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GENERAL ORTHOPAEDICS

30-day mortality following trauma and orthopaedic surgery during the peak of the COVID-19 pandemic

A MULTICENTRE REGIONAL ANALYSIS OF 484 PATIENTS

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Aims

Now that we are in the deceleration phase of the COVID-19 pandemic, the focus has shifted to how to safely reinstate elective operating. Regional and speciality specific data is important to guide this decision-making process. This study aimed to review 30-day mortality for all patients undergoing orthopaedic surgery during the peak of the pandemic within our region.

Methods

This multicentre study reviewed data on all patients undergoing trauma and orthopaedic surgery in a region from 18 March 2020 to 27 April 2020. Information was collated from regional databases. Patients were COVID-19-positive if they had positive laboratory testing and/or imaging consistent with the infection. 30-day mortality was assessed for all patients. Secondly, 30-day mortality in fracture neck of femur patients was compared to the same time period in 2019.

Results

Overall, 496 operations were carried out in 484 patients. The overall 30-day mortality was 1.9%. Seven out of nine deceased patients underwent surgery for a fractured neck of femur. In all, 27 patients contracted COVID-19 in the peri-operative period; of these, four patients died within 30 days (14.8%). In addition, 21 of the 27 patients in this group had a fractured neck of femur, 22 were over the age of 70 years (81.5%). Patients with American Society of Anesthesiologists (ASA) grade > 3 and/or age > 75 years were at significantly higher risk of death if they contracted COVID-19 within the study period.

Conclusion

Overall 30-day postoperative mortality in trauma and orthopaedic surgery patients remains low at 1.9%. There was no 30-day mortality in patients ASA 1 or 2. Patients with significant comorbidities, increasing age, and ASA 3 or above remain at the highest risk. For patients with COVID-19 infection, postoperative 30-day mortality was 14.8%. The reintroduction of elective services should consider individual patient risk profile (including for ASA grade). Effective postoperative strategies should also be employed to try and reduce postoperative exposure to the virus.

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Introduction

The COVID-19 (SARS-CoV-2) pandemic has affected healthcare provision on a global scale. First declared a pandemic by the World Health Organization on 11 March 2020,[1] the first case was reported in the UK on 31 January 2020[2] and in Northern Ireland on 26 February 2020.[2] A UK-wide lockdown was announced on 23 March 2020.[3] To date, Northern Ireland has confirmed 4,732 positive cases with 526 reported deaths (figures correct 29th June 2020).[2] The rate

of infection per 100,000 population has been lower in Northern Ireland (259/100,000) compared to other parts of the UK (286/100,000 in England, 290/100,000 in Scotland, and 497/100,000 in Wales).[4]

As part of the response to the pandemic, all elective services, including elective orthopaedic surgery, were suspended. The suspension of services remains in effect. Recently, in the deceleration phase of the pandemic, the focus has turned to planning the safe commencement of currently reduced services, such as elective orthopaedic operating.[5,6] It is important to have as much evidence as possible regarding the safety of operating in hospitals exposed to COVID-19. This should be on a regional basis with assessment of the impact on type of surgery and method of anaesthesia.

Initial evidence has suggested that patients who contract COVID-19 in the peri-operative period had a significantly increased mortality. Lei et al[7] highlighted a 20% mortality for patients who developed coronavirus pneumonia postoperatively following elective surgery.[7] This study, however, only included 34 patients, four of whom underwent elective orthopaedic procedures. More recently, COVIDsurg, an international, multicentre collaborative group, reported findings from 235 hospitals across 24 countries with a total of 1,128 patients, including 299 trauma and orthopaedic patients.[8] All involved patients had confirmed COVID-19 within seven days before or 30 days after surgery. COVIDsurg identified a 30-day mortality in this group of 23.8%. The 30-day mortality of the 299 orthopaedic patients was 28.8%. We hope to build on this study by investigating the safety of orthopaedic trauma services within our region.

We hypothesized that mortality during the COVID-19 pandemic would increase and peri-operative mortality would be worse, particularly for patients contracting COVID-19 in this period. We aimed to assess the 30-day postoperative mortality for all patients undergoing orthopaedic surgery within Northern Ireland from 18 March 2020 to 27 April 2020, including the 30-day mortality of those patients confirmed to have COVID-19 peri-operatively. We also compared the 30-day mortality of patients' with hip fractures during the same time period in 2019. Assessing the impact of COVID-19 and the risk to patients undergoing orthopaedic surgery for trauma will aid decision-making regarding the reinstatement of elective orthopaedic operating.

Methods

A retrospective multicentre review of all patients undergoing trauma and orthopaedic surgery within Northern Ireland from 18 March 2020 until 27 April 2020 was undertaken. This 40-day period began during the inception of the nationwide social distancing measures and allowed adequate timing to capture all deaths within 30 days of surgery.

Table I. Cohort demographics.

Variable	Overall	Elective	Trauma
Sex, n (%)			
Total	484 (100)	37 (7.6)	447 (92.4)
Male	211 (43.6)	15 (40.5)	195 (43.6)
Female	273 (56.4)	22 (59.4)	252 (56.4)
Age, yrs (SD, range)			
Mean	64.2 (21.7, 16 to 99)	42.9 (17.0, 19 to 79)	65.9 (21.2, 16 to 99)
30-day mortality, n (%)			
Total	9 (1.9)	0 (0)	9 (2.0)
COVID-19	4 (0.8%)	0 (0)	4 (0.9)
ASA grade, n (%)			
1 and 2	256 (52.9)	35 (94.6)	221 (49.4)
3, 4 and 5	226 (46.7)	2 (5.4)	224 (50.1)
Not recorded	2 (0.4)	0 (0)	2 (0.5)
Anaesthetic, n (%)			
General	259 (53.5)	29 (78.4)	230 (51.5)
Spinal	224 (46.3)	7 (18.9)	217 (48.5)
Local	1 (0.2)	1 (2.7)	0 (0)
COVID-19-positive, n (%)			
Total	27 (5.6)	0 (0)	27 (6.0)
Pre-operative	5 (18.5)	0 (0)	5 (18.5)
Postoperative	21 (77.8)	0 (0)	21 (77.8)
Not recorded	1 (3.7)	0 (0)	1 (3.7)

SD, standard deviation; ASA, American Society of Anesthesiologists.

Data was collected from all sites providing orthopaedic surgery within Northern Ireland (four fracture units and a previous elective centre that subsequently became a fracture unit during the pandemic). Patients were identified from a Fracture Outcome Research Database (FORD), theatre lists, and cross-referenced electronically using theatre management systems (TMS). This allowed collection of the patients' demographic data, American Society of Anesthesiologists (ASA) score, and method of anaesthesia. Northern Ireland has a regional electronic care record (ECR), which allowed data on all patients to be collated including comorbidities, laboratory results, imaging results, discharge summaries, and death certification.

Patients were classified as COVID-19 if they had a positive laboratory result (nasal or oral swab via quantitative PCR sampling for viral RNA) and/or positive imaging findings (PA chest radiograph or CT chest) during their admission or up to 30 days postoperatively. All imaging was reported by a consultant radiologist who reported changes in keeping with COVID-19 infection. This included peripheral ground glass changes or shadowing on chest radiograph or CT chest as has been reported in the literature.[9,10]

Table II. Mortality for patients at 30 days.

Age, sex	ASA grade	Operation	Comorbidities	COVID-positive/negative	Days death from surgery	Reported cause of death
63, F	3	Hip hemiarthroplasty	Hypoxic brain injury, alcohol excess	Positive (postoperative	26	Seizure at home
90, F	4	Hip hemiarthroplasty	Ischaemic heart disease, previous CABG, NSTEMI Mi	Positive (postoperative)	13	Congestive cardiac failure/pneumonia
99, F	4	Hip intramedullary nail	Dementia, atrial fibrillation, ischaemic heart disease	Positive (postoperative)	22	COVID-19
80, M	3	Hip hemiarthroplasty	Vascular dementia, ischaemic heart disease, stroke, diabetes (type 2)	Positive (postoperative)	14	COVID-19
91, F	4	Closed reduction THA	Aortic stenosis, congestive cardiac failure, atrial fibrillation	Negative	30	General debility of old age
56, F	3	ORIF wrist (previous hip fracture surgery ten days previous)	COPD, falls, multiple recent fracture surgery, alcohol excess, liver cirrhosis	Negative	30	Multiorgan failure and PE
64, F	4	DHS	Metastatic squamous cell carcinoma	Negative	16	Metastatic Squamous cell carcinoma of the oropharynx
90, F	4	Hip hemiarthroplasty	Dementia, hypertension	Negative	19	Community acquired pneumonia
90, F	4	Hip intramedullary nail	Hypertension, hypercholesterolaemia, diabetes (type 2), stroke	Negative	1	Sudden cardiac event

THA, total hip arthroplasty; ORIF, open reduction internal fixation; PE, pulmonary embolism; DHS, dynamic hip screw; CABG, coronary artery bypass grafting.

A subgroup analysis compared the 30-day mortality of hip fracture patients in this 2020 cohort to the 30-day mortality of hip fracture patients during the same time period in 2019. This data was obtained from the FORD, a validated hospital database which adds data to the national hip fracture database (NHFD).[11,12]

Statistical analysis was carried out using SPSS version version 26 (IBM, Armonk, New York, USA). Categorical variables were compared, and odds ratio calculated using the Fisher's Exact test or chi squared analysis where appropriate. Student's *t*-test was used to compare continuous variables. Statistical significance was set at a p-value < 0.05. The study was registered as an audit (numbers 6177 and 6179).

Results

Between 18 March 2020 and 27 April 2020, 496 operations were carried out in 484 patients (211 male, 273 female). The mean age was 64.2 years. The 30-day mortality for the cohort was 1.9% (9/484) as shown in Table I.

Overall, 27 (5.6%) patients in the cohort were confirmed as COVID-19-positive; 21 (77.8%) were diagnosed postoperatively (first positive swab or imaging changes only identified in the postoperative period). Of these 21 patients, all had one or more negative swabs prior to the positive swab or imaging diagnosis. Five patients were diagnosed pre-operatively; 21 out of 27 (78%) patients who tested positive for COVID-19 (pre- or postoperatively) underwent surgery for a hip fracture. At 30 days, four out of the 27 patients were confirmed deceased (mortality of 14.8%) (Table II). 46.7% of the 27 were documented as ASA level 3 to 5 and 21 out of the 27 were over the age of 75 (77.8%).

The death of four out of the 27 patients (14.8%) was attributed to COVID-19. A Fisher's Exact test was carried out to determine the risk of death due to COVID-19 and observed a significant risk; odds ratio (OR); 15.72 (95% confidece interval (CI) 3.96 to 62.49) with a risk ratio (RR) 13.54 (95% CI 3.86 to 47.56) $p < 0.001$.

There were 227 patients with ASA grade 3 to 5 and their 30-day mortality was investigated. A total of 22 patients within this group tested positive for COVID-19; of these, four (18.2%) died within 30 days of their operation. When compared to patients who did not have COVID-19, five (2.3%) died within 30 days following their procedure. A Fisher's Exact analysis determined the risk of death within 30 days of operation in COVID-19-positive, ASA grade 3 to 5 patients was highly significant; OR 8.9, 95% CI 2.2 to 36.1, with a RR 7.5 (95% CI 2.2 to 25.7), $p = 0.006$.

During the study period, 202 patients were aged 75 years of age or older, their 30-day mortality was investigated. A total of 21 patients within this group tested positive for COVID-19, of these three (14.3%) died within 30 days of their operation. When compared to patients who did not have COVID-19, three patients (1.7%) died within 30 days following their procedure. A Fisher's Exact analysis determined the risk of death within 30 days of operation in COVID-19-positive patients aged 75 years or older was significant; OR 9.9 (95% CI 1.9 to 52.6) with RR 8.6 (95% CI 1.9 to 40.0), $p = 0.016$.

Table III. Operation types.

Operation type	Number of cases
Trauma	**458**
Hip hemiarthroplasty	113
Dynamic hip screw	48
Intramedullary nail for hip fracture	35
Total hip arthroplasty for hip fracture	7
Femoral, tibial or humeral intramedullary nail	12
External fixation	7
Upper limb arthroplasty	6
Lower limb arthroplasty	7
Upper limb ambulatory	96
Lower limb ambulatory	68
Spinal stabilization	7
Wound management	22
Other	30
Elective	**38**
Total hip arthroplasty	1
Revision arthroplasty	1
Knee arthroscopy (including meniscal debridement/repair)	8
Excision of tumour ± endoprosthetic arthroplasty	3
Spinal/nerve decompression	13
Other	12
COVID-19-positive patients only	**27**
Operation type	
Hip hemiarthroplasty	14
Dynamic hip screw	3
Intramedullary nail for hip fracture	4
ORIF distal radius	1
ORIF elbow	1
Posterior stabilization of thoracic or lumbar spine	2
Femoral nail	1
ORIF ankle	1

ORIF, open reduction internal fixation.

Table IV. Fracture neck of femur 2019 compared to 2020.

Fracture neck of femur, n (%)	2019 (n = 266)	2020 (n = 203)
Conservative*	5 (1.9)	0 (0)
Operative	261 (98.1)	203 (100)
30-day mortality, n (%)		
Total	16 (6.0)	7 (3.4)
Conservative*	4 (80.0)	0 (0)
Operative	12 (4.6)	7 (100)
Sex, n (%)		
Male	79 (29.7)	65 (32.0)
Female	187 (70.3)	138 (68.0)
Mean age (SD, range)		
Overall	78.0 (12.8, 21 to 101)	81.3 (9.7, 49 to 99)
Conservative*	88.0 (7.3, 73 to 91)	N/A
Operative	77.9 (12.9, 21 to 101)	81.3 (9.7, 49 to 99)
Operative patients only, n (%)		
Total	261 (100)	203 (100)
Sex, n (%)		
Male	76 (29.1)	65 (32.0)
Female	185 (70.9)	138 (68.0)
ASA grade, n (%)		
1 & 2	66 (25.3)	35 (17.2)
3, 4 & 5	195 (74.7)	168 (82.8)
Time from admission to theatre, n (%)		
< 24 hours	56 (21.4)	78 (38.4)
24 hr to 48 hrs	85 (32.6)	92 (45.3)
> 48 hours	120 (46.0)	33 (16.3)
Anaesthesia, n (%)		
General anaesthetic	76 (29.1)	37 (18.2)
Spinal/nerve block	185 (70.9)	166 (81.8)
Fixation, n (%)		
Hemiarthroplasty	115 (44.1)	113 (55.7)
Dynamic hip screw	68 (26.0)	47 (23.1)
Intramedullary nail	43 (16.5)	36 (17.7)
Total hip arthroplasty	35 (13.4)	7 (3.4)

*non-operative management.
N/A, not applicable.

Overall, 496 operations were carried out over the course of the study period (Table III). The most commonly performed procedure was hip hemiarthroplasty for neck of femur fracture and then upper limb ambulatory cases such as open reduction internal fixation (ORIF) of wrist. Only 38 urgent elective cases were carried out, the majority in week one of the study period.

Table IV shows the differences between neck of femur fractures during the time period of the study and during the same time period in 2019. There was a 24% reduction in number of surgeries (266 compared to 203). Overall 30-day mortality was higher in 2019 compared to 2020 (6.0% vs 3.4%) but this was not significant (chi squared analysis, p = 0.202). The mean age of patients in 2020 was significantly older than in 2019 (*t*-test, p = 0.001). There was a greater proportion of ASA 3 to 5 patients in 2020 (82.8%) compared to 2019 (74.7%), which was significant (chi squared analysis; OR 1.62, 95% CI 1.03 to 2.57) p = 0.041.

A significantly greater proportion of patients in 2020 had their operation within 24 hours of admission (38.4%) compared to 2019 patients (21.4%) (chi squared analysis; p < 0.001). There was also a significant difference in patients having their operation between 24 and 48 hours of admission (45.3% in 2020, 21.4% in 2019; chi squared analysis, p = 0.004) and a significantly greater proportion of patients in 2019 had their operation more than 48 hrs after admission (46.0%) compared to 2020 patients (16.3%) (chi squared analysis, p < 0.001).

Table II shows details for the nine patients in the cohort who died within 30 days of undergoing surgery. All patients had an ASA score of 3 or above, and seven had surgery for neck of femur fracture. The one patient who died following ORIF wrist surgery within the study

period had previous had revision hip surgery for complications following neck of femur fracture in the previous two weeks, which was outside the time period of this study.

Of the four patients who died and were confirmed COVID-19-positive, two had this recorded as their cause of death.

Conclusion

We noted an all-cause mortality of 1.9% at 30 days for all patients undergoing orthopaedic surgery within Northern Ireland during the peak of the COVID-19 pandemic. We observed a mortality rate of 14.8% at 30 days for patients contracting COVID-19. This figure is concerning yet it is lower than mortality rates reported in other regions both in the UK and among other developed countries (20% to 28.8%).[7,8,13] The reasons for this lower mortality rate are not clear from this study. However, the lower prevalence of COVID-19 infection within Northern Ireland compared to the rest of the UK (259/100,000)[4] may have played a role. The reasons for this remain unclear, but population distribution and cultural differences may have contributed.

Of the nine patients who died, seven underwent surgery for neck of femur fracture. The patient who died following wrist ORIF had multiple complex surgeries following a neck of femur fracture the previous month. Only four patients who died in the study period had confirmed COVID-19 infection and all had been admitted with a fractured neck of femur.

The patients who died from COVID-19 were all high-risk surgical candidates (ASA 3 to 4, and in three out of four ≥ 75 years) with recognized risk factors for mortality, even without a diagnosis of COVID-19.[14] As expected, these patients were therefore at higher risk of an adverse outcome if they contracted COVID-19.

We noted a significantly higher risk of mortality for patients with ASA 3 to 5 or those aged 75 or older if they contracted COVID-19 during the study period. Of the four patients who died following a positive COVID-19 test, two died in hospital, one died at home (with minimal symptoms on discharge), and one died in a nursing home having been discharged from hospital without symptoms.

In all, two patients had COVID-19 recorded as their cause of death. The patient who died at home had a seizure and one hospital inpatient had congestive cardiac failure and bronchopneumonia listed as their cause of death. As there is a wide variation in symptoms as a result of COVID-19 infection,[15] it was felt to be important to include all deaths with a positive diagnosis, even though COVID-19 was not listed as a direct cause of death in two of the cases.

As expected, there was a reduction in the number of admissions and operations for neck of femur fractures, with a 24% decrease observed during this time period compared to the same time period in 2019. Similar findings have also been observed in other European centres with the lockdown having a dramatic effect on trauma admissions.[3,13] A reduced mortality rate for hip fracture surgery in 2020 compared to 2019 (6% vs 3.4%, p = 0.202) was noted but this was not statistically significant. Patients in 2020 were significantly older (p = 0.001) and a there was a statistically higher proportion of ASA 3 to 5 patients (82.3%) in 2020 compared to 2019 (74.7%) (p = 0.04). Interestingly, in contrast to the findings reported here, other countries have reported a higher mortality rate for neck of femur fracture patients operated on during the COVID-19 pandemic.[13] There are three factors which could explain, in part, the reduction in mortality we have seen. There was a significant reduction in time to theatre from admission in 2020 compared to 2019 both at 24 and 48 hours. This is now well recognized as an important risk factor in mortality of neck of femur fractures,[16] and resulted from the combination of the decreased burden on trauma services as a result of the lockdown and the fact ambulatory care fractures were being operated on in what would have otherwise been elective orthopaedic operating lists. The ortho-geriatric medicine services expanded direct patient cover in the major trauma centre in the Royal Victoria Hospital from a five-day to a seven-day service. There was also a notable increase in the use of spinal and regional anaesthesia (from 70.9% in 2019 vs 80.6% in 2020) in our region. This is likely a result of concerns regarding intubation, an aerosol generating procedure, increasing viral load to healthcare workers.[17] Spinal anaesthesia has been reported to reduce in-hospital mortality and length of hospitalization but to have no effect on 30-day mortality.[18]

There are a number of factors to be addressed when considering the reinstatement of elective services. This includes individualizing patient risk and their previous exposure to COVID-19.[5] Age, co-morbidities, ASA grading, immunocompromise, and body mass index have all been shown to increase the potential severity of the disease.[19–21] These risks are a common occurrence in the urgent and revision patient populations.[17] As demonstrated in our study only patients with an ASA of 3 or greater died following infection with COVID-19. We have had no 30-day mortality in patients ASA grades 1 or 2. These findings would support the recent proposal that commencing operating on low-risk patients requiring low risk surgeries may be the safest and most effective way of reinstating elective services.[5] Given this cohort has demonstrated that the majority of infections were diagnosed in the postoperative period, it is crucial that the risk of virus transmission during this time is minimized. Therefore, measures which should be considered, including limiting inpatient hospital stay, recommending social isolation of patients postoperatively, and reducing

outpatient clinic attendances.[5] It is also important to ensure regular staff testing and maintenance of COVID-19-free sites and pathways for elective surgery.

There are limitations to this study. We only included patients with confirmed positive swab or radiological imaging. Consequently, due to the recognized false negative rate of swabs, there may have been other clinically positive patients who were not recorded as such. Additionally, variability in laboratory and imaging protocols exist between sites and this may have influenced swab and/or imaging requests or reporting. There was also some reported variation in management of elective and trauma patients between sites particularly for those with suspected or confirmed COVID-19. Our data collection had only a limited number of comorbidities recorded, with smoking and do not attempt resuscitation (DNAR) status not included. Our follow-up was limited to 30 days and there are recognized bias with retrospective studies as well as those using electronic records. Finally, comparisons have only been made between this year and one year previous, only limited conclusions between the differences in 30-day mortality for neck of femur fractures can be drawn.

Overall, the all-cause mortality in orthopaedic patients undergoing surgery during the peak of the COVID-19 pandemic was low in our region. However, for patients who were high-risk,such as neck of femur fracture patients (aged over 75 years, ASA score 3 to 5) the risk of mortality if diagnosed with COVID-19 was considerable. Reinstatement of elective services will require careful consideration of patient risk, regional outcomes, and evidence specific to individual surgical specialties.

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