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GENERAL ORTHOPAEDICS

# The impact of COVID-19 on trauma and orthopaedic patients requiring surgery during the peak of the pandemic

## A RETROSPECTIVE COHORT STUDY

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### Aims

COVID-19 represents one of the greatest global healthcare challenges in a generation. Orthopaedic departments within the UK have shifted care to manage trauma in ways that minimize exposure to COVID-19. As the incidence of COVID-19 decreases, we explore the impact and risk factors of COVID-19 on patient outcomes within our department.

### Methods

We retrospectively included all patients who underwent a trauma or urgent orthopaedic procedure from 23 March to 23 April 2020. Electronic records were reviewed for COVID-19 swab results and mortality, and patients were screened by telephone a minimum 14 days postoperatively for symptoms of COVID-19.

### Results

A total of 214 patients had orthopaedic surgical procedures, with 166 included for analysis. Patients undergoing procedures under general or spinal anaesthesia had a higher risk of contracting perioperative COVID-19 compared to regional/local anaesthesia ($p = 0.0058$ and $p = 0.0007$, respectively). In all, 15 patients (9%) had a perioperative diagnosis of COVID-19, 14 of whom had fragility fractures; six died within 30 days of their procedure (40%, 30-day mortality). For proximal femoral fractures, our 30-day mortality was 18.2%, compared to 7% in 2019.

### Conclusion

Based on our findings, patients undergoing procedures under regional or local anaesthesia have minimal risk of developing COVID-19 perioperatively. Those with multiple comorbidities and fragility fractures have a higher morbidity and mortality if they contract COVID-19 perioperatively; therefore, protective care pathways could go some way to mitigate the risk. Our 30-day mortality of proximal femoral fractures was 18.2% during the COVID-19 pandemic in comparison to the annual national average of 6.1% in 2018 and the University Hospital Coventry average of 7% for the same period in 2019, as reported in the National Hip Fracture Database. Patients undergoing procedures under general or spinal anaesthesia at the peak of the pandemic had a higher risk of contracting perioperative COVID-19 compared to regional block or local anaesthesia. We question whether young patients undergoing day-case procedures under regional block or local anaesthesia with minimal comorbidities require fourteen days self-isolation; instead, we advocate that compliance with personal protective equipment, a negative COVID-19 swab three days prior to surgery, and screening questionnaire may be sufficient.

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## Introduction

COVID-19 (SARS-CoV-2) represents one of the greatest global healthcare challenges in a generation. A novel coronavirus originating in Wuhan, China, COVID-19 rapidly spread across the world and reached pandemic level by March 2020.[1] In the UK, the government set strict social distancing measures and a nationwide lockdown commenced on the 23 March 2020 aiming to reduce community transmission of COVID-19.[2]

As part of its response to the pandemic, UK trauma and orthopaedic (T&O) departments have prioritized trauma care and postponed routine elective surgery and clinics. There have been minimal opportunities to manage urgent elective cases. This has been done in accordance with guidelines published by the British Orthopaedic Association (BOA) for the management of trauma patients during this period.[3] The use of the recommended personal protective equipment (PPE) has been essential for the protection of staff and patients.[4]

Currently, the number of new cases and COVID-19-related deaths in the UK is declining, with numbers specific to University Hospitals Coventry and Warwickshire (UHCW) NHS trust confirming this trend in our region (Figure 1).[5,6] The focus now has to be on the safe reintroduction of T&O elective practice and initiating new pathways for these patients, focusing on minimizing the risk of COVID-19. The COVIDSurg Collaborative recommended thresholds for surgery should be heightened after analyzing an international multicentre cohort of patients who had any kind of surgery with a perioperative diagnosis of COVID-19.[7] In this cohort, 25% of cases were elective and 75% emergency, with trauma making up 20.1%. This study reported a 23.8% 30-day mortality with male sex and age 70 years or older associated with higher risk of mortality. It is unknown what the outcomes are for patients from the general population who had a surgical procedure during the pandemic peak who did not have a COVID-19 diagnosis.

The aim of this article is to evaluate a series of our T&O patients who underwent surgery during the COVID-19 pandemic peak, to establish if they contracted COVID-19 perioperatively, the risk factors associated with this, and its effects on 30-day mortality.

## Methods

We retrospectively included all patients who underwent a T&O procedure over a period of one month from 23 March to 23 April 2020. Our department works across two sites within UHCW NHS trust: University Hospital Coventry (UH) and the Hospital of St Cross (StX). Major trauma and non-ambulatory trauma care remained at UH, which also acted as the main treatment centre for those with COVID-19. The Hospital of StX became the site for the assessment and definitive management of ambulatory trauma. The urgent treatment centre (UTC) at the Hospital of StX had a minor operations suite set up.[8] Hand and soft tissue trauma were seen interchangeably by plastic surgery and orthopaedic trainees, with consultant oversight led by T&O.

Patients had their procedure under general anaesthetic (GA), spinal anaesthetic, regional block or local anaesthetic (LA), with appropriate adherence to the procedure specific aerosol-generating and non-aerosol-generating PPE guidelines.[4] This study included children and adults. The data was collected as part of a T&O service evaluation project. Patients across our two sites: UH and the Hospital of StX were included. Their procedure was either done in a formal theatre setting or in the minor operations suite.

Patients were identified from the daily handover and operating lists. Patient's demographics, home situation, comorbidities, type of anaesthesia, location of surgery, procedure, COVID-19 test results, and 30-day mortality were recorded. American Society of Anaesthesiologists (ASA) grade was recorded for patients who had procedures undertaken in a formal operating theatre.

Patients were contacted at minimum of 14 days post-discharge by telephone and a screening questionnaire was completed (Figure 2). Verbal informed consent was obtained from all subjects in this study at point of telephone consultation. Written informed consent was not obtained due to the COVID-19 pandemic and social distancing measures. Patients were asked if they had any of the four key diagnostic factors specified in the British Medical Journal Best Practice Guide on COVID-19.[9] Patients who had a positive COVID-19 swab result or displayed any of the four screening symptoms in the absence of a negative swab test result were deemed to have acquired COVID-19. Laboratory testing for COVID-19 infection was based on viral RNA detection by RT-PCR from a nasal and throat swab. A preoperative diagnosis of COVID-19 had to be within seven days of surgery, a postoperative diagnosis within 14 days. The minimum postoperative follow-up period of 14 days was decided upon as a perioperative diagnosis of COVID-19 would have presented at this stage.

To assess the impact of anaesthesia, three cohorts were determined: those with procedures under GA, under spinal anaesthesia, and under LA or regional block. We also observed a temporal relationship between the date of operation and a positive COVID-19 swab diagnosis, so therefore split the cohort in half based on date of surgery to assess this difference with decreasing COVID-19 prevalence. The first group had their surgery between the 23 March to the 7 April 2020 and the second group had their surgery between the 8 April and the 23 April 2020.

The data collected was input onto a spreadsheet and analyzed utilizing the GraphPad Prism platform (GraphPad Software, La Jolla, California, USA). For the purposes of analyzing continuous variables between

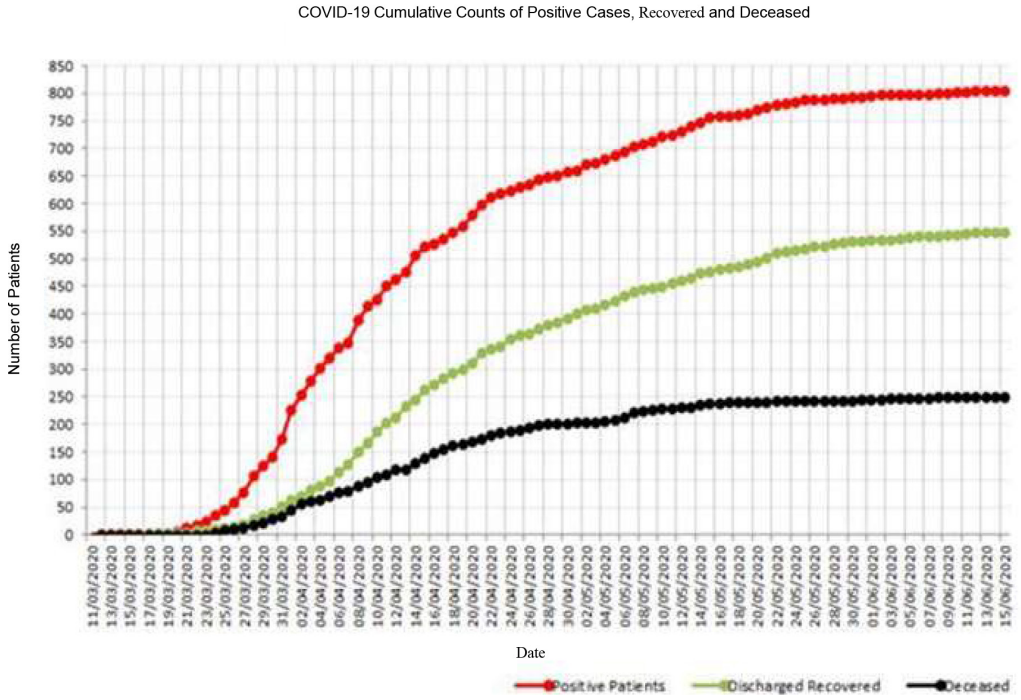



**Fig. 1**

Cumulative volumes of patients in the UHCW NHS Trust plotted over time with a confirmed positive swab result (red line), discharged patients (green), and deceased patients (black).

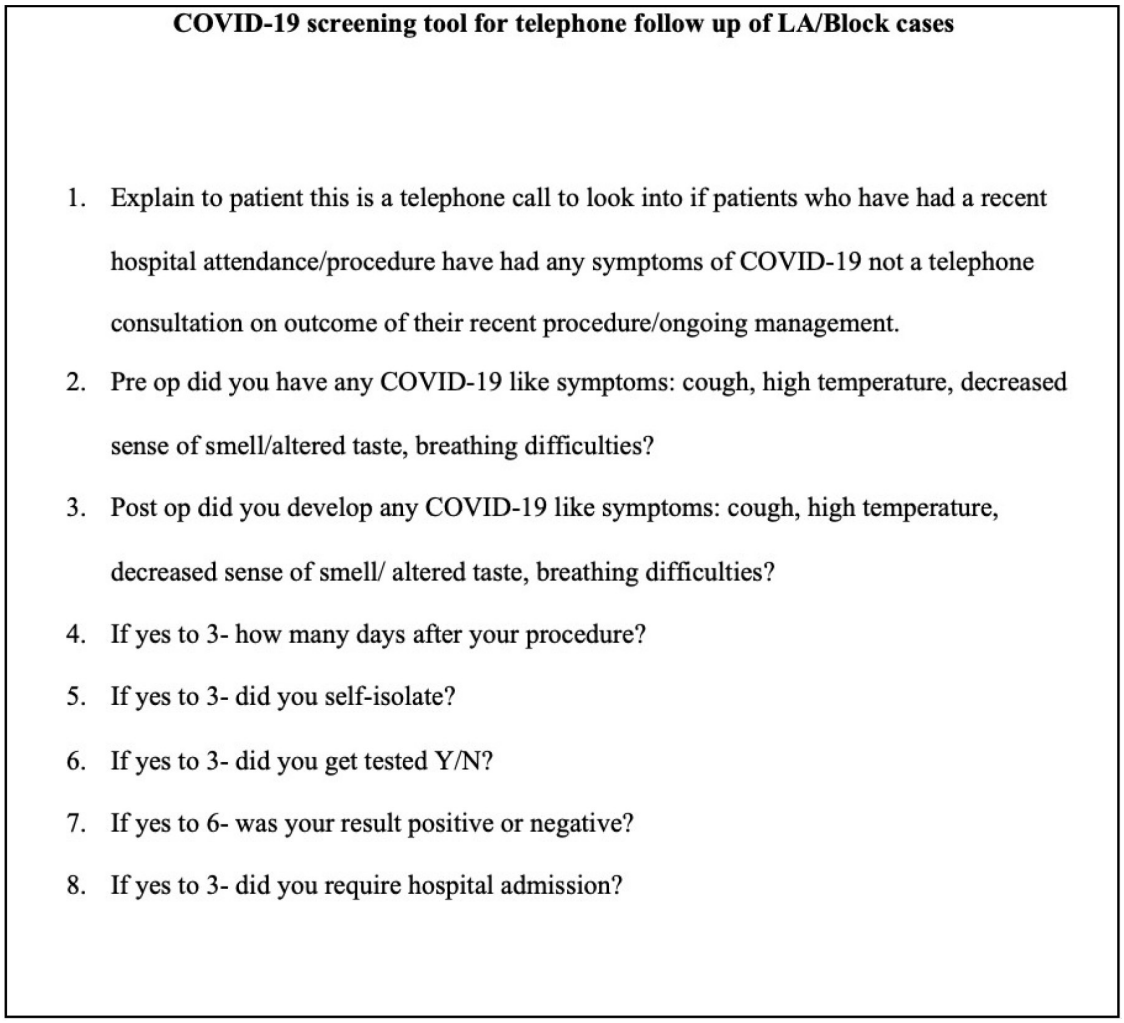
the three anaesthesia cohorts, a one-way analysis of variance (ANOVA) was used to determine significant differences between the three cohorts, with further two-tailed unpaired *t*-tests to determine which groups were significantly different. For statistical analysis of binary outcome measures between the three anaesthesia cohorts, a 3 × 2 contingency table was generated and analyzed using the Fisher-Freeman-Halton test. Between cohort analysis was then undertaken by analyzing a 2 × 2 contingency table by two-tailed Fisher's exact test. Survival analysis was undertaken by generating a Kaplan-Meier survival curve and then analyzing this by log-tank test. Between cohort analysis was then undertaken by repeat log-rank testing. A statistically significant p-value was set at 0.05, with the Bonferroni correction used to control familywise error rate.

The primary outcome measure of this study was a positive swab result for COVID-19 or symptoms in the absence of a negative swab results. Secondary outcome measures included symptoms with a negative COVID-19 swab result, 30-day postoperative mortality, and readmittance to hospital due to COVID-19.

## Results

A total of 214 patients had T&O surgical procedures during the one-month period analyzed. We were able to contact 166 (77.6%) patients a minimum of 14 days postoperatively. Since our clinical results system is updated via the NHS common stem, we utilized this to review those patients not contactable; none had a positive COVID-19 swab result, none were readmitted to our NHS trust, and none were registered as deceased at 30 days postoperatively. The key patient demographics of those patients included in analysis are shown in Table I, with the demographics of those not contactable and therefore not included in our analysis shown in Table II. A total of three patients were still inpatients at time of data analysis and information regarding COVID-19 status was retrievable allowing inclusion in subsequent analysis. Therefore, a total of 166 patients who underwent a T&O procedure between 23 March and 23 April 2020 and were available for telephone follow-up at a minimum of 14 days postoperatively, were included in the analysis. Of the 166 patients, 68 (40.9%) had a procedure undertaken using GA, 67 (40.4%) under LA, and 18 (10.8%) under spinal anaesthesia, with the remaining 13 (7.8%) under regional block.

Overall, 14 of the 166 patients had a positive COVID-19 swab result, two of which occured in the preoperative period. One patient had symptoms of COVID-19 in the postoperative period in the absence of a confirmatory swab. For the purposes of analysis, these 15 (9.0%) patients were considered to have had a perioperative diagnosis of COVID-19. A further eight patients reported symptoms suggestive of infection with COVID-19 but had a negative swab result. Although the



**COVID-19 screening tool for telephone follow up of LA/Block cases**

1. Explain to patient this is a telephone call to look into if patients who have had a recent hospital attendance/procedure have had any symptoms of COVID-19 not a telephone consultation on outcome of their recent procedure/ongoing management.
2. Pre op did you have any COVID-19 like symptoms: cough, high temperature, decreased sense of smell/altered taste, breathing difficulties?
3. Post op did you develop any COVID-19 like symptoms: cough, high temperature, decreased sense of smell/ altered taste, breathing difficulties?
4. If yes to 3- how many days after your procedure?
5. If yes to 3- did you self-isolate?
6. If yes to 3- did you get tested Y/N?
7. If yes to 6- was your result positive or negative?
8. If yes to 3- did you require hospital admission?

**Fig. 2**

Screening proforma for telephone follow-up of cases undertaken during the COVID-19 pandemic response.

authors acknowledge swab testing has a sensitivity of only around 70%,[10] these patients were not included as having a confirmed perioperative diagnosis of COVID-19.

Between the three anaesthesia cohorts there was a statistically significant difference in age (one-way ANOVA, $p = 0.0003$; Figure 3), with the spinal anaesthesia cohort being significantly older than both the local and regional anaesthesia cohort and GA cohort (two-tailed unpaired *t*-test, $p < 0.0001$ and $p = 0.003$, respectively). Between the three cohorts there was no statistically significant difference in sex distribution (Fisher-Freeman-Halton test; $p = 0.139$), although there was a trend for a higher proportion of males to have sustained injuries treated under local or regional anaesthesia. By Fisher-Freeman-Halton test, there was a significant difference in residential status of the patients ($p = 0.015$), with none of the patients requiring care under local or regional block residing in care homes, compared to two patients each in the general and spinal anaesthesia cohorts.

When analyzed as distinct cohorts based upon anaesthesia type, nine out of the 68 patients (13.2%) in the GA cohort had a perioperative diagnosis of COVID-19, compared to five out of 18 (27.8%) in the spinal anaesthetic cohort, and one out of 80 (1.3%) in the local or regional anaesthesia cohort, a statistically significant difference (Fisher-Freeman-Halton test, $p = 0.0003$, Figure 4). Between cohort analysis by two-tailed Fisher's exact test revealed higher rates of perioperative COVID-19 in the GA cohort and spinal anaesthetic cohort when compared with the local or regional anaesthesia cohort ($p = 0.0058$ and $p = 0.0007$, respectively), but no significant difference when comparing the GA cohort with the spinal anaesthesia cohort ($p = 0.158$).

Looking in more detail at patients who had a perioperative diagnosis of COVID-19, 14 of the 15 patients presented with a fragility fracture (Figure 5). Of the 15 cases with a diagnosis of COVID-19, the average age was 79.1 years (59 to 95), and 13 were symptomatic or had

**Table I.** Patient demographics split into cohorts based upon type of anaesthesia the orthopaedic procedure was carried out under.

| Variable | | Local anaesthetic and regional | Spinal anaesthetic | General anaesthetic | p-value |
|---|---|---|---|---|---|
| Anaesthetic type, n | | Local = 67<br>Regional = 13 | 18 | 68 | |
| Age, yrs | Mean (range) | 46.3 (12 to 87) | 70.5 (21 to 95) | 47.3 (1 to 104) | 0.0003* |
| Sex, n (%) | Male | 51 (63.8) | 8 (44.4) | 34 (50) | 0.139† |
| | Female | 29 (36.3) | 10 (55.6) | 34 (50) | |
| Residence, n (%) | Own home | 80 (100) | 16 (88.9) | 66 (97.1) | 0.015† |
| | Care home | 0 (0) | 2 (11.1) | 2 (2.9) | |
| Treatment hospital, n (%) | University Hospital Coventry | 1 (1.2) | 13 (72.2) | 47 (69.1) | < 0.0001† |
| | Hospital of St Cross | 79 (98.8) | 5 (27.8) | 21 (30.9) | |
| COVID-19 status, n (%) | Positive or symptomatic | 1 (1.1) | 5 (27.8) | 9 (13.2) | 0.0003† |
| | Negative and asyptomatic | 79 (98.8) | 13 (72.2) | 59 (86.8) | |
| Survival at 30 days, n (%) | Alive | 80 (100) | 15 (83.3) | 65 (95.6) | 0.002‡ |
| | Dead | 0 | 3 (16.7) | 3 (4.4) | |
| Length of stay, days | Median (IQR) | 0 (0 to 0) | 6 (4 to 14) | 2 (0 to 8.25) | |
| | Range | 0 to 9 | 0 to 35 | 0 to 39 | |
| Comorbidities, n (%) | 0 | 51 (63.8) | 3 (16.7) | 31 (45.6) | |
| | 1 | 20 (25) | 7 (38.9) | 15 (22.1) | |
| | > 2 | 9 (11.3) | 10 (55.6) | 20 (29.4) | |
| ASA grade, n (%) | 1 | 0 | 3 (16.7) | 19 (27.9) | |
| | 2 | 0 | 6 (33.3) | 16 (23.5) | |
| | 3 | 0 | 8 (44.4) | 11 (16.2) | |
| | 4 | 0 | 3 (16.7) | 3 (4.4) | |
| | Not assessed | 80 (100) | 0 | 17 (25) | |

IQR, interquartile range.
*One-way analysis of variance.
†Fisher-Freeman-Halton exact test.
‡Log-rank test.

a positive swab in the postoperative period. Of the 14 cases undertaken in the operating theatre setting, eight patients were ASA 3 or 4. In addition, 11 patients had two or more significant comorbidities (73.3%). None of these patients required readmission to hospital due to COVID-19. Six of the 15 patients died giving a 30-day mortality of 40%.

Within our LA or regional block cohort, 30-day mortality was zero; within the GA or spinal anaesthetic cohort it was 7%. Our 30-day mortality of proximal femoral fractures was 18.2% during the COVID-19 pandemic in comparison to the annual nation average of 6.1% in 2018 and the UH average of 7% for the same period in 2019, as reported in the National Hip Fracture Database (NHFD).[11] All of the patients presenting with a fractured neck of femur who died had a positive COVID-19 swab result. Figure 6 demonstrates overall survival at 30 days postoperatively comparing the three anaesthesia cohorts (log-rank test, p = 0.002). Additional between cohort analysis revealed that the only statistically significant difference in survival at 30 days was between the spinal and LA or regional cohorts (p = 0.0002). For the six patients who died (two males and four females), the average age was 87.8 years (74 to 104), all but one had an assessable ASA grade of 3 or 4, and four had a positive COVID-19 swab result. Of

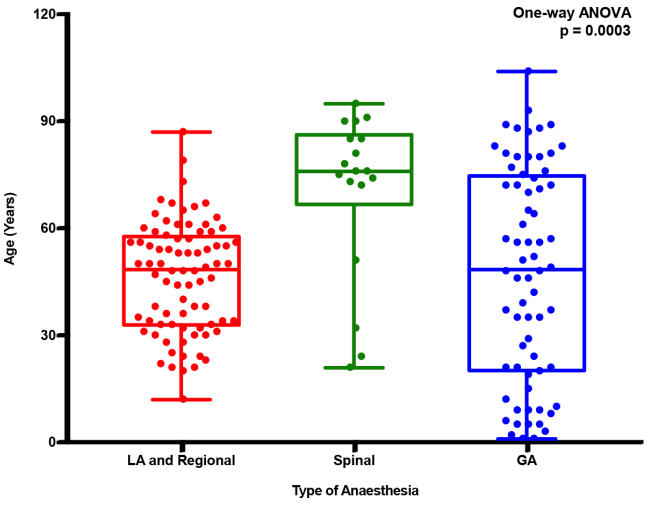



**Fig. 3**

Box and whisker plot with scatter plot comparing the age distribution between the three cohorts which showed a statistically significant difference.

note, a further two patients died after the 30-day period, at days 34 and 38 postoperatively.

Finally, when the cohort was analyzed according to date of operation, of those in the first 16 days, 12 patients had a positive COVID-19 swab diagnosis postoperatively (12/81 cases, 14.8 %), with six deaths at 30 days (6/81

**Table II.** Patient demographics of the 48 patients across the three cohorts who were unavailable for telephone follow-up and therefore were not included in the cohorts for analysis.

| Variable | | Local anaesthetic and regional | Spinal anaesthetic | General anaesthetic |
|---|---|---|---|---|
| Anaesthetic type, n | | Local = 20<br>Regional = 0 | 10 | 18 |
| Age, yrs | Mean (range) | 46.6 (17 to 95) | 67 (32 to 92) | 57.3 (5 to 99) |
| Sex, n (%) | Male | 11 (55) | 6 (60) | 12 (66.7) |
| | Female | 9 (45) | 4 (40) | 6 (33.3) |
| Residence, n (%) | Own home | 20 (100) | 9 (90) | 12 (66.7) |
| | Care home | 0 (0) | 1 (10) | 6 (33.3) |
| Treatment hospital, n (%) | University Hospital Coventry | 0 (0) | 1 (10) | 5 (27.8) |
| | Hospital of St Cross | 20 (100) | 9 (90) | 13 (72.2) |
| Survival at 30 days, n (%) | Alive | 20 (100) | 10 (100) | 18 (100) |
| | Dead | 0 (0) | 0 (0) | 0 (0) |
| Length of stay, days | Median (IQR) | 0 (0 to 0) | 8.5 (3.5 to 14.5) | 7 (0.25 to 8.75) |
| | Range | 0 to 0 | 0 to 16 | 0 to 22 |
| Comorbidities, n (%) | 0 | 13 (65) | 4 (40) | 6 (33.3) |
| | 1 | 5 (25) | 1 (10) | 4 (22.2) |
| | > 2 | 2 (10) | 5 (50) | 8 (44.4) |
| ASA grade, n (%) | 1 | 0 (0) | 3 (30) | 4 (22.2) |
| | 2 | 0 (0) | 1 (10) | 3 (16.7) |
| | 3 | 0 (0) | 3 (30) | 6 (33.3) |
| | 4 | 0 (0) | 2 (20) | 2 (11.1) |
| | Not assessed | 20 (100) | 1 (10) | 3 (16.7) |

IQR, interquartile range.

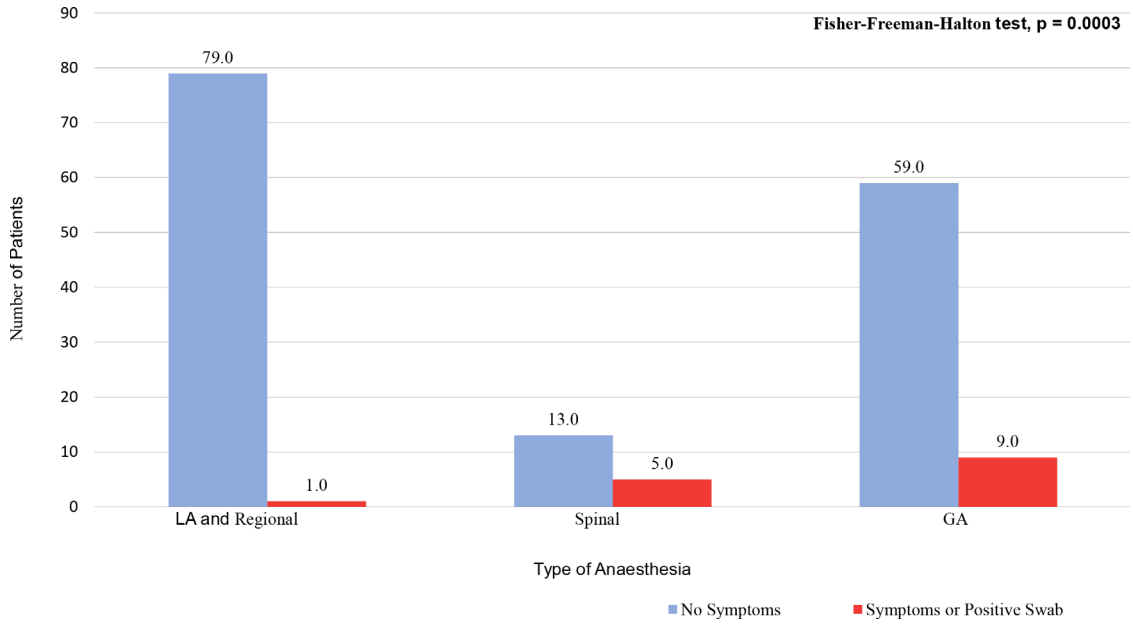



**Fig. 4**

Group bar chart comparing the incidence of perioperative COVID-19 between the three cohorts, with a statistically significant difference noted between the three groups.

cases 7.4%). In the second half of the cohort, there were no positive postoperative COVID-19 swab diagnosis, and no deaths at 30 days. There was a single positive preoperative swab diagnosis in each group.

## Discussion

Despite downward trends in the incidence of positive cases and mortality within the UK, COVID-19 continues to represent a significant consideration as the NHS starts

| Cases with Peri-Operative COVID-19 | |
|---|---|
| Neck of femur # | 11 |
| Distal femoral # | 1 |
| Diaphyseal femoral # | 1 |
| Peri-prosthetic femoral # | 1 |
| FB removal finger | 1 |

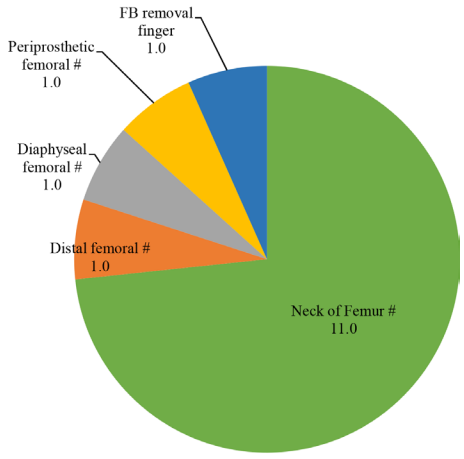



Fig. 5

A table and pie chart demonstrating the operative procedures undertaken on patients with a perioperative diagnosis of COVID-19.

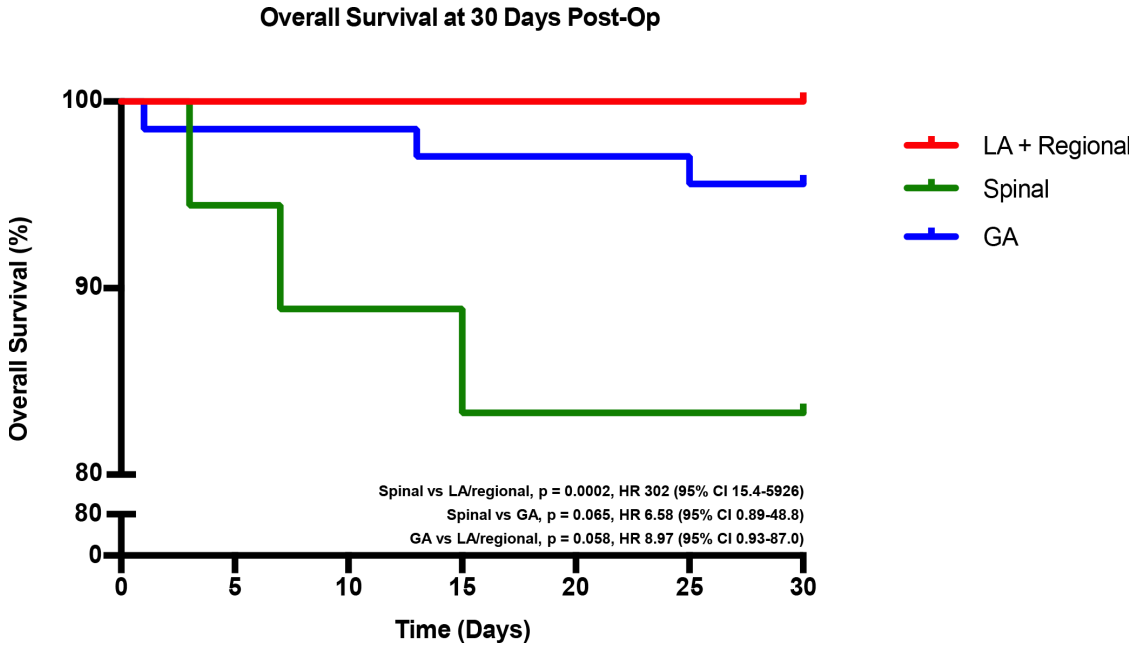



Fig. 6

A Kaplan-Meier curve comparing 30-day mortality between the general, spinal, and local/regional anaesthesia cohorts.

initiating a return to normal working practices. From our cohort, 15 patients (9%) had a perioperative diagnosis of COVID-19. The majority of cases in our cohort testing positive were in elderly patients presenting with fragility fractures, and 69.2% had an ASA of grade 3 or 4. GA and spinal anaesthesia was associated with a statistically higher incidence of perioperative COVID-19. It was noted that patients at UH who had developed COVID-19 postoperatively were admitted in the first two weeks of our time period; this is when community and inpatient incidence of COVID-19 was rapidly increasing in the UK and we were adapting to a very new environment. The majority of diagnoses were in the postoperative period, and so it is likely these patients contracted COVID-19 during their hospital admission. Our data suggests that once stringent infection control policies were practiced, namely adherence to PPE guidelines, strict barrier nursing, isolation of patients with a confirmed, or

suspected COVID-19 diagnosis and minimizing direct face-to-face contact, as well as more widely available and utilized swab testing, patients on our wards were not getting COVID-19 postoperatively.

Old age, multiple comorbidities, and ASA grade of greater than 3 are factors which place hip fracture patients in the high-risk population for the consequences of COVID-19 and ultimately increased mortality.[7] Emerging evidence has confirmed that a perioperative diagnosis of COVID-19 in hip fracture patients is associated with an increase 30 day mortality rate.[12,13] However, early treatment of hip fractures remains advantageous,[14] an Italian study indicated that proceeding with surgery in patients with a diagnosis of COVID-19 contributed to overall stability of the patient, improved physiological ventilation, and overall comfort.[15] Identifying those with fragility fractures as being at higher risk of developing perioperative COVID-19, it may be advantageous to plan for protective care pathways for these patients. Utilization of repurposed elective operating capacity at 'clean' sites has also been demonstrated to reduce the risk of patients with fragility fractures contracting COVID-19; however, these sites may not be available throughout the UK.[16]

Recommendations for the recovery of surgical services from the Royal College of Surgeons England help to inform the reintroduction of elective surgery.[17] 'Clean' sites and creation of 'green pathways' may allow patient journeys which avoid clinical areas dealing with the highest concentration of patients with COVID-19, thus reducing the risk of nosocomial transmission between patients. For example, generating distinct streams with 'green' patients making use of separate hospital entrances, corridors, stairs, and lifts where the use of a face mask is mandatory, and the utilization of separate operating theatres. Several publications highlight the requirement to carefully select cases for restarting elective surgery, and to be vigilant of surges in COVID-19 cases to ensure resources and healthcare workers are equipped for a potential 'second wave' of infections.[18] Pathways including multidisciplinary team meetings have been proposed; to help prioritise limited theatre capacity and large number of patients awaiting surgery. Consent must be a consideration. Advice has been published regarding maintenance of Montgomery principles for informed consent.[19] It has been suggested the increased risk of morbidity and mortality associated with T&O procedures when complicated by COVID-19 may limit the breadth and scope of T&O operative practice during the pandemic until these risks can be confidently mitigated.[20]

The concern raised by the COVIDSurg Collaborative is that patients who acquire COVID-19 during the perioperative time have a more severe illness. From studies regarding the benefit of steroids in COVID-19 in ITU patients, we could hypothesize that the cytokine storm in the postoperative patient will predispose them to a more significant impact of an acquired respiratory infection.[21] If the surgery is minor this will cause a lower inflammatory response than major surgery. We are able to demonstrate that patients undergoing regional or LA procedures, who tend to be younger and have fewer comorbidities, have minimal risk of acquiring COVID-19 perioperatively. This could be extrapolated to elective day-case surgery in a similar cohort.

As we return to a more "normal" way of living post-lockdown we realize the impact of COVID-19 has been far reaching with significant impact on individual's personal welfare and employment. Although evidence is lacking, it is our considered opinion that younger patients may not be able to comply with a period of preoperative isolation due to employment commitments, having children at school or caring for ageing family members. Therefore, we propose a pragmatic but safe option; that self-isolation for 14 days preoperatively for all patients might be excessive, and self-isolation may not be required at all if the patient's age is below 70 years, they have few comorbidities and are having day-case surgery under local or regional anaesthesia. We would still expect that patients have a preoperative negative COVID-19 swab within three days of surgery, self-isolate from day of swab, and complete a COVID-19 screening questionnaire. In addition, we should continue to follow national guidance to minimize in hospital transmission with the use of PPE, regular hand washing, and staff testing.

However, adoption of this approach should be taken with strict measures in place to minimize as far as possible the potential for nosocomial transmission of COVID-19 from an asymptomatic patient attending hospital for a local or regional procedure and those at higher risk. For example, inpatients recovering from a neck of femur fracture or a high-risk patient attending for an elective knee arthroplasty and who has been screened and self-isolating, should have different pathways through the hospital to avoid interaction with those who have not self-isolated pre-operatively. In addition, we cannot guarantee those who have been screened and have a negative swab result actually do not have COVID-19 due to false negative rate of the test.[10] Ultimately, this would be a logical area for a prospective research study in this COVID-19 restoration phase.

Caution should be taken in applying this to all patients as the risks of acquiring COVID-19 when undergoing procedures under GA or spinal anaesthesia were higher, with 16% of our GA/spinal cohort of patients being diagnosed as COVID-19 positive in the perioperative period, and subsequently associated with a 40% mortality. Although the majority of our COVID-19 positive patients were frail and admitted with proximal femoral factures, for elective and non-time urgent trauma cases in at-risk patients, it is vital that asymptomatic patients or those in the incubation period of COVID-19 are identified and

do not proceed to surgery due to this increased risk of morbidity and mortality postoperatively.[22] Based on our cohort, elderly patients undergoing GA/spinal anaesthesia and those with medical comorbidities should be protected from risk. We perceive this can be mitigated by a screening questionnaire, a negative swab three days prior to surgery and a period of 14 days of self-isolation. Furthermore, if the regional incidence of COVID-19 is seen to increase, the threshold for requiring preoperative self-isolation should be lowered to account for the risk of acquiring COVID-19 in the community. Lastly, it should also be considered that our cohort were presenting acutely with traumatic injuries, whereby there is a need for urgent surgery to optimise patient outcomes. For the purposes of elective procedures, this is often not the case and delaying an elective procedure will be less likely to impact on the outcomes of the patient but may at least mitigate the risk of developing COVID-19 perioperatively.

Finally, the newly published NICE COVID-19 guideline (NG179) for arranging planned care in hospitals encompasses patients who plan to undergo elective surgery, and supports our perioperative advice for elective surgery.[23] It recommends those patients at greatest risk of getting COVID-19, or those who would have a poorer outcome if they get it, may wish to self-isolate prior to a procedure for 14 days, as well as have a negative swab three days prior to admission. Otherwise, lower-risk patients should follow social distancing and hand hygiene measures for 14 days prior to admission and have a negative COVID-19 swab three days before admission and subsequently self-isolate until the day of surgery.

We recognize that the findings are from a single trust working across two sites. As a retrospective study, there may be a degree of recall bias as patients were contacted by telephone at a later date. We were unable to ascertain what happened clinically to the group of patients that were not followed up, but we do know if they have a positive COVID-19 swab diagnosis or died, therefore, we are confident in these key aspects of our findings. It must be recognized worldwide the number of patients presenting with T&O injuries has decreased during the peak of the COVID-19 crisis, therefore this study cannot be considered normal practice, rather the short-term outcomes of this time of crisis.[24,25] The strengths were that this is a relatively large cohort from a busy trauma centre in the UK with multiple patient pathways.

## Conclusion

COVID-19 has driven a sweeping adaption of the UK's health service to optimize the management of all patients during this period. Previous studies have demonstrated that a perioperative diagnosis of COVID-19 has a significant impact on 30-day mortality. Few studies provide information on the chances of becoming infected perioperatively. Our retrospective cohort study agrees that those patients with multiple comorbidities and fragility fractures have a higher morbidity if they contract COVID-19. We very clearly demonstrate for younger patients without comorbidities or fragility fractures, the number of patients acquiring COVID-19 was extremely low. With good compliance of infection control measures and use of PPE by staff and patients, we can confidently reassure patients of a low COVID-19 infection risk. We can appropriately counsel patients and relatives if an individual with a fragility fracture or multiple co-morbidities is admitted to our trauma services.

Optimization of pathways for elderly patients with fragility fractures must be adopted to mitigate risk of infection. We would advocate that a preoperative risk assessment including comorbidity review, COVID-19 swabbing, and the use of regional anaesthesia where possible, will provide the safest operative environment. We question if self-isolation is necessary for every surgical patient preoperatively and suggest instead self-isolation of a selected cohort of patients in keeping with the latest NICE guidelines.[23] Ultimately, as healthcare providers we must adapt our practise and guidelines in line with the national prevalence of COVID-19, thus enabling healthcare providers to safely conduct operative interventions required.[20] A prospective multicentre research study would be a logical next step in this area.

## References


1. WHO announces COVID-19 outbreak a pandemic. 2020. https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic (date last accessed 13th June 2020).
2. **Lillie PJ**, **Samson A**, **Li A**, **et al**. Novel coronavirus disease (Covid-19): the first two patients in the UK with person to person transmission. *J Infect.* 2020;80(5):578–606.
3. BOAST - Management of patients with urgent orthopaedic conditions and trauma during the coronavirus pandemic. https://www.boa.ac.uk/resources/covid-19-boasts-combined.html (date last accessed 13th June 2020).
4. COVID-19 personal protective equipment (PPE) - GOV.UK. https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-personal-protective-equipment-ppe (date last accessed 13th June 2020).
5. Worldometer. Coronavirus cases - United Kingdom. 2020. https://www.worldometers.info/coronavirus/country/uk/ (date last accessed 13/08/2020).
6. **Landler M**. Coronavirus Cases Fall in Europe's Capitals but Fears Over Reopening Linger - The New York Times. 2020.
7. **Archer JE**, **COVIDSurg Collaborative**. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet.* 2020;396(10243):27–38.
8. **Mackay N**, **Shivji F**, **Langley C**, **et al**. The provision of trauma and orthopaedic care during COVID-19: the coventry approach. *Transient J Trauma Orthop Coronavirus.* 2020.
9. Coronavirus disease 2019 (COVID-19) - History and exam | BMJ Best Practice. https://bestpractice.bmj.com/topics/en-gb/3000168/history-exam#keyFactors (date last accessed 13th June 2020).
10. **Watson J**, **Whiting PF**, **Brush JE**. Interpreting a covid-19 test result. *BMJ.* 2020;369:m1808.
11. NHFD 2019 annual report. https://www.nhfd.co.uk/20/hipfractureR.nsf/docs/2019Report (date last accessed 13th June 2020).
12. **Hall AJ**, **Clement ND**, **Farrow L**, **et al**. IMPACT-Scot report on COVID-19 and hip fractures. *Bone Joint J.* 2020:1–10.
13. **Kayani B**, **Onochie E**, **Patil V**, **et al**. The effects of COVID-19 on perioperative morbidity and mortality in patients with hip fractures. *Bone Joint J.* 2020:1–10.

14. **Merloz P**. Optimization of perioperative management of proximal femoral fracture in the elderly. *Orthop Traumatol Surg Res*. 2018;104(1S):S25–S30.
15. **Catellani F**, **Coscione A**, **D'Ambrosi R**, **et al**. Treatment of proximal femoral fragility fractures in patients with COVID-19 during the SARS-CoV-2 outbreak in northern Italy. *J Bone Joint Surg Am*. 2020;102(12):e58.
16. **Chui K**, **Thakrar A**, **Shankar S**. Evaluating the efficacy of a two-site ('COVID-19' and 'COVID-19-free') trauma and orthopaedic service for the management of hip fractures during the COVID-19 pandemic in the UK. *Bone & Joint Open*. 2020;1(6):190–197.
17. Recovery of surgical services during and after COVID-19. Royal College of surgeons. https://www.rcseng.ac.uk/coronavirus/recovery-of-surgical-services/ (date last accessed 13th June 2020).
18. **Liow MHL**, **Tay KXK**, **Yeo NEM**, **et al**. From "business continuity" to "back to business" for orthopaedic surgeons during the COVID-19 pandemic. *Bone & Joint Open*. 2020;1(6):222–228.
19. **Harrison N**, **Hewitt H**, **Pandya P**, **Reisel D**. How Montgomery is reconfiguring consent in the UK. *The Lancet*. 2018;392(10142):102–104.
20. **Carroll C**, **Aziz KT**, **Humbyrd CJ**. Elective reconstructive surgery during a pandemic. *J. Bone Jt. Surg*. 2020;1.
21. Dexamethasone - CEBM. https://www.cebm.net/covid-19/dexamethasone/ (date last accessed 27th June 2020).
22. **Lei S**, **Jiang F**, **Su W**, **et al**. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *EClinicalMedicine*. 2020;21:100331.
23. Overview | COVID-19 rapid guideline: arranging planned care in hospitals and diagnostic services | Guidance | NICE. https://www.nice.org.uk/guidance/NG179 (date last accessed 31st July 2020).
24. **Hampton M**, **Clark M**, **Baxter I**, **et al**. The effects of a UK lockdown on orthopaedic trauma admissions and surgical cases. *Bone & Joint Open*. 2020;1(5):137–143.
25. **Scott CEH**, **Holland G**, **Powell-Bowns MFR**, **et al**. Population mobility and adult orthopaedic trauma services during the COVID-19 pandemic: fragility fracture provision remains a priority. *Bone & Joint Open*. 2020;1(6):182–189.



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