 (1.2%)	
Other	1618 (21.5%)	367 (19.4%)	
Mechanism of injury			
GLF	2758 (35.8%)	736 (38.9%)	0.40
MVC/MCC	1502 (19.9%)	356 (18.8%)	
FFH	1357 (18.0%)	351 (18.6%)	
GSW/Knife	953 (12.6%)	225 (11.9%)	
Sports	179 (2.4%)	49 (2.6%)	
Other	787 (10.4%)	174 (9.2%)	
Social factors (% of patients)			
Suicide	105 (1.4%)	18 (1.0%)	0.08
Assault	583 (7.7%)	145 (7.7%)	0.33
Abuse	28 (0.4%)	3 (0.2%)	0.30
Orthopedic injuries			
Shoulder/humerus bony	1133 (5.7%)	317 (6.5%)	0.04
Hip/thigh soft	996 (5.0%)	283 (5.8%)	0.03
Ankle/foot bony	1177 (5.9%)	252 (5.2%)	0.04
Ankle/foot soft	488 (2.5%)	84 (1.7%)	<0.01
Orthopedic procedures (% of patients)			
Vascular	283 (4.0%)	91 (5.2%)	0.04
Cervical bony	166 (2.4%)	25 (1.4%)	0.01
Lumbar bony	75 (1.1%)	21 (1.2%)	<0.01
Hip/thigh soft tissue	422 (6.0%)	129 (7.3%)	<0.05
Non-orthopedic injuries			
Head and face	5599 (57.6%)	1370 (56.5%)	0.65
Chest	2877 (29.6%)	750 (30.9%)	
Abdomen	1250 (12.9%)	305 (12.6%)	
Non-orthopedic procedures (% of patients)	1803 (23.9%)	502 (26.5%)	0.02
Initial presentation			
Glasgow coma scale	13.9	14.0	0.01
Injury severity score	10.6	10.0	<0.01
Blood alcohol level	0.03	0.04	0.01
Positive drug screen	1620 (21.5%)	384 (20.3%)	0.24
Hospital			
Length of stay	5.2 days	4.7 days	0.01
ICU stay	1.2 days	1.3 days	0.45
Ventilator days	0.5 days	0.6 days	0.87
Complications	289 (1.5%)	65 (1.3%)	0.44

All values presented as absolute count and percentage other than Initial Presentation (value on respective scale), and Hospital Variables (days). All bold *p* values are significant at 0.05

Home Injury at home, *Street* Injury on street, sidewalk, or parking lot; *Sport* Injury at sporting event, playground, or swimming pool, *Farm/Forest* Injury at farm or forest, *Other* Injury at other location or unknown location, *GLF* Ground level fall, *MVC/MCC* Motor vehicle or motorcycle crash, *FFH* Fall from height, *GSW/Knife/Trauma* Gunshot wound, knife, trauma by another person, or trauma by another object, *Sports* Injury from playing in sporting event or playground, *ICU* Intensive Care Unit

orthopedic patients undergoing non-orthopedic procedures in the COVID cohort, it is possible that these patients had a higher mortality risk in general, but the magnitude of the difference in mortality does not seem to be explained by these slight differences. With the stress placed on the system during the pandemic, this may point to a lack of available resources (ORs, staff, ventilators, etc.) to perform the procedures themselves or care for these patients in a timely fashion.

The increased mortality in the COVID-19 cohort is consistent with the worse outcomes documented in other reports exploring mortality during the pandemic [16–19]. Unfortunately, we do not have enough COVID testing data on our population to determine a correlation with COVID infection and mortality after orthopedic injury or procedure, though this correlation has been shown elsewhere [20]. That there were not differences in the demographics of the patients who died in both cohorts further suggests that non-patient factors (i.e., system demands from the pandemic, resource allocation, etc.) could have contributed to the increased mortality. While all hospital systems were overtaxed and low on resources during the initial height of the pandemic, these data highlight that resources must continue to be allocated to patients with orthopedic injuries during a pandemic to prevent catastrophic increases in mortality.

Our study has limitations, most of them inherent to a database study. The patients included in this database are those that sustained injuries necessitating a hospital admission. Because of this, our data had a heavy selection bias and may not be representative of all orthopedic injuries and procedures during the pandemic since many patients could have elected to be treated in outpatient settings. This cohort, drawn from the peak month of the initial wave of COVID, also may not represent all comers during each wave of or the entirety of the pandemic. Utilizing a larger cohort spanning more time during the pandemic might yield different results. However, the authors do believe that this cohort can accurately be used to describe injury trends during the pandemic due to its large number and timing. Furthermore, this study also has no way of quantifying the true amount of missed patient data at the participating trauma centers. That said, in order for trauma centers to be continual participants in this database and maintain their trauma accreditation, a threshold of 85% reporting must be met for all comers each month. We feel as though this is sufficient to provide accurate trends in our studied data. Finally, this database only collects data from one state. While this does include patients presenting from rural, suburban, and urban settings, further investigation into the COVID-19 pandemic should include data longitudinally from multiple states or on a national level as different parts of the country were affected and resources stressed at different time points during 2020.

Conclusion

The characteristics of orthopedic injuries sustained by patients presenting to trauma centers during the COVID pandemic were not different from prior to the pandemic. However, there were decreases in the number of orthopedic injuries and procedures and a 50% increase in mortality seen in these patients during the pandemic. Resources should be appropriately marshalled to prevent rises in-hospital mortality for patients with orthopedic trauma treated during a pandemic.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

IRB approval This study was approved by our institution's IRB. Obtained from the St. Luke's University Hospital IRB Committee.

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