



The coronavirus disease clavicle study: a predictor of future trauma trends



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ARTICLE INFO

Keywords:

Clavicle
Fracture
COVID-19
Pandemic
Cycling
Treatment

Level of Evidence: Level III; Retrospective Cohort Comparison; Epidemiology Study

Background: Clavicle fractures are a common presentation to the emergency department after falls and sporting injuries. During 2020, the coronavirus disease 2019 (COVID-19) pandemic brought with it a long period of social isolation, resulting in a change of behavior patterns and, in return, the presentation of fractures to our local hospitals. The effects of this global pandemic on the presentation and management of clavicles were noted with particular interest to the change in mechanism and its future implications. **Methods:** We performed a longitudinal observational study in 10 hospitals in the North West of England, reviewing all patients presenting with a clavicle fracture during 6 weeks in the first peak of COVID-19 pandemic and compared these with the same period in 2019. Collection points included the patient demographics, fracture characteristics, mechanism of injury, and management.

Results: A total of 427 clavicle fractures were assessed with lower numbers of patients presenting with a clavicle fracture during the COVID-2020 period (n = 177) compared with 2019 (n = 250). Cycling-related clavicle fractures increased 3-fold during the pandemic compared with the 2019 control group. We also noted an overall increase in clavicle fractures resulting from higher energy trauma as opposed to low energy or fragility fracture. We also found a faster time to surgery in the COVID cohort by 2.7 days on average when compared with 2019.

Conclusions: Government restrictions and the encouragement of social distancing led to behavioral changes with a vast increase in cyclists on the road. This created a significant rise in clavicle fractures related to this activity. This is likely to be further driven by the government pledge to double cyclists on the road by 2025 in the United Kingdom. We forecast that this increase in cyclists, a behavior change accelerated by the pandemic, is a reliable predictor for future trauma trends.

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Institutional review board approval was not required for this study.

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<https://doi.org/10.1016/j.jseint.2021.12.012>

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Clavicle fractures are a common presentation to the emergency department, often following sporting injuries in the young and falls from standing height in the elderly. Previous

epidemiologic studies have demonstrated that they comprise of 5%–10% of all fractures and are typically seen in young men.²² A recent study by Vun et al has reported an incidence of 55.9/100,000 per year with a bimodal male and unimodal older female distribution.²⁶ On average, over the past couple of years, National Health Service (NHS) trusts in England report more than 19,000 clavicle fractures each year. This has steadily risen over the past 5 years, with the financial year 2019–2020 reporting the highest annual figure.⁹

Significant debate remains over the optimal management of clavicle fractures, in particular, displaced fractures of the middle third of the clavicle. In a recent review article, Moverley et al surmises that the 3 largest studies on the management of clavicle fractures to date offer differing conclusions, and therefore, patients should be counseled appropriately to make an informed choice on their management based on their individual circumstances.¹⁶

During 2020, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) caused the 2019 coronavirus disease (COVID-19) pandemic, presenting healthcare systems all around the world with unique and unprecedented challenges of coping with increased demand. As part of the government response to COVID-19, the United Kingdom entered a period of restriction “lockdown” beginning on March 23, 2020, in an effort to slow the spread of disease and lessen the burden on the NHS.¹⁰ As such, restrictions were placed on the British public who were advised to only leave their home for limited purposes. This period of lockdown brought about a long period of social isolation and changed the normal patterns of behavior of the public and, in return, the presentation of fractures to our local hospitals.

During this initial lockdown, there was a significant increase in the number of people cycling. The UK Department for Transport reported an overall increase in cycling from March 2020 onward, reaching a peak increase of 343% in April 2020.⁶

In this study, we compared data collected on clavicle fractures sustained during the peak of the COVID-19 pandemic to that of the same period during the previous year to review the effects of the global pandemic on the presentation and management of clavicle fractures in the North West of England. We hypothesized that the COVID-19 pandemic had no effect on the presentation and management of clavicle fractures.

Our primary outcomes were to assess the change in numbers and the mechanism of injury of clavicle fractures in the North West of England sustained during the peak of the COVID-19 pandemic compared with that of the same period in 2019. Our secondary outcomes were (1) to ascertain how these fractures were managed, that is, operatively or nonoperatively; and (2) to assess the difference in demographics between the 2 cohorts.

Material and methods

Data were collected from 10 different hospital trusts in the North West of England, which included 3 Major Trauma Centers and 4 Trauma Units. The study was approved by each individual trust via registration through the relevant audit and research departments. All patient information remained anonymous at all times. All collaborators were recruited via the regional research committee (the North West Orthopaedic Research Collaborative) and were orthopedic trainees in the region.

Participants

Table I shows the inclusion and exclusion criteria for this study.

Table 1
Study inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Confirmed new clavicle fracture +/- concurrent fracture(s)	Fractures sustained outside the 6 week time frame
Sustained within the defined 6 week time frame (April 1 to May 14, 2020 and 2019)	Periprosthetic fractures
	Neonatal fractures
	Pathological fractures

Study design

This is a longitudinal retrospective observational study, comparing the data from 2 different years during the same 6-week period. Data were analyzed from April 1, 2020, to May 14, 2020, and compared with the exact same period in 2019. The data from 2019 acted as our control group.

Data collection

Data collected per patient included patient age, gender, date of injury, side of injury, time to presentation and surgery (if relevant), position of the fracture, mechanism of injury, open or closed injury, neurovascular status, shortening of fracture, comminution, final management, and time taken to surgery postinjury.

Each of our collaborators was provided with a Microsoft Excel⁸ spreadsheet for the collection of data. Data were sourced through the coding system of each hospital and requested from individual audit departments. An alternative method was to screen all clavicle X-rays that were completed during this period through the Picture Archiving and Communication system (PACS) of each hospital. Patient demographic and management data were collected from electronic and physical notes as well as clinical letters. Fracture patterns were determined from images reviewed on PACS.

We used the Allman classification system for clavicle fractures (I, II, and III) to determine the position of the fracture.¹ Injury mechanism data were analyzed and grouped into 7 separate categories: bicycle injuries, low-energy injuries (such as fall from standing height), team sports, major trauma, trampoline injuries, equine related, and unwitnessed/unknown mechanism.

Statistics

Data were collected on a prepopulated Microsoft Excel sheet.¹⁵ All data collection points were inputted into a premade template. Simple statistical methods were used to calculate significance via *P* values. A *P* value of <.05 was deemed significant. Chi-squared was used to compare the data between 2 discrete variables. Means were used to present continuous variables with standard deviations and range. Mann-Whitney U test was used to calculate the significance of non-normally distributed continuous variables. Any categorical data were also shown in terms of percentage of number.

Results

Epidemiology

In total, 427 patients met our eligibility criteria. Between the 2 years of data, 3 patients were excluded from the initial search due to pathologic fracture (*n* = 1) or birthing injury (*n* = 2). During the COVID pandemic in 2020, 62% of patients (*n* = 108) were male as

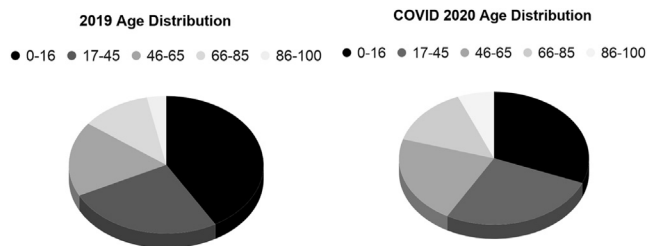


Figure 1 Age group comparison charts in 2019 and COVID 2020.

Table II Number and proportion of different fracture characteristics between COVID 2020 and 2019 data.

Allman classification	Number of fractures in COVID 2020 (%)	Number of fractures in 2019 (%)
I - Midshaft	112 (63.3)	173 (69.2)
II - Lateral third	61 (34.5)	71 (28.4)
III - Medial third	4 (2.2)	6 (2.4)

opposed to female (n = 69). This is in contrast to 2019, where the percentage of male patients was 68% (n = 174). The ratio of men to women fell from 2.3:1 in 2019 to 1.6:1 in 2020.

The mean age of a patient presenting with a clavicle fracture during the pandemic was slightly higher at 35.6 years, compared with 2019, where the mean age was 29.8 years. This increase was not statistically significant where P = .18. Further breakdown of the age between the sexes revealed an overall higher age presentation in females in both cohorts. The mean age in men changed significantly between 2019 and COVID 2020 (from 28.9 years to 35.0 years respectively, P = .0168). In contrast, the mean female age changed less from 41.1 in 2019 and 37.9 in 2020 (P = .373).

Figure 1 illustrates 41.8% of patients presenting in COVID 2020 were more than 45 compared with 32.4% in 2019. A larger proportion of patients fell into the older age groups in the COVID 2020 year compared with 2019. We also saw a significant decrease in the pediatric presentations (16 years old and below), numbers decreasing from 104 in 2019 to 55 in 2020.

The ratio of right to left side injuries remained similar in both years, with a ratio of 1.3:1 (2019) and 1.1:1 (2020) right to left, respectively.

Fracture characteristics

The fracture positions are documented in Table II. Midshaft (Allman I) fractures remained the most frequent position of clavicle fracture in both years, with a slight decrease proportionately from 2019 (69.2%) to COVID 2020 (63.3%).

Of the total 427 clavicle fractures in both years, only 2 open fractures were recorded in the COVID 2020 cohort and none in 2019. Equally, 2 patients presented with neurovascular compromise in the COVID 2020 group, but only one patient had neurovascular damage in 2019.

In the COVID-2020 group, 43 patients (27%) sustained other fractures at the same time in addition to their clavicle fractures. In 2019, this number was substantially less, with only 21 patients (9.8%) sustaining a concurrent fracture to their clavicle fracture. This increase in multiple fracture numbers was deemed statistically significant at P ≤ .05.

In the COVID 2020 group, 30% (n = 53) of all clavicle fractures were classed as comminuted, which is an increase in the number of comminuted fractures from 26% (n = 65) in 2019 (P = .369).

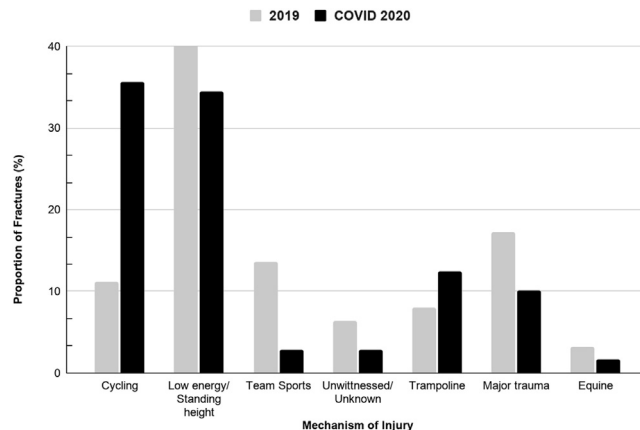


Figure 2 Graph to compare mechanism of injury between COVID 2020 and 2019

Mechanism

Figure 2 shows that the biggest change in mechanism of injury was an increase in cycling injuries from 11.2% (n = 28) to 35.6% (n = 63) in 2020, which was deemed statistically different (P < .0005). There was a decrease in fractures caused by low-energy or standing height injuries from 40.6% (n = 101) to 34.5% (n = 61) from 2019 to 2020. A decline in team sport injuries occurred during the lockdown (2.8%, n = 5 from 13.7%, n = 34). Trampoline-related fractures increased during lockdown from 8% (n = 20) to 12.4% (n = 22). Major trauma, including road traffic accident numbers, fell between 2019 and 2020 from 43 patients (17.3%) to only 18 patients (10.2%) in 2020. Fractures caused by falling off a horse (equine) also decreased from 8 patients in 2019 to 3 patients in 2020.

Treatment methods

When comparing operative numbers, there was little change in the proportion of open reduction internal fixation (11.3%, n = 20) in COVID 2020 in comparison to 2019, which had a 11.2% (n = 28) rate of fixation. There was no statistical difference between the management of patients between COVID 2020 and 2019 (P = .97).

Time to surgery was 2.7 days faster on average in the COVID-2020 cohort, with an average wait of 8.6 days. This is compared to an average of 11.3 days in 2019. Two patients in 2019 were operated on due to nonunion and hence removed from this figure. There was no surgery for nonunion of clavicle fractures at the point of data collection for this study for the COVID 2020 cohort.

During the COVID 2020 period, the total number of trauma cases operated on was 1337, which was a decrease from 2412 trauma patients who were operated on in 2019. The proportion of clavicle open reduction internal fixations from the total operated numbers had a slight increase with 1.50% in COVID 2020 and 1.16% in 2019 (P = .388) and hence not deemed statistically significant.

Discussion

Main findings of this study

During the peak of the COVID-19 outbreak in England, the government imposed a national lockdown to control the spread of the virus and protect the NHS from being overwhelmed by the number of unwell patients. The lockdown included the total closure of all nonessential services, schools, universities, gym, and the hospitality industry. These measures proved to be effective in its aim of reducing the rates of COVID-19 admissions.¹⁸

As a result of these changes, there was also a knock-on effect in other healthcare services, including trauma and orthopedics. The lockdown meant that social activities, such as sports, children's soft play, and road traffic accidents, also reduced during this time as a result of the new restrictions and lifestyle changes. Although official UK Government reports for the number of road traffic accidents in 2020 are yet to be published, in Europe, there have been reports of reduction of road traffic accidents during the peak of the pandemic, with a 36% decrease in road deaths during the 2020 lockdown compared with 2019.⁸ Qureshi et al²¹ found a significant reduction in the number of road traffic accidents resulting in nonfatal or no injuries after the implementation of lockdown in March 2020 in Missouri, USA. Similarly, an article by Saladie et al²³ from the Tarragona province of Spain reported a reduction in the number of road traffic accidents during lockdown.

There have been a small number of studies that have assessed the effects of lockdown on fracture numbers such as Lv et al¹³ who looked retrospectively at the effects of a national lockdown in China on their fracture presentations. Their study also found an epidemiologic change in the presentation of fractures, such as much less low-energy injuries in the elderly as opposed to their control group before COVID-19.

A recent study by Sephton et al looked at all trauma in the United Kingdom during the first lockdown and found similar findings in terms of mechanism of injury patterns, in particular, a concerning rise in push bike-related injuries.²⁴ A distinct focus of our study was to assess how change in behaviors because of this national lockdown restrictions changed the number and the way in which these fractures occurred. We were also interested to see if management of these injuries were affected by the fracture characteristics or by the British Orthopaedic Association (BOA) guidance of acute fracture management during the pandemic.²

Our study looked at a total of 427 patients between the 6-week study period in both years. An epidemiological study of clavicle fractures from the Swedish fracture registry in 2017 by Kihlstrom et al¹² looked at 2422 patients and found that 68% occurred in males as did another study by Postachiini et al.¹⁹ This was mirrored by our study that showed nearly 70% of patients to be male in the 2019 cohort with a small reduction to 62% in 2020. Previous government figures in the United Kingdom have shown that men are twice as likely as women to cycle in the United Kingdom,¹¹ whereas women are more likely to partake in swimming and gym activities, which are less likely to result in clavicle fractures. The same government research also confirmed that men are more likely to participate in team sports in the United Kingdom, an activity that was restricted during the lockdown period.¹¹ This can explain the shift in the change of male to female ratios. Local studies in England showed an increase in female cyclists during the lockdown period, all contributing to a more even distribution of the sexes presenting with clavicle fractures between 2019 and the COVID-2020 period.¹⁴

The mechanism of injury was one of the most significant findings during our study. The 2019 control data show low-energy injuries such as those from a standing height represented the majority of injuries. This is reflected in other studies,^{17,19,22} often followed by cycling injuries in the young.¹⁷ In 2020, cycling injuries dramatically increased 3-fold to be a causative factor for 36% of all clavicle fractures during the first peak. This can be explained by a rise in cycling use for transport during lockdown, driven further by the advice to socially distance and avoid public transport. Government data published by the Department for Transport reported a peak increase of 343% in cyclists at the end of April 2020 compared with March 2020.⁵ This is a clear representation of how the COVID-19 pandemic affected social behavior and, in return, the presentation of fractures to our emergency departments. Equally, the number of fragility fractures caused from standing height fell

from 101 to 61 in 2020. This evidences that the government advice given to the elderly, the comorbid and frail patients to remain indoors as much as possible to avoid exposure to the virus, was effective, resulting in a reduction in the risk of falls outdoors and in uneven terrain.⁷ Another clear decrease in numbers was that of team sports-related clavicle fractures in 2020. Trampoline injuries increased during the COVID-2020 period as expected and mainly in our younger patients as was noted in other studies during this period and will continue to be a concern for the safety of our pediatric population.³ Our total pediatric population did however almost halve in numbers in the COVID-2020 period ($n = 55$ from $n = 104$) from the previous year, a consequence of school and group play restrictions.

The overall proportion of high-energy injuries increased from 53.2% of all clavicle fractures in the 2019 period to 62.7% in the COVID-2020. This is a significant upsurge of high-energy trauma between the 2 years caused by behavioral changes in lockdown.

Despite the BOA guidance² encouraging nonoperative management of upper limb injuries, our study demonstrated little difference in the proportion of patients who underwent surgical fixation of their clavicle fracture between the 2 cohorts (11.3% in 2020 and 11.2% in 2019). The number of trauma operations reduced significantly from 2412 cases in 2019 to 1337 cases in the COVID-2020 group; a reflection of the public adhering to the national guidance, yet the proportion of clavicle fractures remained remarkably similar. Patients were also taken to theater 2.7 days faster during the COVID pandemic than in 2019.

These factors could be explained by the increased proportion of comminuted fractures seen in 2020 compared with 2019 (30% compared with 26%). The quicker timing to surgery reflects the lower overall trauma burden, impacted by the public health message to stay at home and stay safe. This demonstrates the power of unified clear public health messages when delivered by the government can be very influential. Our study evidences the positive impact of this public health message on our NHS, preventing it from being tragically overwhelmed. Therefore, giving us further hope that health services, in the future, can potentially run both more effectively and efficiently with better patient education.

From previous literature, it was reported that the risk of nonunion is increased in clavicle fractures sustained following high-energy mechanisms compared with those from low-energy injuries. There was also a correlation with fracture displacement and comminution resulting in increased risk of nonunion.²² Hence, greater consideration may have been given to operative management for these patients in our study despite BOA guidance.² There have been studies to show that delays in treatment of displaced clavicle fractures may lead to poorer outcomes for patients such as loss of muscle endurance, and hence, the quicker operative times shown in this study may benefit our COVID-2020 patient cohort.²⁰

The UK Government has pledged an increase to £2 Billion in the Summer of 2020 from their initial £1 Billion promise to double the number of cyclists by 2025.⁵ Our study is a predictor of the outcomes of encouraging cycling uptake in the general population. The rates of clavicle fractures and high-energy injuries rose despite lower numbers of cars on the roads and less commuters. This study indicates there will continue to be more cyclists on the roads, a prediction supported by cycling superstore, Halfords', research report, named "The great bike boom continues."²⁵ Which looks at how attitudes and behaviors have changed among the UK population throughout the pandemic leading to the increasing popularity of cycling. The report findings conclude these behavior changes to be sustained postpandemic, particularly as cycling forms both a mode of transport and exercise, increasing its potential participants.

Our evidence shows that further measures need to be taken nationally to improve cycling safety through education and infrastructure. Health services need capacity planning to contend with the rise in cycling-related trauma as well as injury management strategies and protocols.

Strengths

To our knowledge, this is the only study to date, which assesses the effect that lockdown has had on the presentation, classification, and management of clavicle fractures during the peak of the COVID-19 pandemic. Furthermore, because of the multicenter nature, our study has a large demographic population of the North West of England. The total cohort of 427 patients is one of the largest clavicle databases studied in these circumstances.

Limitations

This was a small snapshot observational study, looking at only one area in England during a short period. The retrospective nature of this study leaves it to inherent compromises in data accuracy. Data were collected through the PACS imaging systems, and some fractures may have been missed because of either coding errors or fractures picked up on alternative X-rays, such as chest X-rays, which, in turn, may have underestimated the number of clavicle fractures in both data sets. Fracture data collection was also usually only performed by one individual assessor per trust.

The brief data collection period was also insufficient to capture postmanagement complications in such a vast dataset.

Implications and future research

This study reflects a large increase in clavicle fractures after a 3-fold upsurge in cycling. The sudden escalation in cycling-induced trauma will have important implications for trauma services and, more broadly, intensify the strain placed on an already struggling NHS. There may be greater scope for studies on the management of high-energy clavicle fractures and their outcomes after the increase in cyclists, subsequent to the government drive. Further consideration of the management of heightened trauma numbers created by this ideology may be prudent to prevent trauma centers from being overwhelmed postpandemic. This study also showed a greater efficiency in the time to theater for our surgically managed patients, and further follow-up of long-term outcomes for this group in comparison to the 2019 cohort may be beneficial in highlighting the importance of early intervention of high clavicle fractures.

Conclusion

The “Covid Clavicle study” collated one of the largest databases of clavicle fractures from 10 hospitals in the North West of England throughout the first lockdown period. Our study found an overall lower number of clavicle fractures and trauma cases presented during the first peak of the COVID-19 pandemic, illustrating the effectiveness of the public message delivery by the government.

Because of the restrictions in place and encouragement of social distancing, this led to behavioral changes in the population. We noted a 3-fold increase of cycling-related clavicle fractures when compared with our control group. We believe our study is a predictor of future trauma trends, evidencing that the popularity of cycling in the United Kingdom has soared because of the pandemic restrictions.⁶ We forecast this trend to continue underpinned by the government drive to increase cyclists by 2025 alongside the preexisting “bike to work” scheme.^{4,5}

Consequently, further preventative and management resources will need to be made available to tackle this predicted increase in demand for our trauma services in the United Kingdom.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

Acknowledgments

This study was conducted with the help of the data collection from the North West Orthopaedic Research Collaborative.

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