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Hip fracture care during the 2020 COVID-19 first-wave: a review of the outcomes of hip fracture patients at a Scottish Major Trauma Centre

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ABSTRACT

Background and Purpose of the Study: This study reviewed whether the response to the Coronavirus (COVID-19) pandemic affected the care for hip fracture patients at a major trauma centre in Scotland during the first-wave lock-down period.

Methods: All patients referred to Orthopaedics with a hip fracture in a major trauma centre in Scotland were captured between 14 th March and 28 th May (11 weeks) in 2020 and 2019. Patients were identified using electronic patient records. The primary outcomes are time to theatre, length of admission and 30-day mortality. Secondary outcomes are COVID-19 prevalence, duration of surgery, proportion of patients to theatre within 36 hours and COVID-19 positive 30-day mortality from time of surgery. 225 patients were included: 108 from 2019 and 117 from 2020.

The main findings: 30-day mortality was 3.7% (n=4) in 2019 and 8.5% (n=10) in 2020 (p=0.142). There was no statistical difference with time to theatre (p=0.150) nor duration of theatre (p=0.450). Duration of admission was reduced from 12 days to 6.5 days (p<0.005). 4 patients tested positive for COVID-19 during admission, one 5 days after discharge, all underwent surgical management. 30-day mortality for COVID-19 positive patients during admission was 40%. COVID-19 prevalence of patients that were tested (n=89) was 5.62%. **Conclusions:** This study has shown the care of hip fracture patients has been maintained during the COVID-19 pandemic. There is no statistically significant change in mortality, time to theatre, and duration of surgery, however, the patient's admission duration was significantly less than the 2019 cohort.

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Introduction

Healthcare worldwide has been affected by the Coronavirus COVID-19 pandemic. Rapid service provision changes were required to care for COVID-19 patients. Along with many other countries the United Kingdom and Scottish Governments responded by mandating a national lockdown beginning on 23rd March 2020 to help reduce the spread of the virus and protect the National Health Service (NHS) from being overwhelmed. There were over 11.8 million cases worldwide and

the UK had over 300,000 cases and 45,500 deaths at the time of conclusion of this study.^{1,2}

The first confirmed COVID-19 case in Scotland was reported on 1st March 2020, from then the numbers rapidly increased. Just over two weeks from this date our department stopped elective work on 16th March 2020 and resource reallocated from the Trauma and Orthopaedic service, reducing our in-patient trauma capacity to a quarter of normal. Operating theatre capacity was reduced with the main theatre environment redeployed as a COVID-19 critical care area, our normal access to two allocated orthopaedic trauma theatres

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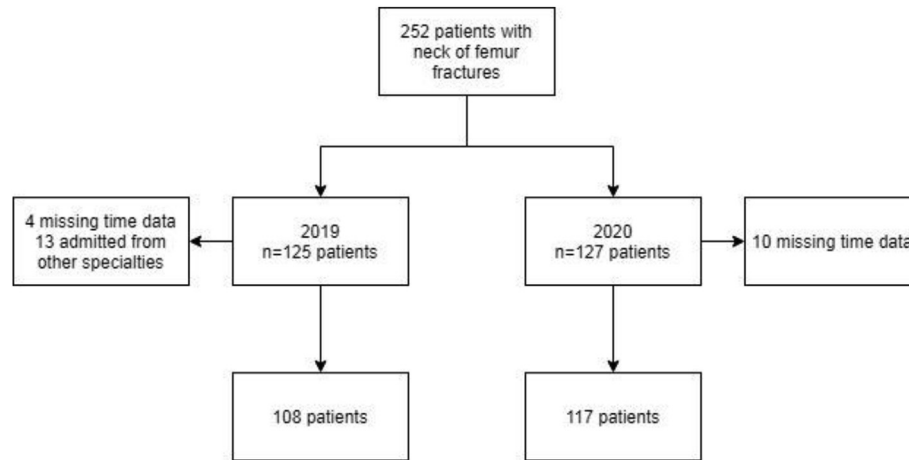


Fig. 1 – Patient selection flow chart.

reduced to one shared emergency theatre. Given this reduction in theatre capacity and increasing ever-changing barriers to get emergency admissions into theatre, there was concern that the impact on orthopaedic trauma service from COVID-19 would affect the outcomes for hip fracture patients. Furthermore, there was concern that mortality of hip fracture patients would be considerably higher in those with concomitant COVID-19 infection.³

This study aims to review the outcomes of hip fracture patients during the Lockdown period at a major trauma centre in Scotland in comparison to the same time period in 2019.

Methods

A cross-sectional study was conducted for the time period 14th March – 28th May for the years 2019 and 2020 at a Major Trauma Centre in Scotland. Data was collected prospectively for 2020 and retrospectively for 2019. In 2019, 108 patients were included, and in 2020, 117 patients were included over an 11-week period. The patient selection flowchart is summarised in Fig. 1.

All patients who had a diagnosis of acute hip fracture identified radiographically, including intracapsular, extracapsular, intertrochanteric and subtrochanteric proximal femoral fractures, admitted directly to Trauma and Orthopaedics were included. Hip fracture diagnoses were confirmed by the primary author through radiographic evaluation using the local Picture Archiving and Communication System (PACS) radiology system. Patients referred to Orthopaedics or from other specialties with missing time data were excluded.

Patient demographics including age, sex, residence, American Society of Anaesthesiologists (ASA) grade and Body Mass Index (BMI) were collected from Electronic Patient Records. Timing data was collected from Electronic Patient Records, with time of admission documented as the time of registration in the Emergency Department. Theatre timing data was extracted from the electronic theatre management system. Data collection was undertaken by multiple authors, with the primary author having overall responsibility for data collection.

All COVID-19 swab results for each patient were recorded from the electronic results reporting system (ICE, Sunquest systems). COVID-19 admission testing initially began for only symptomatic patients, with routine admission testing for all patients starting in the midst of the study period. COVID-19 swabs taken were combined nasal/throat swab and underwent Real Time – Polymerase Chain Reaction (RT-PCR) analysis. A mandatory swabbing local policy was implemented as of 10th April 2020, as mandated by the progression of the pandemic and local service provision for COVID-19 testing capacity increased in early April 2020.

Primary outcome measures were length of hospital stay, time to theatre and 30-day mortality. Secondary outcome measures were the number of COVID-19 positive patients, duration of surgery, proportion of patients to theatre within 36 hours and 30-day mortality for COVID-19 positive patients. The study size was determined by the number of hip fracture patients during the defined study period.

Statistical analysis was performed using Microsoft Excel (Microsoft, Redmond, Washington, USA) and IBM SPSS statistical software (SPSS, IBM Inc., Armonk, New York, USA). Mann Whitney U and Kruskal Wallis tests were performed to compare non-parametric data. Kaplan Meier survival analysis was used to determine 30-day mortality. A chi-square test was performed to examine the relation between ASA grade and year. Statistical significance was set at $p < 0.05$.

Results

Demographic data is summarised in Table 1. No significant difference was observed between age, sex and BMI between 2019 and 2020. A statistically significant difference was observed in ASA with a higher proportion of ASA 4 patients in 2020 compared with 2019. A reduction in overall Orthopaedic trauma operative cases was observed in 2020; 409 operative cases were listed on the trauma list for unscheduled theatre in 2019, compared with 287 in 2020.

Table 1 – Patient demographic data.

	2019	2020	p-value
n	108	117	
Mean age (range)/years	81.2 (46–98)	81.6 (51–103)	0.192
Median age/years	83	83	
Interquartile range/years	10	14.5	
Sex	70 F: 38 M	78 F: 39 M	0.770
BMI/kg m ⁻²	24.6 (16.0–38.0)	18.6 (15.7–38.3)	0.118
ASA	ASA 1 2 ASA 2 42 ASA 3 61 ASA 4 3 Missing 0	ASA 1 5 ASA 2 43 ASA 3 54 ASA 4 14 Missing 1	0.036 ^a

^a Statistically significant.

Patient COVID-19 status

COVID-19 status on admission and at time of surgery is summarised in Table 2. Of 117 patients, 89 underwent COVID-19 testing. Twenty-eight patients did not undergo COVID-19 swab testing at any point during their admission. Prior to 10th April 2020, when the routine testing of all new trauma and orthopaedic admissions commenced, only patients that were symptomatic underwent COVID-19 swab testing. Routine testing every four days during admission for patients over the age of 70 was also introduced during the study period.

Five patients with a hip fracture, all of whom underwent surgical management, had a COVID-19 positive swab result. Only two of these patients were known positives prior to theatre. Four patients were COVID-19 positive during their admission. Of these four patients, one patient tested positive on admission who was asymptomatic and detected on the

routine admission swab. One asymptomatic patient from a care home tested positive prior to surgery, despite the first swab on admission swab being negative. One patient tested positive 5 days post-operatively after developing new pyrexia with on-going cough. One patient was tested day 2 post-operatively through the routine screening of over 70-year-old patients and found to be positive. However, one patient was found to be positive 5 days after discharge, day 6 post-operatively, after the GP arranged for COVID-19 testing in the nursing home as the patient had a new cough.

The five patients found to be COVID-19 positive on RT-PCR testing represents 5.62% of the 2020 cohort that underwent testing; all of whom had operative management of their hip fracture. Of the 89 tested patients four died, with only 2 deaths due to active COVID-19 infection, both within 30 days of admission and both post-operatively. One Patient was suspected of COVID-19 as cause of death but was not tested.

In addition, there were five patients who had tested positive prior to their admission and were deemed recovered COVID-19 patients. These patients tested positive more than 7 days prior to admission with a range 7–44 days.

Time data

Length of hospital stay, length of surgery and time from admission to surgery is summarised in Table 3. No significant difference was observed in length of surgery ($p = 0.450$) and time from admission to surgery ($p = 0.150$). The number of patients with time to surgery after 36 h is not statistically different between the years with 34 patients (28.8%) in 2020 and 32 patients (29.6%) in 2019 ($p = 0.893$). Patients had a significantly shorter inpatient admission length of stay in 2020 compared to 2019 with the average length of stay of 6.5 days in 2020 and 12.0 days in 2019 ($p < 0.005$). Discharge destination of patients discharged from hospital is summarised in Table 4.

Table 2 – COVID-19 status in 2020 cohort.

	COVID-19 status admission		COVID-19 status at time of surgery	
	n	Percent	n	Percent
Negative	88	75.4	87	74.6
Positive	1	0.8	2	1.7
Unknown	28	23.7	28	23.7

Table 3 – A Summary of the length of hospital stay, length of surgery and time from admission to surgery.

	Length of hospital stay/days	Length of surgery/minutes	Time from admission to surgery/minutes
2019 n = 108 N	108		
Mean	12.0	61.4	1984.0
Std. Deviation	14.9	26.5	2226.2
Range	135	185	18062.0
2020 n = 117 N	117		
Mean	6.5	60.4	2007.0
Std. Deviation	3.8	27.4	1693.8
Range	20	163	13286.0
p-value	<0.005 ^a	0.450	0.150

^a Statistically significant.

Table 4 – Discharge destination of patients.

	2019	2020
Home	48	25
Other Hospital, Same Health Board	41	44
Other Specialty, Same Hospital	3	3
Other Health board	0	5
Care Home	10	27
Missing	6	13

30-Day mortality

Causes of death are summarised in Table 5. Four patients (3.7%) died in 2019 and ten patients (8.5%) died in 2020 within 30-days of surgery. Figure 2 demonstrates the Kaplan Meier survival curve at 30-days for the 2020 COVID lockdown period as compared to the 2019 cohort. No significant difference in mortality at 30 days was observed between the cohorts ($p = 0.142$). Of the patients who died, the mean time from admission to surgery in 2019 was 27 h 3 min (SD 6 h 55 min, range 15 h 53 min) and 39 h 46 min in 2020 (SD 49 h 42 min, range 166 h 59 min). No significant difference was observed between time from admission to surgery $p = 0.777$, age $p = 0.258$, or time of surgery $p = 0.137$ between the patients who died within 30-days in 2019 and 2020.

Two patients died during the study had confirmed COVID-19 infection as the cause of death out of five patients in total, resulting in a mortality rate of 40% for COVID-19 positive hip fracture patients in this study. One patient who died was suspected of COVID-19 infection, but this was not confirmed on laboratory testing.

Discussion

This study has shown no statistical difference in 30-day mortality between the 2020 COVID-19 cohort and the 2019 cohort, despite a statistically significant difference in ASA grade between the two years. Time to theatre has remained

the similar with no statistical difference between the two years. The main statistically significant finding is time to discharge has decreased to an average 6.5 days. There has been a significant reduction in overall operative Orthopaedic trauma during this time period in comparison to 2019. Luceri et al. described their experience in an Italian major trauma centre at the height of the first wave, showing a reduction of 73% in their regional trauma hub, observing an increase in proximal femoral fractures and fragility fractures of the elderly.⁴ They explain the overall reduction of patient volume is due to the restrictions implemented by the Italian Government, similar to the national lockdown in the UK. Locally, we have observed a reduction of 409 operative cases in 2019 to 287 in 2020, which is reflective of Orthopaedic departments throughout the world.^{3,5–7} Despite this overall reduction in trauma, the number of patients sustaining hip fractures has remained similar to previous years.

Our response to the pandemic resulted in restructuring the Trauma service, pausing elective services early and the trauma inpatient bed capacity was reduced to a quarter of normal. A COVID-19 positive theatre was set up for all suspected and confirmed cases for all surgical specialties, as well as a surgical COVID-19 ward. Two trauma admission pathways were introduced for COVID-19 suspected patients and COVID-19 unsuspected patients. Ruggieri et al. published their approach to reorganisation of emergency surgery and managing orthopaedic trauma in a major trauma centre during the first-wave of the pandemic in Veneto, an area of Italy heavily affected by COVID-19. Ruggieri et al. also had a large reduction of inpatient bed capacity and access to trauma theatre.⁸ They implemented testing of both all admissions and routine testing of healthcare staff, setting up COVID-free and COVID suspected admission pathways. Ruggieri et al. compared their approach to that in Lombardia which only undertook testing in severe symptomatic cases and had a much larger proportion of COVID-19 positive cases admitted and COVID-19 deaths.⁸ They suggest an approach of swabbing all patients is a better approach, isolating possible and confirmed cases of COVID-19, reporting only three positive people of more than

Table 5 – Causes of death in patients within 30-days of surgery.

Year	Primary cause of death	Frequency	COVID status at time of surgery	Place of origin
2019	Urosepsis	1	N/A	
2019	Complications from disseminated malignancy	1	N/A	
2019	Pulmonary embolism	1	N/A	
2019	Acute coronary syndrome	1	N/A	
2020	COVID-19	2	Unknown ^a	Own home
			Positive	Nursing home
2020	Suspected COVID-19 ^b	1	Unknown	Sheltered home
2020	Complications from disseminated malignancy	1	Negative	Sheltered home
2020	Upper GI haemorrhage	1	Negative	Own home
2020	Aspiration pneumonia	1	Unknown	Nursing home
2020	Sepsis of unknown origin	1	Negative	Own home
2020	Urosepsis	1	Negative	Nursing home
2020	Stroke	1	Negative	Own Home
2020	Community Acquired Pneumonia	1	Unknown	Own Home

^a This patient tested positive after theatre, at the time of theatre COVID-19 status was unknown.

^b COVID-19 status at time of theatre unknown (before routine testing commenced), and not subsequently tested.

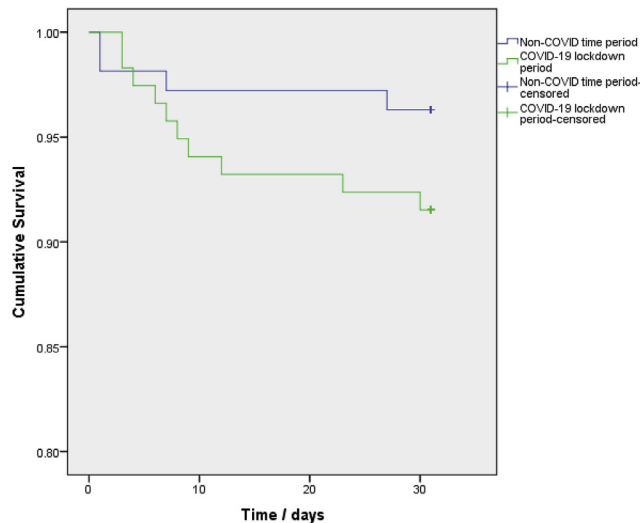


Fig. 2 – Kaplan Meier survival curve comparing non-COVID-19 cohort (2019) and COVID-19 lockdown (2020) cohort.

160 tested during their study period.⁸ Our approach evolved to test all patients admitted mid-way through our study period, however, we notably did not undertake routine staff testing.

We found the prevalence of COVID-19 to be 5.62% in the patients that were tested during their admission. Although, the admission COVID-19 status of patients was not known for 23% of the cohort as they did not undergo testing. Initially, only patients that were symptomatic were screened until testing capacity increased and a routine screening policy of all Orthopaedic admissions was implemented on 10th April 2020. The only patient that was found to be positive for COVID-19 on their admission swab was asymptomatic at the time of testing. The true prevalence of COVID-19, therefore, is difficult to fully quantify for the patients in this study and is likely to be underrepresented. The COVID-19 RT-PCR testing itself is known to have a high false negative rate.⁹ All patients identified as COVID-19 positive underwent operative management. We had access to a designated COVID-19 positive operating theatre for patients of known COVID-19 positive status, of suspected infection or deemed high-risk in which all staff wore appropriate Personal Protective Equipment (PPE) in order to mitigate risk.

The British Orthopaedic Association (BOA) released an emergency BOA Standards for Trauma and Orthopaedics (BOAST) Guideline at the beginning of the pandemic which moved towards more non-operative management for trauma patients to reduce the impact on service requirements.¹⁰ Whilst the number of trauma patients reduced significantly, the number of referrals for hip fracture patients remained constant throughout the lockdown period. Whilst there was an initial move towards non-operative management for general trauma patients; the best care for hip fracture patients is operative management for early mobilisation. Conservative management for the vast majority of hip fracture cases is inappropriate. National guidance from the National Institute for Health and Care Excellence (NICE) sets out clear guidelines

for the management of hip fracture patients.¹¹ Cronin et al. suggests scoring criteria in an attempt to conservatively manage selected hip fracture patients, creating a non-operative management pathway.¹² There is no long-term outcome data for the conservative management of hip fracture patients in this study and the basis of this non-operative pathway was for a time when overall demand on healthcare outstripped supply. NHS England issued specific guidance for the management of patients with fragility fractures during the COVID-19 Pandemic with operative management for hip fracture patients still advised.¹³ The Faculty of Intensive Care Medicine (ICM) Anaesthesia COVID-19 Group published strong guidance stating medical and surgical management of patients with hip fracture should, as far as possible, remain unchanged from that offered before the pandemic.¹⁴

COVID-19 has significantly impacted the provision of surgical care to patients during the peak of the pandemic with reduction in surgical capacity through requisition of resource, reallocation of staff to critical care for COVID-19 patients. Utilisation and efficiency of trauma lists has become even more important. Time to theatre within 36 hours is a key performance indicator for the care of hip fracture patients.¹¹ We have shown no statistically significant difference in the time to theatre from admission with the overall 2020 cohort as compared to 2019. However, there was an observed increase in time to theatre for patients known to be COVID-19 positive, although numbers in each subgroup were small. There were numerous factors which were all felt to contribute to a perceived sense of general decreased productivity in surgical provision for patients. These included decreased theatre availability, constantly evolving patient pathways and swabbing criteria, increased use of PPE, more vigorous cleaning of theatre after each case and scrutiny of air change requirements within the theatre. It is reassuring that despite the changes to care and indirect effects of COVID-19, outcomes have not been compromised for the hip fracture population. This is likely a reflection of the collective prioritization of these patients, and a continual pressure to overcome any barriers which were hindering safe and expeditious care of hip fracture patients.

One of the main findings is a statistically significant reduction in the length of stay in patients with hip fractures from an average of 12.0 to 6.5 days. There has been a push to reduce the time patients spend in hospital to reduce possible exposure to COVID-19 and potential nosocomial infection. Shorter length of stay has been shown to reduce the risk of hip fracture patients acquiring any nosocomial infection.¹⁵ Longer length of stay is associated with higher patient care cost and has been shown to have increased odds of death at 30-days after discharge.¹⁶ Therefore, the COVID-19 cohort of patients may have actually benefited from the change of service and reduction in length of stay in hospital as a result. We were able to benefit from an increased provision of in-patient physiotherapy from outpatient physiotherapists who were redeployed to the Orthopaedic wards as their routine clinical activities had been cancelled. Patients were discharged to peripheral hospitals away from the regional centre which managed the care of COVID-19 positive patients, however, the number of patients discharged to down-stream hospitals remained similar to the previous year.

More patients in 2020 were discharged to a nursing home (2020: 27, 2019: 10), with fewer patients discharged to their own home in 2019 (2020: 25, 2019: 48). However, what is not clear is whether these patients were discharged to a care home because of reduced community care availability. Unfortunately, we have not been able to ascertain this for the patients included in this study. There is concern that a patient who resides in a nursing home may have a higher risk of contracting COVID-19 than in hospital and may be at higher risk from an earlier discharge back to care. Currently, there is no robust evidence that this is the case and would be an interesting point for further study.

There were concerns reported early in the pandemic in both elective and emergency surgical setting regarding general anaesthesia and surgical morbidity associated with peri-operative COVID-19 infection.¹⁷ Thirty-day mortality appears to increase from 3.7% in 2019 to 8.5% in 2020, but this is not statistically significant ($P = 0.142$). Amongst patients who died, it was found that time to theatre had increased between 2019 (27 h) and 2020 (40 h). We found that of the five patients found to be COVID-19 positive, that two patients died from confirmed COVID-19 infection giving a mortality rate of 40%. Given the small numbers of COVID-19 positive cases, and that not all patients underwent testing, drawing meaningful conclusions on mortality is difficult. One patient was suspected of COVID-19 as the cause of death but did not undergo testing and cannot be confirmed. Considering this, it could be that the COVID-19 mortality rate is different and a true value of the mortality of COVID-19 positive hip fracture patients is difficult to accurately quantify.

A study published by Macey et al. from another major trauma centre in Glasgow, Scotland included patients of a similar demographic to this study with fewer patients overall, and a similar number of COVID-19 positive patients.¹⁸ The Glasgow study showed a mortality of 20% ($n = 2$) in COVID-19 positive patients ($n = 10$) with an overall 30-day mortality of 14% ($n = 11$), reporting fewer COVID-19 deaths and a higher overall 30-day mortality than our study. The length of stay from the Glasgow study remained unchanged between 2020 and 2019 which differs to the finding in our study. The IMPACT-Scot report on COVID-19 and hip fractures by Hall et al. included 317 hip fracture patients, of similar demographics to this study, from multiple centres in Scotland, excluding our centre.³ They described 8.5% ($n = 27$) with a positive COVID-19 test, with an overall mortality rate of 15.2% and of COVID-19 positive patients a mortality rate of 33% ($n = 9$). Kaynai et al. published the results of a multicentre study in London, England including 422 hip fracture patients that underwent surgical management.⁷ This study has one of the highest number of patients and COVID-19 positive patients in the current literature, including 82 COVID-19 positive patients, showing a mortality rate of 30.5% ($n = 25$) for COVID-19 positive hip fracture patients at 30-days. They did not include a comparison to the previous year and the study was retrospective in design. Morelli et al. published a series of 10 patients with hip fractures who were swab confirmed COVID-19 positive, all of whom underwent surgical management within 48 h, showing mortality rate of 20%.¹⁹ This is the lowest rate of mortality in the literature published to date. However,

this is a small patient cohort, and the authors remark it is unclear why this is lower than other reported mortality rates.

Internationally, the COVIDSURG international project published the first internal multicentre study related to post-operative 30-day mortality and showed that for all orthopaedic operative patients the rate of mortality was 28.8%.²⁰ Egol et al. published the experience of hip fracture care in New York with similar demographics to the patients included in our study, although ASA grade was not reported.⁶ The New York study compared patients in three separate time periods, two periods in 2020 pre-pandemic and pandemic in comparison to 2019 data. The reported 30-day mortality was significantly higher in 2020 of 12.3% compared to 3% in 2019, with a reported 53% ($n = 9$) 30-day mortality for COVID-19 positive patients which is similar to our study. The New York study is also limited with small numbers of patients in the COVID-19 positive group, was retrospective in design and compared different time periods to our study. Studies from Maniscalco et al. in Italy and Munoz Vives et al. in Spain both show worse mortality for hip fracture patients with COVID-19 infection, with a 30% COVID-19 hip fracture mortality in Spain – although at a limit of 14-day mortality.^{5,17} These studies were published earlier in the COVID-19 pandemic and were both retrospective and included small numbers of patients.

There are a number of limitations to this study. The main limitation is low patient numbers in the cohorts of our single centre study, with low COVID-19 positive case numbers in the 2020 cohort and the overall number of deaths was small. A larger study would be required to review mortality data in greater detail. The data collection for the 2019 cohort was retrospective. We excluded patients from analysis that were referred whilst in hospital from other specialties due to incomplete time data. At the beginning of the lockdown period, not all patients being admitted were routinely tested for COVID-19 which likely causes an under representation of the true number of COVID-19 infected patients. We do not have the local data on the sensitivity or specificity of the COVID-19 RT-PCR testing for the duration of this study period.

In the future, and whilst in the midst of the second wave, we must be clear that the care of elderly frail patients who sustain hip fractures must not be compromised. It may be that COVID-19 continues for many more months, perhaps into years, and appropriate risk assessment, robust patient pathways and an efficient testing system should be implemented to optimise the possible outcomes for this patient cohort. The appropriate use of Personal Protective Equipment and the use of a designated COVID-19 positive operating theatre can mitigate the risk to medical staff involved in the patient's operative care. Rapid testing of all patients to promptly detect positive patients allows risk stratification; the patients pre-operative condition to be optimised in the correct admission pathway; and appropriate shared decision making between involved specialities and family members. Therefore, efficiently identifying the COVID-19 status of the patients could allow expeditious surgery so that lengthy delays to theatre are not an additive factor to a worse outcome and increased mortality.

Conclusion

Significant changes to the overall delivery of healthcare due to COVID-19 could take many months, if not years, to return to the pre-COVID-19 state. The care of hip fracture patients should remain a priority. As this study has demonstrated, it is indeed possible to maintain the highest standard of care for these vulnerable, elderly patients. Overall, despite the reported trends of increased mortality of COVID-19 positive hip fracture patients, it is reassuring that the majority of patients presenting with hip fractures during the COVID-19 pandemic have not been significantly impacted and received care in line with current national standards. As further prospective, international collaborative research is continuing to be collected, this will hopefully give us further valuable insights into the true mortality of hip fracture patients with COVID-19 infection.

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Declaration of competing interest

None of the authors have any conflicts of interest to declare.

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