


## CLINICAL ARTICLE

# The Effects of COVID-19 on Geriatric Hip Fracture Management and 1-Year Mortality in Beijing

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**Objectives:** Concerns about the coronavirus disease 2019 (COVID-19) pandemic resulted in unprecedented challenges to the management of geriatric hip fractures. We aimed to evaluate the effects of the COVID-19 surge on the time to surgery and 1 year mortality in geriatric patients with hip fracture at a large, urban Level 1 trauma center in Beijing, and to guide the management of geriatric hip fracture patients throughout the COVID-19 pandemic.

**Methods:** This single-center retrospective study included consecutive patients aged  $\geq 65$  years and injured 3 weeks prior to admission. Demographic and surgical data were collected between January 20 and May 31, 2020, and from the same period in 2019. Mortality data and functional status were collected at follow-up of 1-year after surgery. The primary outcomes were time to surgery and 1 year mortality.

**Results:** There were no significant differences in sex, fracture type, and surgical pattern between the 2020 ( $n = 261$ ) and 2019 time-matched ( $n = 307$ ) cohorts. The time from admission to surgery was significantly delayed in the 2020 cohort compared with that in the 2019 cohort (48.9 h vs 20.5 h,  $p < 0.001$ ). Fewer patients underwent surgery within 48 h in the 2020 cohort (65.5% vs 87.6%,  $p < 0.001$ ). Surgical delay was also associated with an increased risk of inpatient complications (30.2% vs 20.8%,  $p = 0.010$ ), however there was no significant difference in the 1-year mortality rate, nor between pre-injury and 1 year follow-up mobility as assessed by Parker score. Only approximately half of the patients in both groups completely returned to their pre-injury mobility levels.

**Conclusions:** The COVID-19 pandemic has significantly increased the surgery waiting time for geriatric patients with hip fractures, which resulted in increased inpatient complications without a higher mortality rate within 1 year. This reinforces the importance of maintaining timely and protocolized care for geriatric hip fractures throughout any subsequent waves of the pandemic.

**Key words:** China; COVID-19; geriatrics; hip fractures; mortality

## Introduction

The novel coronavirus disease 2019 (COVID-19) pandemic was caused by the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), which was first reported in December 2019 in Wuhan, China. COVID-19 has caused worldwide upheaval and was subsequently declared a public health emergency by the World Health Organization on January 30, 2020<sup>1</sup>. The rapid spread of COVID-19 called for immediate action by policymakers and governments at all levels in China. Multiple preventive measures were implemented to control the spread of the disease, including lockdowns, traffic

control, restrictions on public gatherings, and mandatory self-isolation at home. These measures minimized the number of emergency department admissions. Significantly fewer patients presented with injury due to trauma, and among these, the most vulnerable were elderly people. The number of cases with geriatric hip fractures remained unchanged during the COVID-19 pandemic, despite all the restrictions<sup>2-5</sup>. This might have been because the low-energy mechanisms resulting in hip fractures occur most frequently in the patients' homes.

Most geriatric patients with hip fractures are at a high risk of experiencing fracture-related complications, thereby

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imposing a huge burden on patients and health systems due to increase in mortality, disability, and medical expenses<sup>6</sup>. Early surgery and orthogeriatric care are associated with lower mortality and lower rates of postoperative complications after geriatric hip fractures<sup>7,8</sup>. Surgery within 48 h of admission significantly reduces the risk of mortality in hip fracture patients<sup>9</sup>. Despite well-established clinical guidelines for older patients with hip fracture, implementation of these best practices in China remains limited. Our previous study revealed a significant disparity in hip fracture management between the care provided at our hospital and best practices followed in England<sup>10</sup>. In accordance with this finding, we implemented multidisciplinary orthogeriatric co-management care for geriatric hip fracture patients in 2015. The introduction of the multidisciplinary model significantly reduced the time to surgery and improved the clinical outcomes during hospitalization<sup>11</sup>. Furthermore, a multicenter prospective non-randomized controlled study conducted by our hospital also reported that our co-management care of elderly patients with hip fracture resulted in better outcomes. It has significantly reduced time from admission to surgery and 1-year mortality and has improved many process outcomes for better hip fractures management<sup>12</sup>.

However, the COVID-19 pandemic has placed a substantial strain on the healthcare system worldwide, and the healthcare workforce has been reallocated to areas with urgent clinical need; consequently, elective surgeries have been reduced to allow more services in acute specialties and maximize hospital beds and resources for patients. These changes have also posed unique challenges for the management of geriatric patients with hip fracture and the maintenance of standards of care. Several studies have reported the effects of the COVID-19 pandemic on geriatric hip fracture outcomes and the delivery of care. COVID-19-positive patients with hip fracture have shown a higher 30-day mortality rate<sup>13</sup>. Moreover, COVID-19 impacted key healthcare standards for high-quality hip fractures care, specifically time to surgery, which reflects the difficulty of maintaining normal workflow during the pandemic due to a significant decrease in the availability of operating rooms and healthcare staff. Several studies have also reported an increase in the rate of severe complications and mortality rate during the pandemic, even in COVID-19-negative patients<sup>14</sup>.

To our knowledge, no studies in China have analyzed the impact of the COVID-19 pandemic on the care of hip fracture patients. The maintenance of a smooth workflow is of paramount importance for the delivery of care. Since patient care was compromised by the COVID-19 pandemic, especially in the first 3 months, how the first COVID-19 wave impacted the management and outcomes remains unknown. In this study, the main objectives were: (i) to assess the impact of the COVID-19 pandemic on operative geriatric hip fracture care at a Beijing Level I trauma hospital, specifically analyzing variations in the time to surgery, length of stay, and inpatient mortality; (ii) to analyze the difference in 1-year mortality between patients admitted during

the COVID-19 pandemic and those admitted during an identical pre-pandemic period; and (iii) to compare the functional outcomes of long-term survival in geriatric patients undergoing hip fracture surgery between the two groups.

## Materials and Methods

### Study Design

An active geriatric hip fracture audit system prospectively recorded data, providing a systematic overview of the management of all geriatric hip fracture patients in one of the largest and most influential orthopaedic facilities in Beijing over a period of almost 5 years. This study was approved by the Institutional Review Board of Peking University Health Science Center (IRB00001052-17021).

### Inclusion and Exclusion Criteria

The inclusion criteria were: (i) age 65 years or older; (ii) injured 3 weeks prior to admission; (iii) having undergone surgery for hip fracture. The exclusion criteria were: (i) pathological fractures and (ii) periprosthetic fractures.

The study population was stratified according to the care model used in each study period: (a) 2020 cohort: patients who had received surgery from January 20 to May 31, 2020, were represented as the pandemic group; (b) 2019 cohort: patients who received surgery from the same period in 2019 were represented as the pre-pandemic group.

### Patients

We performed a retrospective search of patient records and images from our institutional database and enrolled all eligible patients who met the inclusion criteria. Those who had undergone operations from January 20 to May 31, 2020, were allocated to the 2020 cohort, and those who had undergone operations from January 20 to May 31, 2019, were allocated to the 2019 cohort. This study was approved by the local ethics committee (201807-11).

### Intervention

#### The 2019 Cohort

During this pre-pandemic period, the intervention was a multidisciplinary co-management involving surgeons, anesthesiologists, geriatricians, nurses, physical therapists, and pharmacists. The implementation of the co-management care model started from admission to the emergency department (ED) to the time of discharge from the hospital. In the ED, patient care was jointly provided by orthopaedic surgeons and ED physicians along with anesthesiologists. The ED physicians provided the initial assessments followed by admission to the orthogeriatric ward, where orthopaedic surgeons and geriatricians jointly managed patient care. Geriatricians provided preoperative assessments, comorbidity treatments, postoperative prevention of complications, and secondary prevention of fractures. Orthopaedic surgeons and geriatricians shared surgical and clinical information during

daily briefings with anesthesiologists, and decisions regarding surgical fitness and the optimal timing of surgery were generally shared. Postoperatively, orthopaedic surgeons determined a weight-bearing regimen with physical therapists and walking exercises were started within 3 days after surgery. The management indicators of OGC adapted the recommendations of the UK guidelines for hip fractures management, including quick admission to an orthogeriatric ward, expedited surgery, geriatrician assessment, secondary prevention of fractures, pressure ulcer prevention, provision of physiotherapy, and early discharge.

#### *The 2020 Cohort*

During the pandemic, our hospitals were forced to reallocate resources, surgeons, and nursing staff of our multidisciplinary team, and the availability of inpatient beds and theater capacity were reduced. Hospital policies during COVID-19 changed over time, and we adapted new protocols and continued to provide co-management care for geriatric hip fracture patients. All patients were first questioned about the etiology and epidemiological history of the fracture. All patients underwent swab tests for SARS-CoV-2. Patients suspected of having COVID-19 were immediately isolated. A consultation was then conducted by a multidisciplinary team comprising a surgeon, a physician, and an anesthesiologist to develop a personalized treatment plan. Patients were excluded from medical observation when the results of two consecutive swab tests were negative. COVID-19 was ruled out before patients were transferred to the orthopaedic ward. Patients confirmed COVID-19-positive were taken to a specialty hospital for additional treatment (Figure 1).

#### *Data Collection*

The study population included 886 eligible patients who were stratified according to the care model used in each group (261 in the 2020 cohort and 307 in the 2019 cohort). The following variables were collected.

#### *Baseline Data*

The patients' demographic data were recorded, including age, sex, fracture patterns, and surgical procedures. The age-adjusted Charlson comorbidity index (CCI)<sup>15</sup> was calculated based on preoperative comorbidities. The Parker score was used for functional evaluation.

#### *Outcome Variables*

##### *Time to Surgery*

The time to surgery was defined as the number of hours a patient stayed in the hospital prior to the surgical procedure and the number of patients who could undergo surgery within the first 48 h after admission. The time to surgery is an important marker of geriatric hip fracture care, and current guidelines recommend surgery within 48 h. Early hip surgery within 48 h is associated with lower mortality risk and fewer perioperative complications.

##### *Inpatient Complications*

Reduced perioperative mobility with extended bed rest predisposes geriatric patients with hip fracture to a variety of complications including pressure ulcers, deep vein thrombosis (DVT), pneumonia, and urinary tract infection (UTI). Details of these complications during hospitalization were obtained from the case report form. We used this outcome to explore the relationship between inpatient complications of prolonged bed rest and the time to surgery.

##### *Parker Score*

At the 1 year follow-up after surgery, patients or their caregivers were asked for information regarding their functional status by telephone. The Parker score was used to evaluate the patients' mobility<sup>16</sup>, including their ability to walk inside and outside of the house, and go shopping or visit family. For each question, there were four ordinal responses with individual fixed counts, which were then summed. The final sum ranged from 0 to 9, with the maximum score indicating independent mobility.

##### *Mortality*

The mortality rate was calculated as the number of deaths divided by the number of patients in each group after surgery. The mortality rates can be influenced by medical care, disease status, and comorbidities of patients or by medical or surgical therapies.

##### *Statistical Analysis*

SPSS 25.0 (IBM Corp.) was used for statistical analysis. Continuous variables are presented as mean and standard deviation, and categorical variables are presented as numbers and percentages. Chi-square tests were used to compare categorical variables. Statistical analysis of the study outcomes was performed using the independent-samples *t*-test for continuous variables with normal distributions and the Mann-Whitney *U* test for continuous variables with non-normal distribution. A *p*-value of <0.005 was considered statistically significant.

## **Results**

##### *Baseline Data*

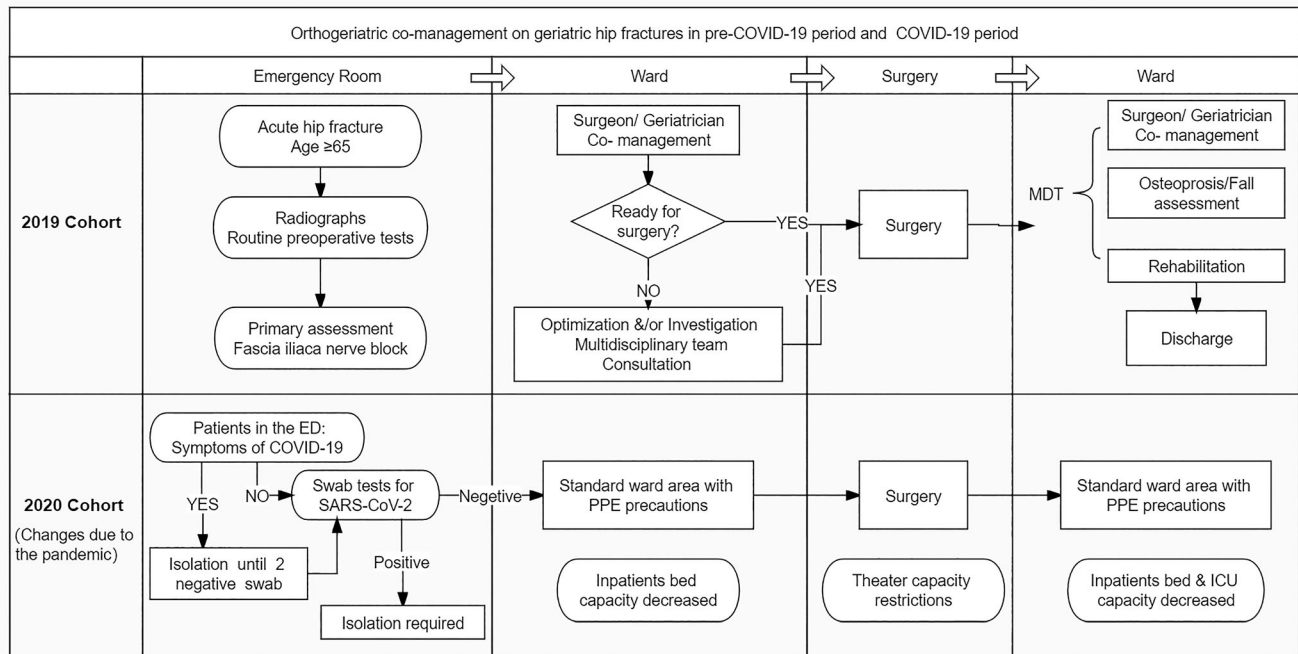
There were no differences between the groups regarding demographics, age-adjusted CCI, mechanism of injury, or characteristics of the fracture or surgery (*p* > 0.05) (Table 1).

##### *Time to Surgery*

During the first COVID-19 wave, the mean waiting time between admission and surgery significantly increased from 20.5 to 48.9 h (*p* < 0.001) and surgeries within 48 h of admission decreased from 87.6% to 65.5% (*p* < 0.001).

##### *Inpatient Complications*

Inpatient complications were observed at a significantly higher rate in the 2020 cohort than in the 2019 cohort; there



**FIGURE 1** Flow chart of co-management care on geriatric hip fractures in pre-COVID-19 period and COVID-19 period

was one in-hospital death in the 2019 cohort, and no patients in the 2020 cohort were diagnosed with COVID-19 (Table 2).

### Mortality

The follow-up rate at 1 year was 89.2% (233/261) in the 2020 cohort and 84.4% (259/307) in the 2019 cohort. There were no significant differences in age, sex ratio, age-adjusted CCI, fracture type, surgical procedures, or pre-injury Parker

scores between the two groups ( $p > 0.05$ ). There were no significant differences in the mortality rates at the 1-year follow-up after surgery between the two cohorts ( $p = 0.313$ , Table 3).

### Functional Recovery at the 1-Year Follow-Up

For patients who were still alive at the 1-year follow-up, functional status was similar as assessed by the Parker score ( $6.8 \pm 2.6$  in the 2020 cohort vs  $7.1 \pm 2.3$  in the 2019 cohort;

**TABLE 1** Baseline data of the patients in the 2020 and 2019 cohorts

	2020 (n = 261)	2019 (n = 307)	t value	p value
Age, mean (SD)	80.7 (7.3)	79.6 (7.6)	-1.689	0.091
Gender, n (%)			0.785	0.376
Male	82 (31.4)	86 (28.0)		
Female	179 (68.6)	221 (72.0)		
Age-adjusted CCI, mean (SD)	4.92 (1.64)	4.90 (1.57)	-0.194	0.846
Type of hip fracture, n (%)			2.267	0.132
Femoral neck	155 (59.4)	163 (53.1)		
Intertrochanteric	106 (40.6)	144 (46.9)		
Injury mechanism, n (%)			1.398	0.237
High energy	7 (2.7)	14 (4.6)		
Low energy	254 (97.3)	293 (95.4)		
Surgical procedure, n (%)			7.016	0.071
Screw fixation	20 (7.7)	31 (10.1)		
Intramedullary nail	104 (39.8)	144 (46.9)		
Hemiarthroplasty	110 (42.1)	114 (37.1)		
Total hip arthroplasty	27 (10.3)	18 (5.9)		

Abbreviation: CCI, Charlson comorbidity index.

**TABLE 2 Procedures and outcomes in the 2020 and 2019 cohorts**

	2020 (n = 261)	2019 (n = 307)	t value	p value
Time to surgery (h), mean (SD)	48.9 (25.7)	20.5 (23.8)	-11.096	0.000
Time to surgery within 48 h, n (%)	171 (65.5)	269 (87.6)	39.486	0.000
Inpatient complications n (%)				
≥1 complication	79 (30.3)	64 (20.8)	6.647	0.010
Pneumonia	32 (12.3)	22 (7.2)	4.256	0.039
UTI	16 (6.1)	4 (1.3)	9.677	0.002
Pressure ulcers	20 (7.7)	15 (4.9)	1.881	0.170
DVT	30 (11.5)	25 (8.1)	1.811	0.178
Inpatient mortality, n (%)	0 (0.0)	1 (0.3)	0.849	0.357

Abbreviations: DVT, deep vein thrombosis; UTI, urinary tract infection.

$p = 0.462$ ). Only approximately half of the patients completely returned to their pre-injury mobility levels (45.1% in the 2020 cohort vs 51.4% in the 2019 cohort,  $p = 0.164$ ). At 1 year postoperatively, the percentage of fully independent patients was 35.6% (83/233) in the 2020 cohort and 43.6% (133/259) in the 2019 cohort ( $p = 0.070$ , Table 3).

## Discussion

In this observational study, we investigated the effects of the COVID-19 pandemic on geriatric hip fracture care at a Level 1 trauma center in Beijing. We found that the pandemic caused a one-day delay of surgery during the first wave of the pandemic; however, 1-year mortality did not change. This research highlights that despite the pandemic, maintaining timely hip fracture care remains essential to improved outcomes in the geriatric population.

## Effects of COVID-19 on Geriatric Hip Fracture Management

China has the largest population in the world, and the number of older people is rapidly increasing with a considerable annual increase in the number of hip fracture cases. Geriatric patients with hip fractures need to have safe, quick, and efficient recovery after injury to return to their pre-injury life. However, the situation is not optimistic in China. A retrospective study published in 2015 showed a significant disparity in geriatric hip fracture care<sup>10</sup>. Following this study, multidisciplinary co-management care was implemented for the first time in our hospital to provide better care through a multidisciplinary approach for geriatric patients with hip fracture in mainland China<sup>11</sup>. Consequently, in the 2019 cohort, 87.6% of hip fractures were operated on within 48 h after admission, which is significantly better than the rates reported in previous studies, and the performance

**TABLE 3 Baseline data, mortality, and functional recovery of patients who were followed for 1 year**

	2020 (n = 233)	2019 (n = 259)	t value	p value
Age, mean (SD)	80.2 (6.8)	78.8 (7.1)	-1.732	0.083
Gender, n (%)			10.98	0.656
Female	164 (70.4)	187 (72.2)		
Male	69 (29.6)	72 (27.8)		
Fracture type, n (%)			0.696	0.404
Femoral neck fracture	140 (60.6)	146 (56.4)		
Trochanteric region fracture	93 (39.4)	113 (43.6)		
Surgical procedure, n (%)			1.164	0.280
Internal fixation	111 (47.6)	136 (52.5)		
Hip arthroplasty	122 (52.4)	123 (47.5)		
Age-adjusted CCI, mean (SD)	4.81 (1.58)	4.93 (1.41)	-0.609	0.543
Parker Score before injury, mean (SD)	8.3 (1.6)	8.4 (1.5)	-0.205	0.837
1-year mortality, n (%)	22 (9.4)	18 (6.9)	1.020	0.313
Functional recovery				
Parker Score at 1 year, mean (SD)	6.8 (2.6)	7.1 (2.3)	-0.689	0.491
Complete recovery <sup>a</sup> , %	45.1% (105/233)	51.4% (133/259)	1.941	0.164
Fully independent <sup>b</sup> , %	35.6% (83/233)	43.6% (113/259)	3.281	0.070

Abbreviation: CCI, Charlson comorbidity index.; <sup>a</sup>The Parker score at 1 year was completely restored to that before injury;; <sup>b</sup>Parker score = 9.



outcomes according to the six key care standards of the Blue Book in the pre-pandemic group were comparable to those of the 2019 UK National Hip Fracture Database Annual Report<sup>17</sup>.

Several studies have shown that there are significant reductions in the number of injury-related visits to EDs, traffic and workplace accidents, and hospital inpatient stays compared to the pre-pandemic period. This is likely because of government-imposed lockdowns and travel bans on an unprecedented scale, with the population being mandated and/or encouraged to stay at home. Therefore, the epidemiological characteristics of traumatic fractures have changed dramatically; however, the absolute number of geriatric hip fracture admissions remained stable due to the low-energy falls that occur in home or the usual place of residence<sup>2,4,18,19</sup>. The pandemic is also a public health crisis that has profoundly modified the delivery of medical and surgical care. Healthcare organizations have responded by restricting medical care to emergency cases and postponing nonessential medical and surgical procedures. Elderly patients are at the greatest risk of COVID-19 and osteoporosis-related fractures, and osteoporosis care is almost completely suspended largely because of the closure of outpatient clinics<sup>20,21</sup>. An incredible number of resources have been reallocated by our hospital. Although our multidisciplinary team continued to care for elderly patients in need of essential surgery, we aimed to assess whether the disruptions to the routine pathway caused by COVID-19 resulted in a detrimental effect on the management of hip fracture patients compared with the management done in the same period in 2019.

The COVID-19 pandemic has led to a major disruption of routine hospital services globally and significant delays in both urgent and emergent surgical procedures, leading to a backlog of cases. The time to surgery is an important marker of geriatric hip fracture care, and repair within 48 h was associated with lower complication and 30 day mortality rates. Previous authors have noted that the time to surgery during the pandemic varied from area to area, and some authors reported a prolonged waiting time<sup>22,23</sup>, while others reported equivalent waiting time to pre-pandemic<sup>5,13</sup>. In our study, 65.5% of the patients in the 2020 cohort underwent surgery within 48 h of admission, compared with 83% in the 2019 cohort. Moreover, the average waiting time for surgery increased from a mean of 20.5 h to 48.9 h, which demonstrates the difficulty of maintaining normal workflow during the COVID-19 pandemic and notwithstanding the suspension of nonessential procedures. This delay may have been caused by a variety of reasons: (1) all patients were routinely screened for COVID-19 before surgery, and PCR test results were delivered within 24–48 h, due to the limited testing capacity during the first pandemic period; (2) the inpatient bed capacity was reduced to half of normal as some wards were converted to quarantine wards in preparation for the expected patient surge due to COVID-19; (3) insufficient availability of staff due to the reallocation

of healthcare resources, as all available practitioners in our multidisciplinary team—including orthopaedic surgeons, geriatricians, and nursing staff—were redeployed to another area of the hospital with unmet needs; (4) reduced availability of operation theater capacity. The patient transfers, deep cleaning of theaters, and use of personal protective equipment took time. Anesthetists and operating practitioners were also redeployed with constantly changing guidelines and policies, which resulted in a substantial challenge to theater efficiency and capacity. These setups rapidly became incompatible with the volume of daily geriatric hip fracture cases, resulting in a significant backlog for patients awaiting admission and surgery.

The current guidelines indicate that surgeons should perform surgery for hip fractures within 48 h of admission, as performing surgery early can minimize prolonged bed rest, thereby reducing the risk of associated complications. Additionally, early surgery has been associated with better functional outcomes, shorter duration of pain and length of hospital stay, and lower rates of non-union and mortality<sup>24,25</sup>. Our study showed that the pandemic has led to severe disruptions in services for geriatric hip fractures at our hospital, with the time to surgery being prolonged compared with that in the pre-pandemic period. We also found a significant association between surgical delay and an increased incidence of inpatient complications associated with extended bed rest, including pneumonia, UTI, pressure ulcers, and DVT. The increased types and frequency of inpatient complications observed in our research mirror the results from other studies<sup>13</sup>.

### **Mortality**

Reducing short- and long-term mortality is the primary goal in the management of geriatric hip fractures. Timely hip fracture care is fundamental to minimizing the mortality associated with hip fractures. Due to the significant backlog of patients awaiting admission and surgery during the pandemic, the average time from injury to surgery for the 2020 cohort was 2 days longer with higher 1-year mortality; although this increase was not statistically significant, in this study, the 1-year mortality rate was 9.4% in the 2020 cohort and 6.9% in the 2019 cohort. Some investigators found increased mortality during the pandemic<sup>22</sup>, while others found no difference in mortality pre and during the pandemic<sup>5,22,26</sup>, similar to our results. Colum *et al.*<sup>27</sup> performed a systematic review of the mortality rate of hip fractures at 1-year follow-up. In their study, they reported a consistent worldwide reduction in mortality at 1 year post surgery compared with the previously published results, and 1-year mortality data from the Asian continent were lower than the mean overall 1-year mortality rate. The low mortality may be due to the worldwide adoption of current best practice in care and demonstrates the importance of efforts to continue delivering protocolized hip fracture care during the COVID-19 pandemic<sup>5</sup>.

### Functional Outcomes

Another important goal of geriatric hip fracture management is to restore the pre-injury mobility and quality of life. In our study, the percentages of fully independent and complete recovery were lower in the 2020 cohort, although the difference was not significant. Early postoperative mobilization, including standing and ambulation, is important for functional recovery. Rehabilitation after a hip fracture requires joint effort and takes a long time. In the pre-pandemic period, intensive post-discharge physical therapy was offered by hospitals, communities, and caregivers with appropriate rehabilitation plans. In the 2020 cohort, the rehabilitation of patients was greatly affected by the COVID-19 pandemic, and patients were afraid of going out. The rehabilitation center went into complete protective lockdown, which may have led to worse mobility for patients. However, further evidence on this matter must be gathered and presented.

Several studies have reported an impact of the pandemic on the management of geriatric patients with hip fracture worldwide; however, there is a need to manage such patients even during the pandemic. Prompt surgical treatment for hip fracture patients is crucial while preventing the spread of COVID-19<sup>23,28</sup>. In addition, the optimal approach to postoperative rehabilitation should be determined to optimize outcomes after surgery. A multidisciplinary approach remains the key to prioritizing surgery for patients with hip fractures, despite limited medical resources. Guidelines and patient pathways should be optimized quickly during the pandemic based on the clinical situation. Moreover, there should be an international consensus for special care of geriatric patients with hip fracture during pandemics.

Strengths of our study included robust 1-year follow-up and the ability to compare our results with retrospective pre-pandemic data. Moreover, our experience during the COVID-19 pandemic represents an instructive event in China, which has the potential to guide decision-making in the care of geriatric patients with hip fractures.

Our study had few limitations. First, due to its retrospective nature, the quality of the data collected was dependent on the information that was recorded. Therefore, there could be other complications which contributed to surgical delay that were not considered in this study. Second, it provides a picture of a limited timeframe, that is, the first wave of the pandemic. Third, only patients who had undergone surgery were included in this study; some patients who were neither operated on nor admitted to the hospital and all patients who received conservative treatment were not followed-up. Lastly, there were no confirmed cases of

COVID-19 in our study, as other studies have shown that geriatric patients with hip fracture and COVID-19 are at high risk for major complications and death; however, despite the high mortality rate, COVID-19-positive patients could still benefit from early surgery<sup>13,29,30</sup>.

### Conclusion

This study addressed the impact of the COVID-19 pandemic on healthcare quality and 1-year mortality for geriatric patients with hip fractures. Due to the pandemic and resource reallocation experienced by our hospital system, the result showed a reduction in the proportion of patients receiving timely surgery, with no significantly increased rates of 1-year mortality. Our results indicated that maintaining timely and protocolized care remains essential, and multi-disciplinary teams involved in geriatric hip fracture care should be preserved, which may also lead to improved processes and outcomes for patients during the pandemic. Further studies are needed to analyze the long-lasting effects of the pandemic on geriatric hip fracture care worldwide.

### Author Contributions

Gang Liu and Minghui Yang designed the study and wrote the manuscript. Ning Li and Shaoliang Li provided research ideas and performed the statistical analysis. Professor Shiwen Zhu and Xinbao Wu supervised this study. All authors reviewed the manuscript before submission.

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All authors acknowledge that they meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and that all authors are in agreement with the manuscript.

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### Conflict of Interest

All authors declare no financial support or relationships that may pose a conflict of interest.

### Ethics Statement

The ethics committee of our institution has approved this study (201807-11).

### References

1. Coronavirus Disease (COVID-19) Pandemic: World Health Organization; 2020.
2. Lv H, Zhang Q, Yin Y, Zhu Y, Chen W. Epidemiologic characteristics of traumatic fractures during the outbreak of coronavirus disease 2019 (COVID-19) in China: a retrospective & comparative multi-center study. *Injury*. 2020;51:1698–704.
3. Zhu Y, Chen W, Xin X, Yin Y, Hu J, Lv H, et al. Epidemiologic characteristics of traumatic fractures in elderly patients during the outbreak of coronavirus disease 2019 in China. *Int Orthop*. 2020;44:1565–70.
4. Nuñez JH, Sallent A, Lakhani K, Guerra-Farfan E, Vidal N, Ekhtiari S, et al. Impact of the COVID-19 pandemic on an emergency traumatology service: experience at a tertiary trauma Centre in Spain. *Injury*. 2020;51:1414–8.
5. Malik-Tabassum K, Crooks M, Robertson A, To C, Maling L, Selmon G. Management of hip fractures during the COVID-19 pandemic at a high-volume hip fracture unit in the United Kingdom. *J Orthop*. 2020;20:332–7.
6. Papadimitriou N, Tsilidis KK, Orfanos P, Benetou V, Ntzani EE, Soerjomataram I, et al. Burden of hip fracture using disability-adjusted life-years:

- a pooled analysis of prospective cohorts in the CHANCES consortium. *Lancet Public Health*. 2017;2:e239–46.
7. Lefaiivre KA, Macadam SA, Davidson DJ, Gandhi R, Chan H, Broekhuysen HM. Length of stay, mortality, morbidity and delay to surgery in hip fractures. *J Bone Joint Surg Br*. 2009;91:922–7.
  8. Brox WT, Roberts KC, Taksali S, Wright DG, Wixted JJ, Tubb CC, et al. The American Academy of Orthopaedic surgeons evidence-based guideline on Management of hip Fractures in the elderly. *J Bone Joint Surg Am*. 2015;97:1196–9.
  9. Klestil T, Röder C, Stotter C, Winkler B, Nehrer S, Lutz M, et al. Impact of timing of surgery in elderly hip fracture patients: a systematic review and meta-analysis. *Sci Rep*. 2018;8:13933.
  10. Tian M, Gong X, Rath S, Wei J, Yan LL, Lamb SE, et al. Management of hip fractures in older people in Beijing: a retrospective audit and comparison with evidence-based guidelines and practice in the UK. *Osteoporos Int*. 2016;27:677–81.
  11. Wu X, Tian M, Zhang J, Yang M, Gong X, Liu Y, et al. The effect of a multidisciplinary co-management program for the older hip fracture patients in Beijing: a “pre- and post-” retrospective study. *Arch Osteoporos*. 2019;14:43.
  12. Zhang J, Yang M, Zhang X, He J, Wen L, Wang X, et al. The effectiveness of a co-management care model on older hip fracture patients in China – a multicentre non-randomised controlled study. *Lancet Reg Health West Pac*. 2022;19:100348.
  13. Egol KA, Konda SR, Bird ML, Dedhia N, Landes EK, Ranson RA, et al. Increased mortality and major complications in hip fracture care during the COVID-19 pandemic: a New York City perspective. *J Orthop Trauma*. 2020;34:395–402.
  14. Lim SM, Tan M, Sze YL, Au L. Effects of the COVID-19 pandemic on COVID-19 negative geriatric patients with hip fractures. *J Frailty Aging*. 2021;10:75–6.
  15. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *J Clin Epidemiol*. 1994;47:1245–51.
  16. Parker M, Palmer C. A new mobility score for predicting mortality after hip fracture. *J Bone Joint Surg Br*. 1993;75:797–8.
  17. Royal College of Physicians. National hip fracture database annual report 2019 [Internet]. London: RCP, 2019. Available from: <https://www.nhfd.co.uk/>. Accessed November 1, 2021.
  18. Ogliari G, Lunt E, Ong T, Marshall L, Sahota O. The impact of lockdown during the COVID-19 pandemic on osteoporotic fragility fractures: an observational study. *Arch Osteoporos*. 2020;15:156.
  19. Hadfield JN, Gray AC. The evolving COVID-19 effect on hip fracture patients. *Injury*. 2020;51:1411–2.
  20. Singer AJ, Fuggle NR, Gill CB, Patel AR, Greenspan SL. COVID-19 and effects on osteoporosis management: the patient perspective from a National Osteoporosis Foundation survey. *Osteoporos Int*. 2021;32:619–22.
  21. Peeters J, Berg P, Bergh J, Emmelot-Vonk MH, Appelman-Dijkstra NM. Osteoporosis care during the COVID-19 pandemic in The Netherlands: a national survey. *Arch Osteoporos*. 2021;16:11.
  22. Narang A, Chan G, Aframian A, Ali Z, Carr A, Goodier H, et al. Thirty-day mortality following surgical management of hip fractures during the COVID-19 pandemic: findings from a prospective multi-centre UK study. *Int Orthop*. 2021;45:23–31.
  23. Wignall A, Giannoudis V, De C, Jimenez A, Sturdee S, Nisar S, et al. The impact of COVID-19 on the management and outcomes of patients with proximal femoral fractures: a multi-Centre study of 580 patients. *J Orthop Surg Res*. 2021;16:155.
  24. Orosz GM. Association of Timing of surgery for hip fracture and patient outcomes. *JAMA*. 2004;291:1738–43.
  25. Grimes JP, Gregory PM, Noveck H, Butler MS, Carson JL. The effects of time-to-surgery on mortality and morbidity in patients following hip fracture. *Am J Med*. 2002;112:702–9.
  26. Craig J, Maguire M, Shevlin SP, Black ND. The effects of COVID-19 on hip fracture management and mortality in a regional trauma centre. *Anaesthesia*. 2021;76:710–1.
  27. Downey C, Kelly M, Quinlan JF. Changing trends in the mortality rate at 1-year post hip fracture—a systematic review. *World J Orthop*. 2019;10:166–75.
  28. Onizuka N, Topor LN, Schroder LK, Switzer JA. Outcomes of COVID-19 negative hip fracture patients during the acute and subacute pandemic. *Geriatr Orthop Surg Rehabil*. 2021;12:21514593211006692.
  29. Vives JMM, Jornet-Gibert M, Cámara-Cabrera J, Esteban PL, Marcano-Fernández F. Mortality rates of patients with proximal femoral fracture in a worldwide pandemic: preliminary results of the Spanish HIP-COVID observational study. *J Bone Joint Surg Am*. 2020;102:e69.
  30. Catellani F, Coscione A, D'Ambrosi R, Usai L, Fiorentino G. 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:e58.