RESEARCH ARTICLE

The Relationship of the COVID-19 pandemic with the Incidence and Management of Upper Limb Fractures: Double-Centre Study

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Abstract

Background: The COVID-19 pandemic brought about the placement of severe social restrictions in the United Kingdom, limiting activity and impacting public behavior. Limited studies have been published on the relationship of the coronavirus pandemic with the presentation and management of upper limb fractures. The aims of this study were first to assess the change in the incidence of upper limb fractures at key points during the COVID-19 pandemic such as the enactment and lifting of lockdowns, and second to evaluate the relationship between local COVID-19 burden and measures of service efficiency across our trust.

Methods: We undertook a retrospective analysis of all upper limb fracture referrals, admissions, and surgical procedures from the 1st of March 2020 to the 28th of February 2021. Changes in upper limb fracture incidence were mapped to significant changes in social restrictions. Measurements of service efficiency including time from admission to theatre and length of stay for admitted upper limb fracture patients were mapped to local COVID-19 burden. Subgroup analysis was undertaken to compare across age groups, including the pediatric population, all adults, and the elderly.

Results: The study involved 1251, 659, and 641 patients with upper limb fracture referrals, admissions, and procedures across the trust, respectively. Referrals (n=128) and procedures (n=72) both peaked in August 2020. Admissions peaked in both May and December 2020 (63 for both). Admissions and procedures both demonstrated a decrease in March and April 2020 compared to the rest of the study period (40 and 38 admissions, as well as 48 and 29 procedures respectively). Across the cohort, referrals and admissions did not demonstrate a statistically significant relationship with the relaxing of social restrictions (*P=0.504*). There were statistically significant differences among referrals, admissions, and procedures when stratifying patients by age (*P=<0.001*). Length of stay demonstrated an inverse relationship with COVID-19 burden throughout the study period, with the shortest average length of stay recorded in months with the highest number of local COVID-19 cases. The average time from injury occurrence to theatre increased during the winter months (*P=0.001*).

Conclusion: There is a relationship between changes in social restrictions and the incidence of upper limb fractures. These changes also had differing impacts on upper limb fracture rates when stratifying by patient age groups. The orthopedic service demonstrated adaptability in response to the local COVID-19 burden, and further research is needed to determine what effect this had on clinical outcomes.

Level of evidence: IV

Keywords: COVID-19, Coronavirus, Upper limb trauma

Introduction

In the United Kingdom, a rapid rise in COVID-19 cases throughout February 2020 prompted the government to announce the most severe form of social restrictions observed in England since the Second World War, termed lockdowns, with the first coming into effect on the 23rd of March 2020, and lasting until the 1st

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of June 2020 ("the first wave").[1] Over the following year, the country experienced fluctuating social distancing restrictions, with two further national lockdowns in November 2020 ("the second wave") and January 2021 "the third wave".[2,3] The onset and lifting of lockdowns marked the start and end of each wave for the purposes of this study.

The introduction of lockdowns had a profound impact on public behavior, with virtually all social activities canceled. This had a significant impact on activity, as evidenced by the decline in accident and emergency department attendance and road traffic activity levels.[4,5]

In a similar manner to the sudden cessation of activity when the lockdown was imposed, there was likely a similar increase in activity when major restrictions were lifted. This will have had a concomitant impact on the healthcare burden, particularly in regard to injuries sustained that were far less likely under lockdown conditions. For instance, sporting injuries such as ankle and clavicular fractures were far less likely during the cancellation of organized sports; therefore, increase in likelihood as restrictions were lifted.

Few studies have been published scrutinizing the effect of the coronavirus pandemic on upper limb trauma and fractures specifically.6-8 Our primary aims are to assess the change in the incidence of upper limb fractures at key points during the COVID-19 pandemic, and to assess the impact of being in a state of national lockdown against relaxed restrictions. Our secondary aim is to establish the effect of pandemic severity on measures of service efficiency such as time to theatre and length of stay for admitted patients.

Materials and Methods

Study Setting

We performed a retrospective analysis of all orthopedic upper limb fracture referrals, admissions, and surgical procedures for our trust, which comprises two large teaching hospitals. The analysis was performed between the time period 1st March 2020 to the 28th February 2021, to reflect the period between the first national lockdown and the most recent completed lockdown month at the time of data collection.

Data Collection

Patient information was obtained through a dedicated orthopedic patient database, Pathpoint eTrauma (OpenMedical – London, United Kingdom), including age, diagnosis, date of injury, data of admission, surgical intervention performed, and date of surgery. Length of hospital stay, as well as time from injury to theatre and time from booking to the theatre, were calculated as measures of service efficiency.

Inclusion/Exclusion Criteria

All patients with an upper limb fracture referral, admission, or surgical procedure during the specified period were included in the study. The upper limb was defined as any bone that comprises the shoulder joint or upper limb, hence the inclusion of scapular and clavicular fractures in the study. Patients with multiple pathologies were included if they were diagnosed with at least one upper limb fracture.

Analysis

Three core domains were used for the overall analysis: the number of referrals, admissions, and procedures for each month of the study period. Within this, we performed subgroup analyses of these domains stratified by age. We stratified the cohort into patients aged less than 16 years, all patients over the age of 16 (so we could analyze adult upper limb fractures as a whole), and all patients over the age of 70 at the time of injury.

Measures of service efficiency were calculated as an approximation of the service performance in response to fluctuating levels of local COVID-19 burden. Length of stay was calculated using the corresponding admission and discharge dates for each patient. The duration between the onset of injury and surgery ("injury to procedure" – ITP) as well as the duration from which the patient was booked for theatre and surgery ("booking to procedure" – BTP) were also calculated.

Microsoft Excel (version 16.60) software was used for statistical analysis; in addition, the two-way ANOVA without replication test was employed for all continuous variables in the study. A *P value* of <0.05 was considered statistically significant.

Data Cleaning

Where there were clear errors in regard to inputs, such as a discharge date occurring prior to an admission date, such data were removed from the analysis process. Furthermore, a minimum length of stay of 12 hours and a maximum of 30 days were specified to avoid the averages being affected significantly by a small number of admissions mistakenly recorded as several months long.

Results

Demographics

This study encompassed data for 1251, 659, and 641 participants with upper limb fracture referrals, admissions, and procedures, respectively, [Table 1] from the 1st of March 2020 to the 28th of February 2021. The average ages with standard deviation are presented in Table 1.

To observe the relative impact of restrictions on each age group, the cohort was divided into three age groups: less than 16, 16 or over, and 70 or over years (i.e., pediatric, all adults, elderly) [Table 1].

Table 1. Numbers of upper limb fracture referrals, admissions, and procedures undertaken in MFT and divided by age group

Category	Referrals	Admissions	Procedures
Count	1251	659	641
Mean Age (SD)	52.9 (25.9)	50.7 (25.2)	43.6 (21.9)
Age group:			
≤16 (%)	121 (9.67)	69 (10.5)	75 (11.7)
>16 (%)	661 (90.33)	590 (89.5)	391 (88.3)
>70 (%)	410 (32.8)	183 (27.8)	86 (13.4)

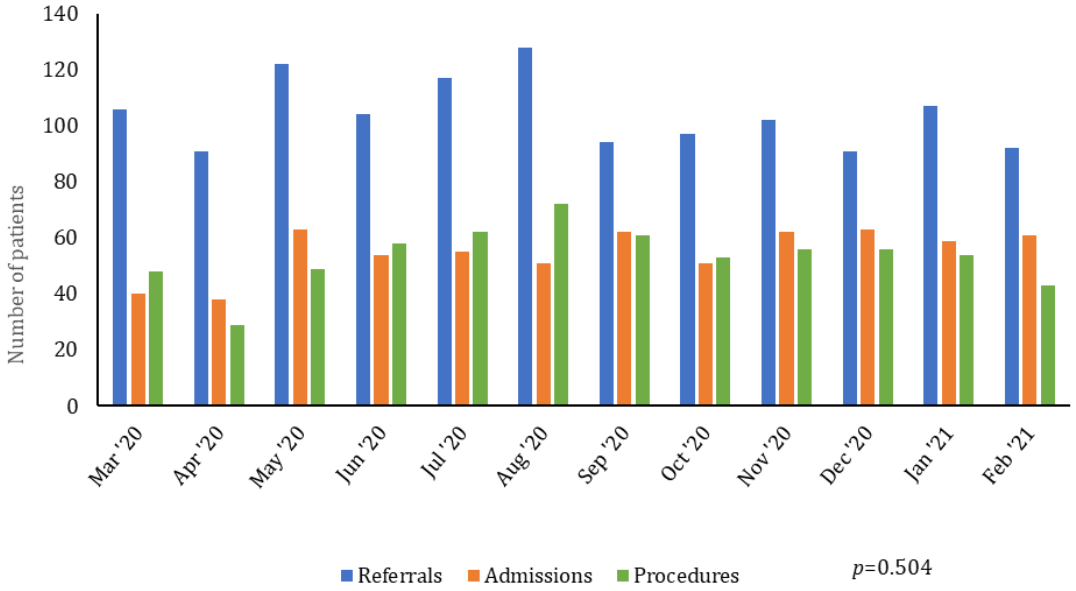

Figure 1. Monthly upper limb fracture referrals, admissions, and procedures in MFT during the COVID-19 pandemic.

Referrals

Monthly referrals were elevated in the summer months of 2020, peaking in August 2020 at 128 cases, and declined on either side of this [Figure 1]. The monthly variations between referrals, admissions, and procedures were not statistically significant (*P=0.504*).

Referral rates by age group represents in Table 2. Referrals for patients under the age of 16 were particularly low from March to June 2020, then rose steeply during the summer months, peaking in September 2020 (*P=<0.001*). Patients over the age of 16 years experienced a higher rate of monthly referrals from March to August than from September to February (*P=<0.001*). Patients over the age of 70 years were more variable but had a distinct peak during May 2020 (*P=<0.001*).

Admissions

Except for lower rates in March and April 2020,

Table 2. Monthly referral, admission, and procedure rates for the 3 age groups. Highest and lowest values for each category are highlighted in green and yellow, respectively

	Mar 20	*Apr 20*	*May 20*	*Jun 20*	*Jul 20*	*Aug 20*	*Sep 20*	*Oct 20*	*Nov 20*	*Dec 20*	*Jan 21*	*Feb 21*
						Referrals						
<16 years	4	6	5	6	14	18	22	11	12	6	7	10
≥16 years	102	85	117	98	103	110	72	86	90	85	100	82
≥70 years	35	26	49	30	38	33	23	35	27	42	34	38
P=<0.001												
						Admissions						
<16 years	2	0	1	0	9	13	16	9	6	3	3	7
≥16 years	38	38	62	54	46	38	46	42	56	60	56	54
≥70 years	14	7	20	9	15	17	13	17	11	18	18	24
P=<0.001												
						Procedures						
<16 years	3	0	1	0	11	17	15	9	6	4	3	6
≥16 years	45	29	48	58	51	55	46	44	50	52	51	37
≥70 years	8	2	7	6	6	10	6	10	7	6	10	8
P=<0.001												

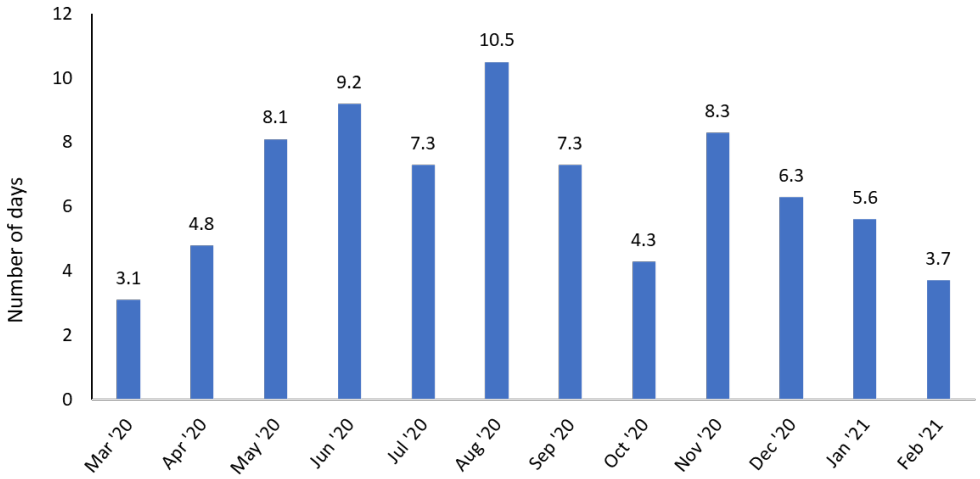

Figure 2. Monthly average length of stay for upper limb fracture patients during the COVID-19 pandemic.

monthly admission rates were consistent across the time period [Figure 1].

As with the referrals, admissions for patients under 16 years of age were very low during the period March to June 2020, before rising sharply during the summer months (*P=<0.001*) [Table 2]. Admissions for patients over 16 years were more consistent, and patients over 70 years had a sharp decline in April 2020 and a distinct peak in February 2021 (*P=<0.001*) [Table 2].

Similar to the admission rates data, March and April had low lengths of stay, which increased during the summer months, with a peak in August before declining again towards winter [Figure 2].

Procedures

The monthly rate of surgical procedures performed across the trust followed a similar pattern to admissions, with a consistent rate across the time period except in March and April 2020, where the procedure rate was lower [Table 2].

As with admissions, monthly procedure rates for patients under 16 years were less than three procedures per month until a sudden surge in June, which peaked in July and then steadily declined to January 2021 (*P=<0.001*) [Table 2]. Rates of procedures for patients over 16 years dropped in May and April 2020 before peaking in May 2020 (*P=<0.001*) [Table 2]. There were peaks for patients over 70 years in August and October 2020, as well as January 2021; there was also a substantial decline in April 2020 (*P=<0.001*) [Table 2].

As a measure of the effects of COVID-19 on service efficiency, duration of ITP and BTP were also calculated. The duration of both ITP and BTP gradually increased towards the winter months, with peaks in October and December 2020, respectively (*P=0.001*) [Figure 3].

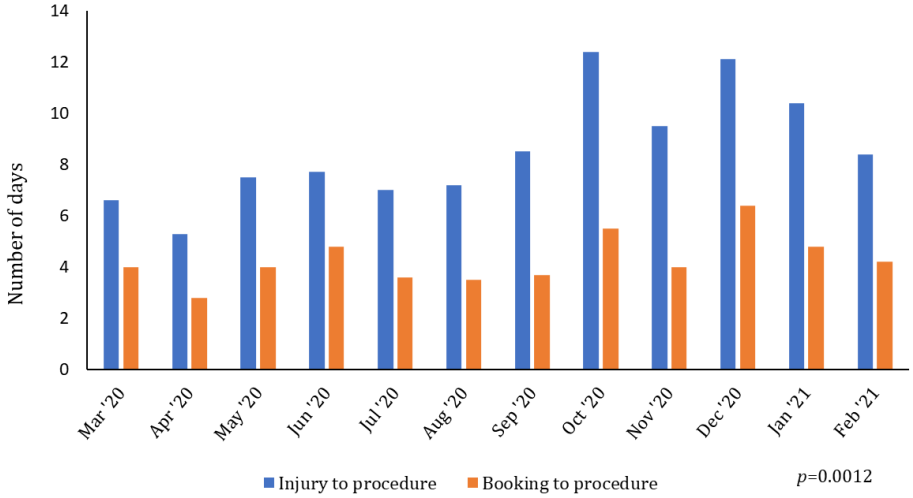

Figure 3. Monthly average time from injury to procedure and time from booking to procedure.

Discussion

Overall Results

The results suggest that referral rates during the pandemic were mainly driven by changes in restriction, whereas admission and procedures were mainly driven by local COVID-19 burden. The measures of service efficiency do not suggest that the service was overwhelmed by the local COVID-19 burden at any point during the study period.

Referrals, Admissions, and Procedures

The volume of referrals, admissions, and procedures followed similar trends throughout the specified time period, with several notable divergences. Referrals increased during the months of May to August 2020, which may reflect the increase in socializing and sporting activities as the lockdown was lifted. Admissions and procedures rates were relatively low during March and April 2020 and consistently higher thereafter. There are two reasons why this might be the case. Firstly, it may be due to patient hesitancy in presenting to healthcare with the concomitant risk of catching COVID-19. Secondly, it may also be due to the desire to manage patients in the community, both to increase bed capacity and reduce the threat of exposure to COVID in the hospital, as per advice from the British Orthopaedic Association guidelines.[9]

Age Stratified Subgroups

To gain further insight into the relationship between different demographics and the evolving social restrictions, the cohort was grouped by age into those under 16, all adults 16 and over, and 70 years of age or over. Across all three domains, the under 16 years subgroups demonstrated a relative increase in the months of July to September, perhaps due to closer associations with sporting injuries which would have been more likely during this time period, as it coincided with the relaxing of restrictions on organized sport.

Conversely, the same three domains in the 70 and over years subgroup decreased during April and then increased in May 2020, which adds further weight to the above suggestion. In addition, there was either hesitancy for patients to present or hesitancy from the medical team to admit and surgically treat patients in the earlier, more uncertain stages of the pandemic. This also relates to the time period when care home deaths were rapidly increasing.[10] There was a second peak of upper limb fractures during February 2021, which coincided with the peak of the third wave of COVID-19 and may therefore suggest a relationship between the prevalence of COVID-19 infection and the rate of upper limb fractures in the elderly.[11] This could be due to an increased risk of falling due to physical deterioration following the contraction of COVID-19.[12]

Length of Stay

Length of stay data reflected the drive to free up inpatient hospital beds. At times of peak COVID-19 burden in our city (March/April, October, Jan/Feb), the average length of stay fell to its lowest value. This most likely reflects a desire by the healthcare teams to minimize the time in hospital as a method of both reducing hospital COVID-19 transmission and preserving bed capacity.

Duration to Procedure

As well the length of stay, another important measure of service efficiency is the duration of time before the surgical procedure, assessed from both onset of injury as well as booking of the patient for surgery. The ITP and BTP appeared to be at their longest duration in the months of October to December 2020, when the second wave of COVID-19 was escalating.[11] This is often a busy period for orthopedic teams due to adverse weather conditions and subsequent increases in trauma around this time.[13] These results suggest that the combination of lack of resources due to the COVID-19 burden combined with an increase in upper limb fracture referrals meant the service may have been more stretched during this time period.

Limitations

There were several limitations to this study. The first was a lack of greater insight into patient characteristics including patient sex, BMI, and the mechanism of injury (e.g., through playing a sport or a fall). Furthermore, poor record keeping for COVID-19 cases and deaths locally during the early stages of the pandemic made correlating changes to service efficiency with the COVID-19 burden difficult. The baseline rates of upper limb fractures in the preceding years were not used as a comparison due to the electronic patient system used to extract data only being introduced to the trust several months before the pandemic. We would typically expect seasonal variation in upper limb fracture incidence, therefore attributing the degree of input from change to the COVID-19 restrictions has been limited.

The local COVID-19 burden had an impact on upper limb fracture referrals, admissions, and procedures in our trust. The volume of presenting patients was higher with the relaxation of social restrictions, while admission and surgery rates were lowest during the start of the pandemic. There were fewer elderly patients being admitted to hospitals and undergoing surgery for upper limb fractures near the beginning of the pandemic. Length of hospital stay was significantly lower during times of peak COVID-19 infections.

These findings suggest patterns in COVID-19 rates and orthopedic trauma workload, which may be extrapolated for use in future pandemics or national lockdowns to help guide departmental resources. Further study is warranted into how COVID-19 lockdown measures have affected orthopedic patients' long-term outcomes in the context of upper limb trauma.

Disclosure: The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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