RESEARCH ARTICLE

The Impact of COVID-19 on Neck of Femur Fracture Care: A Major Trauma Centre Experience, United Kingdom

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Abstract

Background: The aim of this study was to investigate the impact of the COVID-19 pandemic on the management and outcome of patients with neck of femur fractures.

Methods: Data was collected for 96 patients with neck of femur fractures who presented to the emergency department between March 1, 2020 and May 15, 2020. This data set included information about their COVID-19 status.
Parameters including inpatient complications, hospital quality measures, mortality rates, and training opportunities were compared between the COVID-19 positive and COVID-19 negative groups. Furthermore, our current cohort of patients were compared against a historical control group of 95 patients who presented with neck of femur fractures before the COVID-19 pandemic.

Results: Seven (7.3%) patients were confirmed COVID positive by RT-PCR testing. The COVID positive cohort, when compared to the COVID negative cohort, had higher rates of postoperative complications (71.4% vs 25.9%), increased length of stay (30.3 days vs 12 days) and quicker time to surgery (0.7 days vs 1.3 days).
The 2020 cohort compared to the 2019 cohort, had an increased 30-day mortality rate (13.5% vs 4.2%), increased number of delayed cases (25% vs 11.8%) as well as reduced training opportunities for Orthopaedic trainees to perform the surgery (51.6% vs 22.8%).

Conclusion: COVID-19 has had a profound impact on the care and outcome of neck of femur fracture patients during the pandemic with an increase in 30-day mortality rate. There were profound adverse effects on patient management pathways and outcomes while also affecting training opportunities.

Level of evidence: VI

Keywords: Coronavirus, COVID-19, Hip fracture, Neck of femur fracture, SARS-CoV-2

Introduction

Neck of femur fractures account for 50% of all hip fractures, with the majority of these fractures occurring in elderly patients with underlying osteoporosis (1, 2). With an ageing population, this is a significant concern for health care systems worldwide as hip fractures cause a huge economic and social burden (3). The general principles for neck of femur fracture care include a holistic assessment, prompt medical optimisation and early surgery to provide patients with the best chance of recovery while minimizing the incidence of postoperative complications and mortality (4).

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2/2019-nCoV disease (COVID-19)) in China at the end of 2019 has caused a large global pandemic, endangering the health and well-being of everyone, especially the elderly (5). At the time of writing, a total of 216 countries and territories have reported cases, with 26.9 million confirmed diagnosis and greater than 880,000 deaths worldwide

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(6). The virus spreads via droplet, contact and aerosol transmission, resulting in a flu-like upper respiratory illness, with severe cases developing dyspnoea, refractory hypoxaemia and acute respiratory distress syndrome (7). The general population is susceptible to COVID-19 with an incubation period ranging from 1-14 days. COVID-19 patients are infectious in the incubation period but can also be asymptomatic, hence this represents a great challenge to the safety of both healthcare workers and other hospital patients.

Health system resources around the world have been redeployed to manage the crisis, with human and physical resources diverted to meet the rising critical care demands. Many of the resources usually used to provide orthopaedic care were repurposed, thus limiting the capacity to continue providing urgent orthopaedic care. Despite this reallocation of resources, patients with neck of femur fractures have continued to present to Emergency Departments (ED) and require urgent medical care (8, 9).

Our hospital has restructured its medical operations to tackle the large number of COVID-19 patients that presented in the spring of 2020. Despite this fact, the department's orthopaedic trauma service has continued to provide care to all patients presenting with the diagnosis of a neck of femur fracture. The purpose of this report is to analyse the perioperative complication rate, mortality rate, impact on training as well as in patient hospitalisation issues associated with neck of femur fracture patients who presented during the global COVID-19 pandemic.

Materials and Methods

A single-centre cross-sectional study was performed where two different time periods were analysed. We analysed a consecutive series of neck of femur fracture patients who presented to our Hospital's ED between March 1, 2020 to May 15, 2020 (COVID-19 pandemic time) as well as the same time period in 2019 (pre-COVID-19). Inclusion criteria were patients who presented with either an OTA/AO 31A or OTA/AO 31B fracture, whilst patients who had OTA/AO 31C or peri-prosthetic fractures of the femur were excluded. Fracture of the femoral neck was confirmed on physical exam and with standard radiographs of the affected hip. The surgical treatment was decided by the attending orthopaedic surgeon and followed the general standard of care for neck of femur fractures. Patients were identified as COVID positive if they had a positive COVID-19 RT-PCR test prior to, during or after hospitalisation for their neck of femur fracture.

March 1, 2020 was chosen as the start date as this was the first date in which our Hospital performed its first COVID-19 test. Findings were reported in accordance with the Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) checklist for retrospective cohort studies (10). Patient demographics, pre-operative assessment scores, comorbidities, hospital quality measures were identified and recorded. We also recorded the operative procedure performed, the grade of the surgeon, anaesthetist and geriatrician involved, and any inpatient complications. Complications included hospital acquired pneumonia, urinary tract infection, acute kidney injury, myocardial infarction, atrial fibrillation and sepsis. Given that all covariates and outcomes assessed were documented as the standard of care in the electronic medical record, there was minimal missing data (<5%) for all demographic and clinical characteristics.

Statistical analysis was performed to determine differences between expected and observed frequencies. Chi-square tests of association and independent sample t-test were utilized to assess differences between the pre-COVID-19 cohort and the recent neck of femur fracture cohort and between the COVID positive and COVID negative cohorts. All analysis was completed with SPSS software (IBM Corporation) and were considered significant for $P<0.05$.

Ethics approval

Ethical approval was waived by the local Ethics Committee of the Trauma and Orthopaedics Department of Cambridge University Hospitals in view of the retrospective nature of the study and all the procedures being performed were part of the routine care. This study was registered and approved by the clinical audit team.

Results

2019 cohort vs 2020 cohort

Between March 1, 2020 and May 15, 2020, 96 patients (72.9% female) with a mean age of 84.9 years presented to our hospital's ED and were diagnosed with a neck of femur fracture. In order to assess the COVID-19 pandemic era cohort, we compared them to a second group of 95 neck of femur fracture patients who presented to the same ED before the pandemic in 2019. In terms of patient's demographics between the two groups, the only significant difference was the higher incidence of pre-existing renal disease in the 2020 cohort compared to the 2019 cohort (22.9% vs 8.4%, $P = 0.009$). There were also no significant differences in terms of fracture location between the 2 cohorts.

When comparing surgical information and hospital quality measures between the two groups, the 2020 cohort had more cases of delayed surgery (25.0% vs 11.8%, $P = 0.023$) and a higher 30-day mortality rate (13.5% vs 4.2 %, $P = 0.039$) while having fewer admissions into an orthopaedic specific ward as there was no orthopaedic specific wards due to re-allocation of wards (54.1% vs 100%, $P < 0.001$). Furthermore, the indirect impact of COVID-19 on training could be seen as there was a reduction in number of operations performed by ST3-ST8 orthopaedic registrars in the 2020 group (22.8% vs 51.6%, $P < 0.001$), whilst the number of geriatrician assessments performed by specialist registrars increased in the 2020 group (35.4% vs 0.0%, $P < 0.001$) [Table 1].

COVID-19 positive cohort vs COVID-19 negative cohort

Among the 2020 cohort patients, seven (7.3%) were confirmed COVID positive by testing. Five patients were diagnosed post-operatively after a patient on their

Table 1. 2019 cohort (Pre-pandemic) vs 2020 cohort (COVID-19 pandemic)

Patient Demographics			
	2019 Cohort (n = 95)	**2020 Cohort (n = 96)**	***P***
Age (years) (mean ± SD)	83.6 ± 9.0	84.9 ± 8.3	0.286
Sex, n (%)			1.000
Male	25 (26.3%)	26 (27.1%)	
Female	70 (73.7%)	70 (72.9%)	
Home Status			0.143
Own Home	81 (85.3%)	73 (76.0%)	
Nursing Home	14 (14.7%)	23 (24.0%)	
Pre-operative AMTS[a] (mean ± SD)	7.7 ± 3.3	6.6 ± 3.9	0.052
ASA[b], n (%)			0.375
I	0 (0%)	3 (3.1%)	
II	17 (17.9%)	17 (17.7%)	
III	60 (63.2%)	60 (62.5%)	
IV	18 (18.9%)	16 (16.7%)	
Nerve Block at A&E, n (%)	68 (71.6%)	61 (63.5%)	0.280
Bone Protection Pre-fracture, n (%)	14 (14.7%)	10 (10.4%)	0.391
Bone Protection Post-fracture, n (%)	44 (46.3%)	40 (41.7%)	0.561
Delirium Assessment (mean ± SD)	1.5 ± 2.7	2.3 ± 3.0	0.084
Pre-existing Lung Disease, n (%)			0.052
Asthma	11 (11.6)	6 (6.3%)	
COPD	11 (11.6%)	6 (6.3%)	
Other	4 (4.2%)	13 (13.5%)	
Pre-existing Cardiovascular Disease, n (%)	64 (67.4%)	59 (61.5%)	0.451
History of Malignancy, n (%)	25 (26.3%)	33 (34.4%)	0.271
Pre-existing Diabetes, n (%)	12 (12.6%)	16 (16.7%)	0.540
Pre-existing Renal Disease, n (%)	8 (8.4%)	22 (22.9%)	0.009*
Pre-existing Dementia, n (%)	23 (24.2%)	19 (19.8%)	0.489
Injury Information			
	2019 Cohort (n = 95)	**2020 Cohort (n = 96)**	***P***
Fracture Type			0.344
Intra-capsular	67 (70.5%)	59 (61.5%)	
Intratrochanteric	23 (24.2%)	28 (29.2%)	
Subtrochanteric	5 (5.3%)	9 (9.4%)	
Additional Trauma, n (%)	2 (2.1%)	8 (8.3%)	0.100
Surgical Information			
	2019 Cohort (n = 93)	**2020 Cohort (n = 92)**	***P***
Non-operative Cases, n (%)	2 (2.1%)	4 (4.2%)	0.683
Time from presentation to surgery (days) (mean ± SD)	1.2 ± 0.9	1.2 ± 0.7	0.719
Implant, n (%)			0.207

Table 1. Continued			
Hemiarthroplasty	47 (51.5%)	37 (40.2%)	
Sliding Hip Screw	22 (23.7%)	34 (37.0%)	
Total Hip Replacement	6 (6.5%)	11 (12.0%)	
Long Intramedullary Nail	3 (3.2%)	6 (6.5%)	
Cannulated Screws	5 (5.4%)	4(4.3%)	
Anaesthesia Type, n (%)			0.708
General	77 (82.8%)	74 (80.4%)	
Spinal	16 (17.2%)	18 (19.6%)	
Length of procedure (minutes) (mean ± SD)	79.3 ± 26.9	82.2 ± 39.7	0.558
Delay >36 Hours to Surgery, n (%)	11 (11.8%)	23 (25.0%)	0.023*
Post-operative Complication Rate, n (%)	29 (31.2%)	27 (29.3%)	0.873
Hospital Quality Measures			
	2019 Cohort (n = 95)	**2020 Cohort (n = 96)**	***P***
Inpatient Mortality, n (%)	5 (5.3%)	8 (8.3%)	0.567
30- Day Mortality, n (%)	4 (4.2%)	13 (13.5%)	0.039*
Length of Stay (days) (mean ± SD)	14.1 ± 8.4	13.4 ± 9.5	0.581
Admission to Orthopaedic Ward, n (%)	95 (100%)	52 (54.1%)	<0.001*
Time to Geriatrician Assessment (days) (mean ± SD)	1.1 ± 0.9	1.2 ± 1.1	0.292
Registrar Training Information			
	2019 Cohort (n = 93)	**2020 Cohort (n = 92)**	***P***
Surgeon Grade, n (%)			<0.001*
Consultant	45 (48.4%)	71 (77.2%)	
ST3+	48 (51.6%)	21 (22.8%)	
Anaesthetist Grade, n (%)			0.553
Consultant	51 (54.8%)	55 (59.8%)	
ST3+	42 (45.2%)	37 (40.2%)	
Geriatrician Grade, n (%)			<0.001*
Consultant	95 (100%)	54 (56.3%)	
ST3+	0 (0%)	34 (35.4%)	

[a]AMTS = Abbreviated Mental Test Score, [b]ASA = American Society of Anaesthesiologist Classification, * *P < 0.05*

recovery ward tested positive, whilst two were diagnosed pre-operatively. Two (28.6%) of the seven COVID positive patients passed away; one dying due to bacterial pneumonia secondary to COVID infection in hospital, whilst another patient died two months after discharge in the community. 27 (28.1%) patients were not tested in primary hospitalization. When comparing demographic and injury characteristics, there were no differences between the COVID positive and COVID negative groups.

In terms of surgical information, the COVID positive group had a faster time to surgery (0.7± 0.5 days vs 1.3 ± 0.7 days, *P = 0.028*) as well as a higher post-operative complication rate (71.4 % vs 25.9%, *P = 0.021*). In terms of hospital quality measures, the COVID positive group had a longer length of stay (30.3 ± 16.8 days vs 12.0 ± 7.3 days, *P < 0.001*) and had a greater admission rate into orthopaedic specific wards (100% vs 50.6%, *P = 0.014*) [Table 2].

Table 2. COVID-19 positive cohort vs COVID-19 negative cohort

Patient Demographics			
	COVID-19 Positive (n = 7)	**COVID-19 Negative (n = 89)**	***P***
Age (years) (mean ± SD)	88.4 ± 4.4	84.6 ± 8.5	0.241
Sex, n (%)			0.670
Male	1 (14.3%)	25 (28.1%)	
Female	6 (85.7%)	64 (71.9%)	
Home Status			0.353
Own Home	4 (57.1%)	69 (77.5%)	
Nursing Home	3 (42.9%)	20 (22.5%)	
Pre-operative AMTS[a] (mean ± SD)	3.9 ± 4.4	6.9 ± 3.8	0.051
ASA[b], n (%)			0.522
I	0 (0%)	3 (3.4%)	
II	0 (0%)	17 (19.1%)	
III	6 (85.7%)	54 (60.7%)	
IV	1 (14.3%)	15 (16.9%)	
Nerve Block at A&E, n (%)	4 (57.1%)	57 (64.0%)	0.703
Bone Protection Pre-fracture, n (%)	1 (14.3%)	9 (10.1%)	0.549
Bone Protection Post-fracture, n (%)	2 (28.6%)	38 (42.7%)	0.696
Delirium Assessment (mean ± SD)	2.4 ± 1.5	2.2 ± 3.1	0.866
Pre-existing Lung Disease, n (%)			0.738
Asthma	1 (14.3)	5 (5.6%)	
COPD	0 (0%)	6 (6.7%)	
Other	1 (14.3%)	12 (13.5)	
Pre-existing Cardiovascular Disease, n (%)	5 (71.4%)	54 (60.7%)	0.703
History of Malignancy, n (%)	3 (42.9%)	30 (33.7%)	0.689
Pre-existing Diabetes, n (%)	2 (28.6%)	14 (15.7%)	0.330
Pre-existing Renal Disease, n (%)	3 (42.9%)	19 (21.3%)	0.195
Pre-existing Dementia, n (%)	3 (42.9%)	16 (18.0%)	0.137
Injury Information			
	COVID-19 Positive (n = 7)	**COVID-19 Negative (n = 89)**	***P***
Fracture Type			0.183
Intra-capsular	3 (42.9%)	56 (62.9%)	
Intratrochanteric	2 (28.6%)	26 (29.2%)	
Subtrochanteric	2 (28.6%)	7 (7.9%)	
Additional Trauma, n (%)	0 (0%)	8 (9.0%)	1.000
Surgical Information			
	COVID-19 Positive (n = 7)	**COVID-19 Negative (n = 85)**	***P***
Non-operative Cases, n (%)	0 (0%)	4 (4.5%)	1.000
Time from presentation to surgery (days) (mean ± SD)	0.7 ± 0.5	1.3 ± 0.7	0.028*
Implant, n (%)			0.170

Table 2. Continued

Hemiarthroplasty	2 (28.6%)	35 (41.2%)	
Sliding Hip Screw	2 (28.6%)	32 (37.6%)	
Total Hip Replacement	1 (14.3%)	10 (11.8%)	
Long Intramedullary Nail	2 (28.6%)	4 (4.7%)	
Cannulated Screws	0 (0%)	4(4.7%)	
Anaesthesia Type, n (%)			0.619
General	5 (71.4%)	69 (81.2%)	
Spinal	2 (28.6%)	16 (18.8%)	
Length of procedure (minutes) (mean ± SD)	103.0 ± 55.4	80.5 ± 38.1	0.152
COVID Lab Test Before Surgery, n (%)	2 (28.6%)	35 (41.1%)	0.698
Delay >36 Hours to Surgery, n (%)	0 (0%)	23 (27.1%)	0.186
Post-operative Complication Rate, n (%)	5 (71.4%)	22 (25.9%)	**0.021***
Hospital Quality Measures			
	COVID-19 Positive (n = 7)	**COVID-19 Negative (n = 89)**	***P***
Inpatient Mortality, n (%)	1 (14.3%)	7 (7.9%)	0.467
30- Day Mortality, n (%)	1 (14.3%)	12 (13.5%)	1.000
Length of Stay (days) (mean ± SD)	30.3 ± 16.8	12.0 ± 7.3	<0.001*
Admission to Orthopaedic Ward, n (%)	7 (100%)	45 (50.6%)	0.014*
Time to Geriatrician Assessment (days) (mean ± SD)	1.1 ± 0.9	1.2 ± 1.1	0.876
Registrar Training Information			
	COVID-19 Positive (n = 7)	**COVID-19 Negative (n = 85)**	***P***
Surgeon Grade, n (%)			1.000
Consultant	6 (85.7%)	65 (76.5%)	
ST3+	1 (14.3%)	20 (23.5%)	
Anaesthetist Grade, n (%)			1.000
Consultant	4 (57.1%)	51 (60.0%)	
ST3+	3 (42.9%)	34 (40.0%)	
Geriatrician Grade, n (%)			0.702
Consultant	5 (71.4%)	49 (55.7%)	
ST3+	2 (28.6%)	32 (36.4%)	

[a]AMTS = Abbreviated Mental Test Score, [b]ASA = American Society of Anaesthesiologist Classification, * $P < 0.0^5$

Discussion

The COVID-19 pandemic has led to a global surge in critically ill patients, forcing hospitals to reallocate resources, potentially resulting in reduced health care access for patients requiring essential care (11). The prognosis of COVID-19 is relatively poor for elderly patients, especially those who have multiple co-morbidities (12). Neck of femur patients treated at our hospital were optimized, and the great majority were treated expeditiously when possible as we tried to treat these patients as we would have before the pandemic.

In our present cohort of patients, COVID positive patients experienced a greater complication rate compared to COVID negative patients, which included complications such as hospital acquired pneumonia, urinary tract infection, acute kidney injury, myocardial infarction, atrial fibrillation and sepsis. The increased frequency and types of perioperative complications observed in this cohort mirrors reports from other specialties (13, 14). Damage caused by COVID-19 infection is a dysfunctional immune response accompanied by pulmonary and

systemic inflammation (15, 16). This, compounded with the secondary insult of anaesthetic use and operative intervention may have primed these patients for the pulmonary and cardiac complications observed in this cohort. It is also interesting to note that the COVID positive cohort compared to the COVID negative cohort had a lower pre-operative AMTS (3.9 ± 4.4 vs 6.9 ± 3.8, *P = 0.051*), which was borderline significant, mirroring the findings by Kuo *et al* that pre-existing dementia is a major risk factor for developing COVID-19 in the elderly (17).

According to COVID-19-BOAST guidelines, patients were allowed to fully weight bear immediately to allow faster rehabilitation with the aim of reducing inpatient stay and exposure to COVID-19 (18). It is important that patients were encouraged to mobilise as bed bound patients are prone to develop hypostatic pneumonia, which exhibits similar symptoms to COVID-19 as well deep vein thrombosis of the lower extremities and bed sores (19). When comparing the 2020 cohort to the 2019 cohort, there was no significant difference in the length of stay in hospital, but when comparing the COVID positive to COVID negative patients, the COVID positive patients had a significantly longer length of stay. The reason for this was that our hospital's guidelines required all COVID positive patients to be isolated for 14 days and no longer test positive before being discharged.

The British Geriatric Society issued guidelines for the management of hip fractures during the COVID-19 pandemic with the aim of promoting prompt (<24h) consultant-delivered surgical and anaesthetic care where possible (20). The average time to surgery from presentation for the 2020 cohort was 1.2 days and 23 (25%) patients had a greater than 36-hour delay before their surgery. 20 of the 23 patients had a delay as they were waiting for space on the theatre list, whilst the other 3 patients were delayed due to reversal of anti-coagulation medication.

Hip fractures should be treated as soon as possible regardless of their COVID status as 30-day mortality rates after surgery decreases from 6.55 to 5.8% when the wait time for surgery is less than 24h (21). Recent studies from Spain and New York conducted by Muñoz Vives *et al* and Egol *et al* respectively both found a significant higher mortality rate in elderly patients with a hip fracture and an associated positive test for COVID-19 (22, 23). However, no significant difference in mortality rates between the COVID positive and COVID negative patients were found in our study. On the other hand, there was a significantly higher 30-day mortality rate in the 2020 cohort compared to the 2019 cohort, which was also reported by Egol *et al* (23). Among the 13 patients in the 2020 cohort who passed away, 6 were found to have delayed surgery (>36 hours) due to a long theatre waiting list and this could potentially explain the higher 30-day mortality rate in the 2020 cohort as the risk of mortality increases by 1.8% for every hour of delay past 24 hours (24).

Apart from the direct impact of COVID-19 on the quality of patient care, there were indirect impacts on surgical training as well due to despecialisation and redeployment of orthopaedic registrars. The Royal College of Surgeons of England published guidance of emergency care during the pandemic and it is thought that the burden of trauma care provision will be undertaken by consultants, whilst orthopaedic registrars will be providing general medical services to other patients around the hospital (25). This was true in our study as the number of surgeries carried out by orthopaedic registrars decreased in the 2020 cohort compared to the 2019 cohort, whilst there was an increase in number of registrars performing geriatric assessments in the 2020 cohort, which was solely done by consultant geriatricians in the 2019 cohort.

Limitations of our study include its retrospective design as well as a lack of long-term outcomes. We also limited our analysis to patients who tested positive for COVID-19 in hospital. There was a chance that there were potential missed cases in individuals with clinical or radiological evidence of COVID-19 due to the limited sensitivity of the RT-PCR test. Given the high likelihood of asymptomatic COVID-19, it was possible that some patients in our cohort had asymptomatic COVID-19 and were not tested or potentially developed COVID-19 after a negative test and were therefore missed. It should also be noted that the number of COVID positive patients in our study sample were fairly low (7.3%).

In conclusion, the COVID-19 pandemic has had a drastic impact on the care of elderly patients presenting with neck of femur fractures. Our study found that patients with neck of femur fractures treated during the pandemic had an increased 30-day mortality rate potentially due to longer waiting times for surgery, whilst there was also a reduction in admission to orthopaedic specific wards during the pandemic, which was associated with less specialist nursing care and lower consultant orthogeriatric reviews. Furthermore, the COVID-19 positive cohort were found to have a longer length of stay in hospital as well as higher post-operative complication rates.

Patient Consent: Being a retrospective study without patient interventions, consent for participation was not required.

Conflicts of Interest: 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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