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Thirty-Day Mortality for Proximal Femoral Fractures Treated at a U.K. Elective Center with a Site-Streaming Policy During the COVID-19 Pandemic

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Background: COVID-19 led to the reconfiguration of U.K. orthopaedic trauma services because surgical capacity was threatened in acute centers. We report the 30-day mortality of proximal femoral fractures in older adults treated at an elective orthopaedic center.

Methods: Patients >60 years old who presented with a proximal femoral fracture to any of 4 sites in the regional trauma network were transferred to our elective center for emergency surgery. Care was modeled according to the National Institute for Health and Care Excellence guidelines, and efforts were made to treat all patients within 36 hours. Data were collected prospectively, and mortality outcomes were recorded.

Results: Of the 192 patients who presented to the elective orthopaedic center, 167 were treated there. The median age of the latter patients was 88 years (interquartile range, 83 to 79 years). The median Charlson Comorbidity Index was 4 (interquartile range, 4 to 6). The median time from emergency department admission to surgical treatment was 24.5 hours (interquartile range, 18.8 to 34.7 hours). The 30-day rate of mortality was 10.2%. A total of 29 (17.4%) tested positive for COVID-19 during their admission, of whom 10 died, for a case-fatality rate of 34.5%. There were no significant differences in age ($p = 0.33$) or Charlson Comorbidity Index ($p = 0.13$) between patients who tested positive and those who did not. There was no significant difference in age between those who tested positive and died and those who tested positive and did not die ($p = 0.13$), but there was a significant difference in Charlson Comorbidity Index between those subgroups ($p = 0.03$).

Conclusions: During a pandemic, an elective orthopaedic center can be reconfigured to a surgical center for older patients with proximal femoral fractures with acceptable health-care quality outcomes.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

In the United Kingdom, orthopaedic trauma treatment is modeled on a hub-and-spoke Regional Trauma Network, with major trauma centers surrounded by trauma units and local emergency hospitals[1]. This model is similar to that utilized in the U.S., in which trauma centers are designated as level I through IV. U.K. elective orthopaedic hospitals are not a part of these trauma networks and do not normally admit acute trauma patients, choosing instead to admit patients through outpatient pathways.

The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and Coronavirus Disease 2019 (COVID-19) resulted in national-level emergency measures and hospital reconfiguration that were intended to maximize capacity for COVID-19 patients. International and national bodies recommended that surgery for older, frail adults with hip fractures remain a priority despite the pandemic[2-4]; therefore, in our region, emergency care for these patients was moved from acute hospitals to an elective orthopaedic center—The Royal Orthopaedic Hospital Birmingham. This hospital usually performs non-urgent, inpatient orthopaedic surgeries—most commonly, large-joint arthroplasty. During the reconfiguration, The Royal Orthopaedic Hospital accepted patients with proximal femoral fractures from 1 major trauma center, 1 trauma unit, and 2 local emergency hospitals across a city with population of 1,141,400[5]. Our institute was designated as a non-acute surgical site, and the major trauma center and trauma unit remained acute sites. The non-acute site had a lower burden of COVID-19 than the acute sites, which were reserved for the extraordinary number of patients requiring mechanical ventilation. The elective site was reserved solely for the treatment of orthopaedic patients and was

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reconfigured to provide expedient surgery, whereas it was previously an elective-only surgical site.

Given that our institution did not normally treat hip fractures in older patients and that these injuries were still likely to occur at the same rate, irrespective of the pandemic situation[6], it was pertinent to assess the outcomes in this relatively frail population during a pandemic. It was important to know whether a newly reconfigured hospital was safe for patients, and thus it was important to assess the 30-day rate of mortality. A summary timeline of the U.K. government action, elective/acute site reconfiguration, and COVID-19 swabbing strategy is presented in Figure 1.

The aim of this paper was to report recognized mortality parameters (i.e., in-hospital mortality, 30-day mortality, and case fatality rate from SARS-CoV-2) for proximal femoral fractures in older patients during a viral pandemic within a single U.K. center that had been reconfigured from elective to emergency practice. This study will help to inform the suitability of reconfigured elective centers for urgent orthopaedic procedures and may also be utilized to compare surgical outcomes between acute and elective sites.

Materials and Methods

Participants

The study period included the duration of the emergency reconfiguration, which spanned from March 28, 2020, to May 25, 2020. All consecutive patients >60 years old with a fragility fracture of the proximal femur (International Classification of Diseases 10, S72.0 to S72.2) who presented to the emergency departments of 1 of the 4 regional trauma network hospitals were transferred to our institution for surgical treatment. All presenting patients were considered for transfer; however, patients who were not fit for surgery or likely to require level-3 intensive care (i.e., multiple-organ support or mechanical ventilation) were admitted to 1 of the acute sites. The highest level of care at our institution is level 2 (i.e., single-organ support excluding mechanical ventilation).

Patients <60 years old and fractures with high-energy mechanisms were excluded from the study. Patient data were entered into a prospectively maintained database. Data were collected from paper records, electronic records, theater records, and electronic patient management systems.

Infection Prevention

The admission and viral screening policy for our site is summarized in Figure 1. Patients who did not fulfill the admission criteria were treated locally at the major trauma center or one of the local trauma units.

If a patient developed symptoms of COVID-19 in the elective site, they were isolated in a single-occupancy room until disease status was confirmed by a further swab. Patients who tested positive for COVID-19 were admitted to a segregated area within the hospital. Staff were specially assigned to this area, and all patients were treated in single-occupancy rooms. Throughout the duration of the study period, Public Health England Infection Prevention Control guidelines were followed with respect to personal protective equipment and swabbing.

Perioperative Management

National Institute for Health and Care Excellence (NICE) clinical guidelines[7] were closely followed. A primary goal was for patients to undergo surgery within 36 hours of admission, as recommended by the U.K. Department of Health best practice tariff[8]. All operating lists were led by a consultant surgeon, from either the elective or acute site on a day-by-day basis, and theaters were run according to national guidance. Postoperatively, patients were seen by a consultant orthopaedic surgeon, consultant physicians (who were specially recruited for this purpose), and a team of occupational therapists and physiotherapists. Patients were mobilized on the first postoperative day.

Data Collection and Analysis

Data were collected for patient demographics, emergency department arrival time, surgical center arrival time, anesthetic

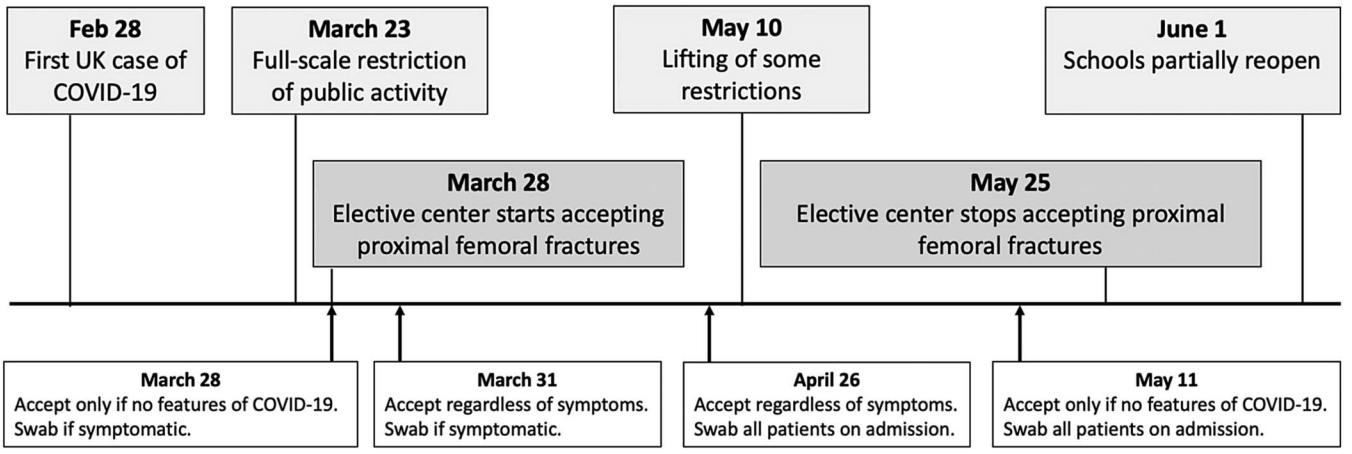

Fig. 1

Timeline showing U.K. government action, site-streaming reconfiguration, and swabbing strategy during the year 2020.

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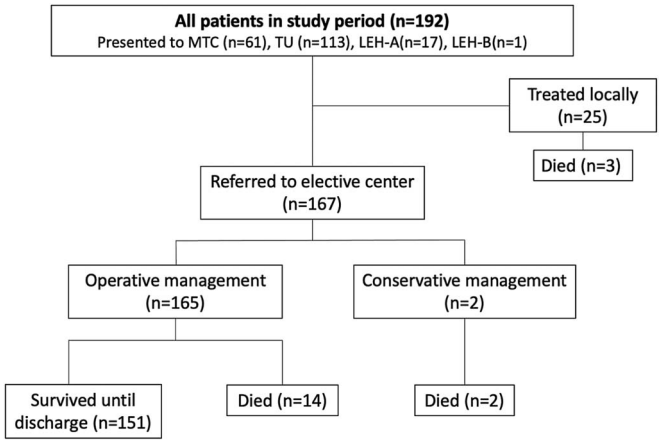

Fig. 2

Flowchart showing the sites of presentation and treatment and in-hospital mortality among patients with proximal femoral fractures. MTC = major trauma center, TU = trauma unit, and LEH = local emergency hospital.

room arrival time, diagnosis, treatment, Charlson Comorbidity Index, discharge date, discharge destination, admission location, length of stay, death as an inpatient, death within 30 days postoperatively, cause of death on the death certificate, preoperative and postoperative hemoglobin, and COVID-19 status.

Non-normally distributed data were presented as the median with the interquartile range. Significance was assessed with use of the Mann-Whitney test for nonparametric data and the Student t test for normally distributed data. Significance testing was not performed when comparing mortality rates to known controls.

Source of Funding

There were no sources of funding for the study.

Results

A total of 192 patients >60 years old with proximal femoral fragility fractures were identified during the 8-week study period. Of these, 167 underwent treatment at the specialist elective center, 18 at the major trauma center acute site, and 7 in the trauma unit acute site. The 30-day rate of mortality among patients who were managed at the elective site was 10.2%, compared with 13.0% overall. The sites of presentation, treatment, and in-hospital mortality of all patients are summarized in Figure 2. Demographic data are presented in Table I. There were no significant differences between patients who underwent treatment at acute sites versus the elective site in terms of age ($p = 0.29$) or Charlson Comorbidity Index ($p = 0.24$). Patients who contracted COVID-19 and died during the study period had a significantly higher Charlson Comorbidity

TABLE I Demographic Data for Patients with Proximal Femoral Fractures Treated from March 28, 2020, to May 25, 2020*

	Transferred to Elective Site (N = 167)	Treated at Acute Sites (N = 25)	Overall (N = 192)
Age *(yr)*	83 (75-89)	84 (79-91)	83 (76-90)
Sex			
Female	119	9	128
Male	48	16	64
Died as inpatient	14 (8.4%)	3 (12%)	17 (8.9%)
Died within 30 days	17 (10.2%)	8 (32%)	25 (13.0%)
Length of stay *(day)*	8 (6-11)	-	-
Charlson Comorbidity Index	4 (4-6)	5 (4-6)	5 (4-6)
COVID-19			
Positive status	29 (17.4%)	11 (44%)	40 (20.1%)
Died	10 (34.5%)	4 (36.4%)	14 (35%)
Fracture pattern			
Intracapsular	88	13	101
Intertrochanteric	69	11	80
Subtrochanteric	7	1	8
Periprosthetic, proximal femur	3	-	3
Treatment			
Operative	165	20	185
Nonoperative	2	5	7

*A total of 192 patients presented to the hospital system. Values are given as the median with the interquartile range in parentheses or as the count with or without the percentage in parentheses.

TABLE II Patient Mortality Data

	Patients Treated in Elective Center Who Died within 30 Days (N = 17)		
	Positive COVID Test*	Negative COVID Test*	P Value
Time from treatment to death *(day)*	14 (12-17)	8 (3-13)	0.08
Hemoglobin (g/L)			
Preoperative	117 (95-128)	110 (100-117)	0.16
Postoperative	105 (100-115)	99 (103-111)	0.21
Primary cause of death (1a on certificate)			
Respiratory failure	5	1	
Delirium	2	-	
Pneumonia	1	1	
Femoral neck fracture	1	-	
Old age	-	1	
Sepsis	-	1	
Missing data	-	4	
Total	9	8	

*Values are given as the mean with the interquartile range in parentheses or as the count.

Index (5.1) than those who contracted COVID-19 and did not die (4.4; p = 0.029). There was no preponderance for any particular comorbidity in those that died.

Elective Site

Among patients managed at the elective site, 78% were admitted from their own home and 22% were admitted from a care or residential facility. The 30-day mortality rate was 8.0% among patients admitted from home and 13.7% among patients admitted from a care or residential facility. The proportion of patients who tested positive for COVID-19 during their hospital stay was 13.8% among those admitted from home and 42.1% among those admitted from a care or residential facility. Overall, 75 patients (44.9%) were discharged to their own homes, 50 (29.9%) to an off-site rehabilitation facility, 14 (8.4%) to a care facility, 8 (4.8%) to another hospital, and 6 (4.0%) to a residential facility. An additional 14 patients (8.4%) died prior to discharge.

The median time from admission to surgical treatment was 12.4 hours (interquartile range, 7.2 to 18.9 hours), with 72% of patients undergoing treatment within 36 hours of admission. There was no significant difference in age between those who died and those who did not die (p = 0.08). A total of 17 patients (10.2%) died during the study period, including 9 who tested positive for COVID-19 and died at a median of 8.1 days postoperatively and 8 who tested negative for COVID-19 and died at a median of 13.6 days postoperatively. There was no significant difference in the time from treatment to death between patients who did and did not test positive for COVID-19 (p = 0.076). Additional data regarding patients who died can be found in Table II.

COVID-19 Patients at the Elective Site

The median age was 87 years (interquartile range, 76 to 91 years) among patients who tested positive for COVID-19 and 88 years (interquartile range, 84 to 93 years) among those who tested positive for COVID-19 and died. There was no significant difference in age between patients who tested positive and those who did not (p = 0.33). There was also no significant difference in age between patients who tested positive and died and those who tested positive and did not die (p = 0.13).

Discussion

We report the in-hospital mortality, 30-day mortality, and COVID-19 case fatality rate of older patients who underwent surgical treatment of a femoral fragility fracture in a reconfigured U.K. specialist elective orthopaedic center. This study serves the purpose of informing the safety of such reconfiguration practices.

The U.K. National Hip Fracture Database 2019 annual report[9] shows a 30-day mortality of 6.1% for the 66,313 patients with hip fractures in 2018. When seasonal variation is accounted for, the adjusted 30-day mortality is 7.5%. This rate of mortality was not calculated in the context of a pandemic and thus for the purposes of the present study was utilized as a "normal" comparison.

International studies assessing hip fracture surgery during the COVID-19 pandemic have reported mortality rates of 9.6% in Spain[10], 12.3% in New York[11], 17% in India[12], and 50% in Wuhan[13] and case fatality rates of 30.4% in Spain[10], 31% in Italy[14], 50% in Wuhan[13], and 53% in New York[11]. These studies were heterogeneous, and therefore the determination of mortality rates for femoral fracture patients was difficult; however, we can conclude that the viral pandemic caused an increased mortality in this frail population.

Over the duration of the present study, we observed large numbers of both newly diagnosed cases (up to 5,000 per day from April 4 to April 9) and daily deaths (up to 1,000 per day

from April 6 to 23), as reported by the U.K. government[15,16]. Our region had a laboratory-confirmed COVID-19 case rate of 284.3 per 100,000 population[17], which was higher than the national average of 281.4 cases per 100,000. Birmingham also had the highest peak excess all-cause mortality of any British city during the pandemic (249.7% for the week ending April 17)[18]. We therefore believe that the patients included in the present study were representative of the greatest burden of COVID-19 observed in the U.K.

The 30-day mortality rate of 10.2% in the present study was higher than the normal rate for hip fracture patients in the U.K. (7.5%) according to the National Hip Fracture Database[9] but similar to the rate reported by the NICE in their clinical guidance document[7]. In the present study, the median time to surgical treatment was 24.5 hours from admission to the emergency department and 12.4 hours from admission to The Royal Orthopaedic Hospital, with 72% of patients undergoing surgical treatment within 36 hours of presentation. According to the National Hip Fracture Database, the average time to surgery in 2018 was 33.1 hours[9], hence time to surgery for the patients in our study was quicker than the national pre-pandemic average.

The high rates of mortality reported for other epicenters at the start of the pandemic were concerning. In the present study, there was a case fatality rate of 34.5% among patients who tested positive for COVID-19 at the elective site. These data can be utilized to measure health-care quality in such a reconfigured pathway, which led to neither grossly high mortality nor substantial delays to surgical treatment. The short length of stay found in the present study was facilitated by systems that were dedicated to accelerating patient discharge.

Sobti et al.[19] reported an overall mortality of 8.5% among patients with proximal femoral fractures, with a case fatality rate of 50% among patients who tested positive for COVID-19. Only 6 of 98 patients in the study tested positive for COVID-19, which was presumably why the reported mortality rate was not significantly different from those reported outside of the COVID-19 pandemic. In a study from multiple sites in Northwest England that evaluated older patients with proximal femoral fractures and confirmed COVID-19 status, Dupley et al.[20] reported a 30-day mortality rate of 32.8%; however, mortality was not reported for patients who did not test positive for COVID-19.

The IMPACT-Scot observational study[21] included 317 older patients with proximal femoral fractures treated at 1 of 6 centers, with an overall mortality rate of 10.4% and case fatality rate of 33% and with only 8.5% of patients testing positive for COVID-19.

The COVIDSurg collaborative report[22] assessed mortality from orthopaedic surgical procedures in 299 COVID-19-positive patients, reporting a rate of 28.8%. This international study did not exclusively include patients with proximal femoral fractures; however, it is worth including in the present discussion because it included a large number of orthopaedic patients.

When taken together, the results of the present study and those of the aforementioned studies suggest a mortality rate of approximately 33% among patients who contract COVID-19 during an admission for a proximal femoral fracture. To our knowledge, no studies have demonstrated a case fatality rate of <30%, with some as high as 50%. By contrast, if the Association of Local Authority Medical Advisors medical risk assessment tool[23] was utilized for female octogenarian patients (i.e., the most common demographic among hip fracture patients), assuming no medical comorbidities, the risk of death from COVID-19 infection would be 6%. This example demonstrates (albeit crudely) how much more damaging COVID-19 is among elderly patients with proximal femoral fractures than among healthy older adults. In the present study, respiratory failure as a cause of death was 4.4 times more likely in those who tested positive for COVID-19, which again illustrates the deadly nature of the disease in the elderly population.

Because of the limited generalizability, it may be challenging to draw firm conclusions from studies[10-14] that exclusively include patients with proximal femoral fractures who have tested positive for COVID-19. It is understood that poor prognostic factors include older age, presence of comorbidities, and male sex[24]. It is likely, therefore, that COVID-19 affects the most vulnerable members of what is already considered a frail population. In the present study, patients who contracted COVID-19 and died had a significantly higher Charlson Comorbidity Index than those who contracted COVID-19 and did not die. However, we believe a more appropriate comparison would be the rate of mortality among the overall study population compared with the rates of mortality reported in previous, pre-pandemic studies. In this context, the rate of mortality observed in the present study was only marginally higher than average. We therefore believe that although COVID-19 may have been associated with greater death among the most vulnerable members of society, it was not necessarily causal in the majority of cases. It should be stressed that the present study was not designed to test this hypothesis, and this sentiment is applied only to an elderly population whose natural mortality is already high.

The main aim of elective-site streaming was to provide expedient surgery because operative capacity was critically compromised in acute sites. This goal was achieved, with a median time to surgery of 24 hours, which was 1.3 times quicker than a national pre-pandemic average[9]. Another potential advantage of operating on this elderly population in an elective site is that doing so protects them from other patients who may have COVID-19 and prevents nosocomial infection. In the present study, streaming patients into an elective site based on their COVID-19 status seemed to prevent a grossly elevated 30-day mortality, but did not reduce it below that in U.K. centers that created separate pathways within their own hospitals. The case fatality rate in the present study was also not obviously different from other series. This suggests that once contracted, COVID-19 has a comparable fatality rate in this population, regardless of treating center or admission protocols.

Limitations

There was selection bias, given that the admission policy excluded a small number of patients who were potentially unsafe to be transferred to the elective site. To mitigate this bias, we reported the in-hospital mortality, 30-day mortality, and case fatality rate from

the entire study population, including patients treated across all sites. There were no significant differences in median age or Charlson Comorbidity Index between patients managed at the acute and elective sites, with the only differences being COVID-19 status and a greater proportion of nonoperatively treated fractures in the acute sites.

The strategy for screening patients for COVID-19 changed halfway through the study period, in accordance with national guidance.

The present study lacked a suitable comparison because our institution had not previously treated acute proximal femoral fractures. This effect was mitigated by comparing our results to those reported in a national, pre-pandemic standard, as well as to some other U.K.-based studies undertaken during the pandemic.

Conclusions

We have demonstrated that an elective orthopaedic center could be reconfigured to provide care to older patients with proximal femoral fractures during the COVID-19 pandemic, with acceptable health-care quality outcomes in one of the hardest-hit major cities in the U.K. The present data do not support any decrease in mortality by adopting elective-acute site streaming rather than streaming pathways within the same hospital site. We suggest a mortality rate of 33% among patients who contract COVID-19 during an admission for a proximal femoral fracture. ■

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