IMPACT OF THE COVID-19 PANDEMIC ON FRAGILITY HIP FRACTURE MANAGEMENT AND MORTALITY RATE

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Abstract

Background: The COVID-19 pandemic has greatly affected patients without COVID, including osteoporotic hip fractures. Treatment protocols and time for surgery have been disrupted and delayed resulting in unsatisfactory outcomes. This study compared the mortality rate among patients with osteoporotic hip fractures during the COVID-19 pandemic and during the prepandemic periods.

Methods: The patients' information recorded in the Fracture Liaison Service (FLS) registry was retrospectively reviewed. We defined the prepandemic group as the admissions between May 2019 and March 2020 and the pandemic group as admissions from April 2020 to February 2021. The demographic data were collected, including serum calcium and 25(OH)D levels. Time to surgery, postoperative complications, length of stay and death were obtained and compared between the two periods.

Results: We included 813 patients, with 444 and 369 patients in the prepandemic and the pandemic groups, respectively. Mean age, sex and comorbidities were comparable in both groups. The proportion of patients with insufficient and deficient vitamin D was significantly higher in the pandemic group (46.41 vs. 62.85%, $p<0.01$). Time to surgery and length of hospital stay was significantly longer in the pandemic period ($p<0.05$). The mortality was higher but did not significantly differ in the pandemic period with an adjusted hazard ratio of 1.08 (95% CI = 0.76-1.54).

Conclusion: Properly managing hip fractures during the pandemic is crucial to prevent and reduce morbidity and mortality. Inadequate serum vitamin D level has been noted in the pandemic group but was not associated with mortality rate.

Keywords: COVID-19, Fragility hip fracture, Osteoporotic fracture, Mortality

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Introduction

Osteoporotic fractures are characterized as fractures occurring at a site associated with low BMD, in which incidence increases after the age of 50 years old. [1] Osteoporotic fracture is more common among females. According to a study conducted in the USA, 17.5% of women and 6% of men experience fragility hip fractures throughout their lifetime. [2] Notably, the world will become an aging society shortly; osteoporosis and osteoporotic fractures are unavoidable Patients with osteoporotic fractures have considerably high morbidity and mortality (up to 20% for one-year mortality).[3] The most effective method to reduce mortality and morbidity are early surgery and standard care using a multidisciplinary team approach.[4, 5]

Coronavirus disease 2019 (COVID-19) is caused by a new coronavirus called SARS-CoV-2. COVID-19 is highly contagious and causes severe acute respiratory syndrome with serious morbidity and mortality. WHO announced the COVID-19 pandemic on March 11th, 2020. [6] Since then, each country has established its social distancing guidelines mainly focusing on the restrictions of outdoor activities. Not only do such restrictions affect people's daily activities, but they also have a vast impact on the health service systems. In most hospitals, medical resources and personnel were allocated and shifted toward COVID-19 management. Thus, treating other diseases and injuries, such as fragility hip fractures, was unavoidably delayed and might have resulted in unfavorable outcomes. It resulted in a small number of patients with hip fractures but a higher mortality rate. [7]

The primary objective of this study was to compare the mortality rate among patients with osteoporotic hip fractures during the COVID-19 pandemic and the prepandemic period. Our secondary objective was to determine the impact of the COVID-19 pandemic on patients' characteristics, such as; serum 25OH D level. Furthermore, we aimed to assess the osteoporotic hip fracture treatment outcomes, including the length of hospital stay and other postoperative complications.

Methods

Population

After obtaining approval from the Institutional Review Boards, the retrospective cohort study was conducted in a single tertiary trauma center. Patients with osteoporotic hip fractures during May 2019 and February 2021 were identified. Patients younger than 60 years or those who failed to adhere to the follow-up plan were excluded from the study. Other exclusion criteria were pathologic fractures, secondary osteoporosis and patients with COVID-19. According to the Thai government's social distancing policy established in April 2020, the prepandemic group was defined as those admitted between May 2019 and March 2020. The pandemic group included admissions from April 2020 to February 2021.

All information was collected from the electronic medical records from admission to one-year follow-up period. In addition, demographic data including age, sex, serum calcium, serum 25-OH vitamin D level, patient's comorbidities, fracture types, time from arrival to surgery and type of treatment were retrieved from the Fracture Liaison Service (FLS) registry program. The primary outcome was mortality rate. Other outcome measurements were the length of hospital stay and postoperative complications.

Pre-operative, surgical procedure and postoperative protocol

Patients presenting osteoporotic hip fractures from low energy trauma would be registered in the FLS registry program. If required, internal medicine or interdepartmental consultation was achieved for optimal status for surgery. Surgery was planned as soon as possible after all pre-operative processes were completed. After admission, venous thromboembolism (VTE) risk was assessed and proper VTE prophylaxis was provided. The difference in preoperative processes between the prepandemic and pandemic periods was the screening laboratory for COVID-19, mostly showing little consequence at time to surgery.

Treatment protocol for cases that could not receive surgery consisted of immobilization with skin traction, which could be transferred to home traction. After the pain subsided, the rehabilitation program for progressive ambulation would be started promptly. Operative treatment remained the gold standard for osteoporotic hip fractures. Determining the types of operations and the types of implants/prostheses depended on the location of the fractures. Closed reduction and internal fixation with cephalomedullary nailing or dynamic hip screws were the mainstays of treatment for intertrochanteric fractures of the femur. On the contrary, the treatment of femoral neck fractures ranged from closed reduction and internal fixation with multiple screws or dynamic hip screws to joint replacement therapy. A patient's age, comorbidity, and activity levels were considered to indicate the most appropriate treatment for each patient.

The postoperative protocol covered progressive ambulation training and gentle range of motion exercises starting the first postoperation day after the pain subsided. In the fixation case, weight bearing was delayed until the bone was united. In contrast with arthroplasty, immediate weight bearing as tolerated was allowed. Patients were often discharged on the third day postoperative when no early complication was detected. A follow-up plan was arranged for two weeks, one month, three months, six months and yearly afterward. Mostly, osteoporotic treatments were initiated and adjusted at the outpatient clinic.

Statistical analysis

Continuous variables such as age, time from admission to surgery, length of hospital stay, serum vitamin D and serum calcium were presented as either mean and standard deviation or median and interquartile ranges (IQR). Categorical variables were demonstrated as frequency and percentage. The differences between continuous data were evaluated using a simple linear regression model or the Wilcoxon rank sum test. Moreover, the chi-square test assessed the differences between categorical variables. Mortality rates between the prepandemic and pandemic periods were compared using survival analysis with the Cox regression model and reported as incidence rate, hazard ratio (HR), adjusted HR and Kaplan-Meier survival curve. Age group, Charlson comorbidity index and early surgery were used to adjust HR due to meaningful clinical signs and associated with mortality rate. Vitamin D status and urinary tract infections were also used to adjust HR due to statistically significant baseline characteristics. Statistical significance was defined as a *p*-value <0.05. All statistical analyses were performed using STATA, Version 15.0 (College Station, TX, USA: StataCorp LLC.)

Results

This study included patients with osteoporotic hip fractures between May 2019 and February 2021. No patient in this study had positive SARS-CoV-2 during hospitalization. The demographic data are described in **Table 1**, with a total number of 813 patients; the prepandemic period had a slightly higher number of 444 patients while the pandemic consisted of 369. In addition, the mean age of patients in the prepandemic group was somewhat older compared with the pandemic group. The highest prevalence of comorbidities was seen in hypertension, followed by type II diabetes mellitus with no significant difference between the prepandemic and pandemic groups regarding all factors.

The proportion of patients undergoing operative treatment was similar in prepandemic and pandemic intervals. The mean time from admission to surgery was 7.04 days in the pre-pandemic season, which was substantially delayed in the pandemic season (8.07 days) with statistical significance ($p<0.01$). Concerning time-to-surgery, the difference was 24.85 hours longer in the pandemic period (95% CI = 6.97 to 42.74). Achieving early surgery was found in 7.23% of patients during the prepandemic period and declined to 3.77% during the pandemic, but without statistical significance. Complications were also noted, and the number of patients with urinary tract infections significantly subsided during the prepandemic. Other postoperative complications did not differ in both groups. The median total hospital length of stay in the prepandemic period was shorter (11 days), orresponding to the pandemic period (12 days) with statistical significance ($p= 0.02$).

Table 1. Demographic data of enrolled participants

Factors	Pre-COVID-19 pandemic (N=444)	COVID-19 pandemic (N=369)	*p*-value
Sex, n (%)			
- Male	96 (21.62%)	91 (24.66%)	0.31
- Female	348 (78.38%)	278 (75.34%)	
Age, mean (SD)	80.08 (8.34)	79.87 (8.39)	0.72
Age group, n (%)			
- <80 years old	185 (41.67%)	155 (42.01%)	0.92
- ≥80 years old	259 (58.33%)	214 (57.99%)	
Comorbidity, n (%)			
- HT	267 (60.14%)	242 (65.58%)	0.11
- DM	126 (28.38%)	108 (29.27%)	0.78
- DLP	102 (22.97%)	95 (25.75%)	0.36
- CKD	61 (13.74%)	48 (13.01%)	0.76
- Heart disease	43 (9.68%)	49 (13.28%)	0.11
- Asthma/COPD	36 (8.11%)	21 (5.69%)	0.18
- Stroke	56 (12.61%)	43 (11.65%)	0.68
Charlson comorbidity index, n (%)			
- 1 - 3	88 (19.82%)	86 (23.31%)	0.17
- 4 – 6	317 (71.40%)	241 (65.31%)	
- ≥7	39 (8.78%)	42 (11.38%)	
Diagnosis, n (%)			
- Extracapsular	279 (62.84%)	252 (68.29%)	0.10
- Intracapsular	165 (37.16%)	117 (31.71%)	
Treatment, n (%)			
- Conservative	126 (28.38%)	104 (28.18%)	0.95
- Surgery	318 (71.62%)	265 (71.82%)	
Surgery, n (%)			
- Fixation	201 (63.21%)	180 (67.92%)	0.23
- Arthroplasty	117 (36.79%)	85 (32.08%)	

Table 1. Demographic data of enrolled participants (Cont.)

Factors	Pre-COVID-19 pandemic (N=444)	COVID-19 pandemic (N=369)	*p*-value
Type of surgery, n (%)			
- Dynamic hip screw	15 (4.72%)	11 (4.15%)	
- Cephalomedullary nail	188 (59.12%)	167 (63.02%)	
- Multiple screws fixation	5 (1.57%)	2 (0.75%)	
- Hemiarthroplasty	54 (16.98%)	69 (26.04%)	
- Total hip arthroplasty	56 (17.61%)	16 (6.04%)	
Time from admission to surgery (day), mean (SD)	7.04 (4.15)	8.07 (5.01)	0.01*
Early surgery (within 48 hr), n (%)	23 (7.23%)	10 (3.77%)	0.07
Complications, n (%)			
- Pressure sore	22 (4.95%)	9 (2.44%)	0.06
- UTI	51 (11.49%)	63 (17.07%)	0.02*
- Pneumonia	39 (8.78%)	29 (7.86%)	0.64
- DVT	3 (0.68%)	3 (0.81%)	0.82
- PE	12 (2.70%)	10 (2.71%)	0.99
- Delirium	57 (12.84%)	44 (11.92%)	0.69
- Wound infection	4 (0.90%)	2 (0.54%)	0.55
LOS (day), median (IQR)	11 (8, 15)	12 (8, 17)	0.02*

HT = Essential hypertension, DM = Type II diabetes mellitus, DLP = Dyslipidemia CKD = Chronic kidney disease, COPD = Chronic obstructive pulmonary disease, UTI = Urinary tract infection, DVT = Deep vein thrombosis, PE = Pulmonary embolism

The mean serum 25(OH)D level of patients in the prepandemic group was 31.99 ng/ml and 28.19 ng/ml in the pandemic group (p<0.01). The vitamin D level was 3.80 ng/ml lower in the pandemic group (95% CI =1.98-5.61). Most patients in the prepandemic group had sufficient vitamin D (53.59%). During the pandemic, the number of patients with sufficient vitamin D levels declined and the number of those with insufficient vitamin D rose remarkably (26.79 and 38.83%, respectively, p <0.01) (**Table 2**). The mean serum calcium level was similar among both groups (9.29 and 9.23 mg/dl, respectively).

The Kaplan-Meier survival curve in **Figure 1** shows the overall mortality rate and one-year mortality rate, i.e., 21.17% in the prepandemic and 24.93% in the pandemic groups. The results showed that the COVID-19 pandemic period exhibited a slightly increased patient mortality rate but failed to reach statistical significance (HR 1.14, 95% CI=0.90-1.45) (**Table 3**). The serum 25(OH)D insufficient and deficient levels also did not significantly affect the mortality rate (1.12, 95% CI = 0.86-1.46 and 1.03, 95% CI = 0.76 to 1.40, respectively).

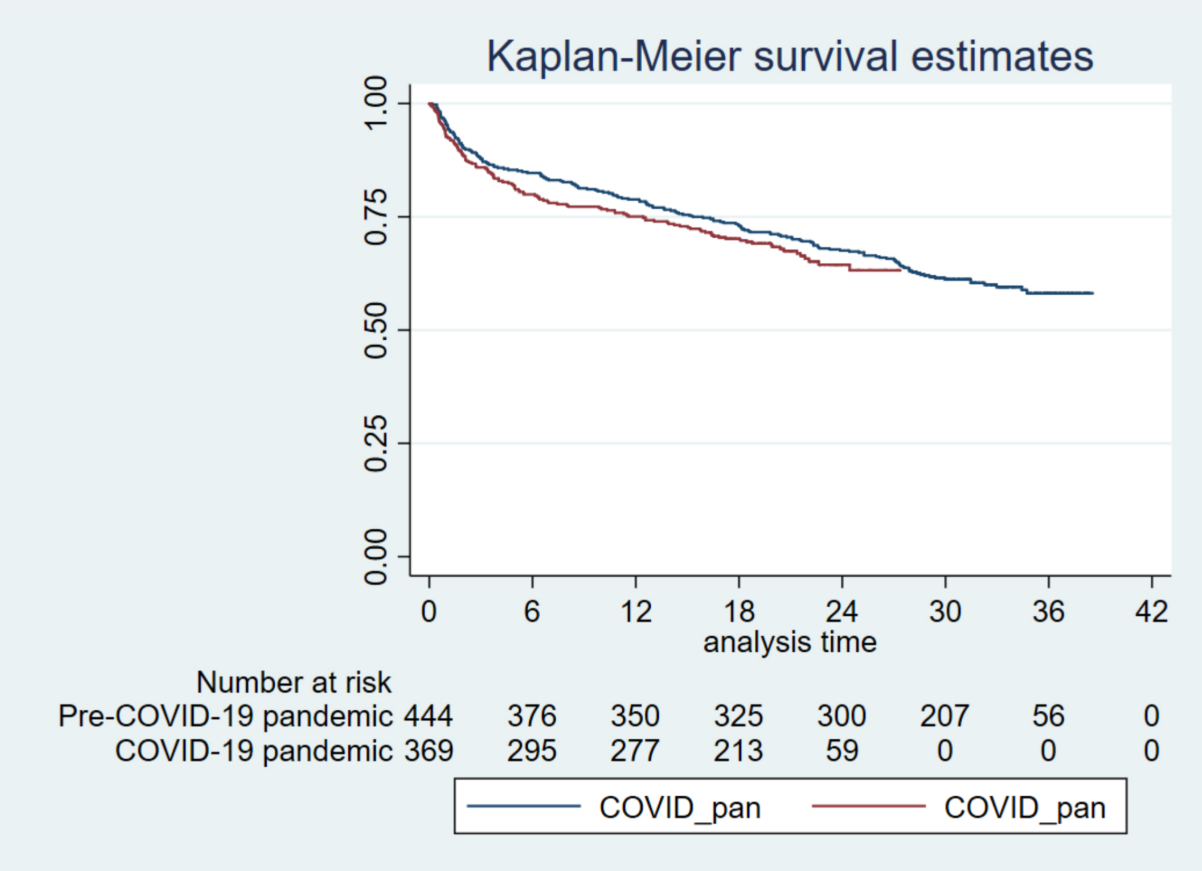

Figure 1. Kaplan-Meier survival curve

Table 2. Serum 25(OH)D and serum calcium level between prepandemic and pandemic groups

	Pre-COVID-19 pandemic (N = 418)	**COVID-19 pandemic (N= 358)**	***p*-value**
Serum 25(OH)D level, mean (SD)	31.99 (13.83)	28.19 (11.59)	<0.01*
Vitamin D status, n (%)			
- Sufficiency	224 (53.59%)	133 (37.15%)	
- Insufficiency	112 (26.79%)	139 (38.83%)	<0.01*
- Deficiency	82 (19.62%)	86 (24.02%)	
Serum calcium, mean (SD)	9.29 (0.46)	9.23 (0.69)	0.12

Discussion

Our study compared the baseline characteristics and treatment outcomes between COVID-19 prepandemic and pandemic periods. Our primary outcome was the mortality rate, as illustrated in **Figure 1**. The prepandemic period one-year mortality rate was 21.17% compared with 24.93% during the pandemic. Compared with the study in our hospital before the FLS Program was adopted, the one-year mortality rate of patients with osteoporotic hip fractures was 29.33%.[8] Shiga et al. revealed that an operative delay of more than 48 hours from the time of admission increased the odds of 30-day mortality by 41% and of one-year mortality by 32%.[9] Due to limitations during the COVID pandemic, the percentage of patients receiving early surgery within 48 hours was only 3.77% compared with 7.23% in the prepandemic period. This limitation could be one of the factors accounting for

Table 3. Effect of COVID-19 and Vitamin D status on mortality rate

	N	Dead	Person Months	Incidence rate	HR (95%CI)	Adjusted HR (95%CI)
COVID-19 status						
- Pre-COVID-19 pandemic	444	177	10,884.93	0.016	Ref.	Ref.
- COVID-19 pandemic	369	123	6,132.90	0.020	1.14 (0.90-1.45)	1.08 (0.76-1.54)**
Vitamin D status						
- Sufficiency	357	130	7,785.77	0.017	Ref.	Ref.
- Insufficiency	251	97	5,081.87	0.019	1.12 (0.86-1.46)	1.19 (0.82-1.72)***
- Deficiency	168	59	3,344.73	0.018	1.03 (0.76-1.40)	0.98 (0.64-1.50) ***

**Adjusted for Age group, Charlson comorbidity index, Early surgery, Vitamin D status, and UTI

*** Adjusted for Age group, Charlson comorbidity index, Early surgery, COVID-19 pandemic status and UTI

the higher mortality rate compared with other studies. Nevertheless, after all the concerned variables were analyzed, the mortality rate did not show statistical significance between the two groups (adjusted HR=1.08, 95% CI = 0.76 to 1.54).

The demographic data of fragility hip fractures during the outbreak of COVID-19 have been reviewed in many different countries. They all agreed that the mean patients' age was significantly older than that in the nonpandemic group, and the proportion of low energy injuries was notably higher during the pandemic.[10-12] While other studies demonstrated a decrease in total visits to the trauma department and the number of high energy injuries during the lockdown, Nunez et al. revealed the number of osteoporotic hip fractures admitted in the hospital had no significant differences between each period.[13] In contrast, our study demonstrated that the number of patients with osteoporotic hip fractures slightly decreased during the pandemic. The nature of the Asian family could explain this. During the lockdown, younger people tended to spend more time at home. The elderly were taken better care of by their offspring, decreasing their risk of falling. In our study, patients' comorbidity differed slightly between the two periods but failed to reach statistical significance. Age and comorbidities were adopted to determine the Charlson comorbidity index to predict the ten-year mortality of patients. We also considered it a parameter to assess the patient's overall health. In this study, we stratified the Charlson comorbidity index in three subgroups, the score 1 to 3, 4 to 6, and over 6. Most patients fell in the second group with a score of 4 to 6 for prepandemic and pandemic periods. The result correlated to findings from Anusitviwat et al. that the Charlson comorbidity index did not significantly differ in both groups. They also explained that this parameter did not statistically affect the inhospital complications among patients with fragility hip fractures. [14] According to Jarvis et al., during the COVID-19 period, young patients tended to move faster from arrival to surgery because elective surgical cases were postponed and the operating rooms were reserved for urgent and emergency cases.[15] This was not true for geriatric patients who needed more time for assessment and pre-operative management before surgery. During the COVID-19 pandemic, due to the hospital's policy on healthcare professional allocation and other reasons, the number of operative theaters was reduced. Elective operations were suspended because human and nonhuman medical resources were reserved for urgent and emergency cases. Hip fractures were prioritized as urgent cases with a high morbidity and mortality rate. The hospital's pre-operative policy for surgery was altered during the COVID-19 pandemic. In addition to the standard protocols, every patient with a fever or upper respiratory tract symptoms during admission would have requested a new PCR test for SARS-CoV-2 for safety reasons. The surgical procedure would have been postponed until the test showed a negative result, taking at least 8 hours. The surgery was usually preceded by the next day. Moreover, for patients indicating evidence of close contact with patients positive for COVID-19-positive, the surgery must be delayed until the PCR test on the 7th day showed a negative result. Even though we prioritized osteoporotic hip fracture as an urgent case, the pre-operative surgery process during the pandemic still took longer than usual. In our study, the surgery was delayed for approximately 24.89 hours during the pandemic. Our findings were parallel to Narang et al., who reported the increased proportion of patients with hip fractures experiencing a delay in operation during the pandemic period in the UK.[16] Another finding in our study was further extended hospital stays during the pandemic period. The estimated length of hospital stay in the prepandemic period was 11 days versus 12 days during the pandemic (p=0.02). Because surgery was delayed, complications such as urinary tract infections occurred at higher incidences (p=0.02), the hospital stay was subsequently extended.

In agreement with the US Endocrine Society, vitamin D status was defined as sufficiency, insufficiency and deficiency. The sufficiency level was defined as >30-100 ng/mL or >75-200 mol/L, while the insufficiency level was 20 to 30 ng/mL and the deficiency level was <20 ng/mL. Inadequate vitamin D levels accounted for secondary osteoporosis and were found to be related to an increased risk of falling, resulting in fractures.[17-19] During the prepandemic period, most patients had sufficient vitamin D levels (53.59%), while in the pandemic period, the percentage of sufficiency subsided to 37.15% with statistical significance (p<0.01). Most patients in the pandemic group established an insufficiency level (38.83%). Mean serum 25(OH) D level declined by 3.80 ng/mL (95% CI=1.98-5.61).We believe that the social distancing policy hindered people from outdoor activities, involving vitamin D production. Another possible cause was the disruption of healthcare services and medications for noncommunicable chronic diseases, including vitamin D supplements. It has been reported in many countries worldwide that the COVID-19 pandemic vastly affected the overall health system in need of medical personnel and resource allocations. Following the Joint Position Statement on managing patients with osteoporosis, it was presumed that patients had stopped treatment and delayed diagnostic study due to social distancing protocol.[20] Similarly, the National Health Service of England and other studies demonstrated a decrease in outpatient attendance and the use of FRAX and DXA scans during the lockdown.[21-23] Vitamin D deficiency is associated with an increased risk of hip fractures, as reported in related studies.[18] Maintaining a normal serum 25(OH) D level is essential, and this remains challenging for all of us on behalf of healthcare providers. Telemedicine was proposed to keep contact with patients and reduce the interruption of pharmacologic treatment for patients having missed their appointment.[24, 25] Reorganizing the anti-osteoporotic therapy based on the convenient method of administration and duration of action was generally recommended.[26, 27] We adopted this service due to our circumstances, for osteoporosis and especially postfracture follow-ups, to make our patients strictly adhere to osteoporotic medications and supplements. The patients were assessed for their general health conditions by phone calls from the medical staff and their medications would be later sent by mail. We emphasized that chronic diseases should not be understated or dismissed during the pandemic.

This study constitutes the first to compare the one-year mortality rate of nonCOVID patients with osteoporotic hip fractures between the prepandemic and the pandemic periods. Even though our study contained the most prominent study population conducted in a single trauma center in Thailand, several limitations were encountered. Firstly, some information was missing based on the nature of the retrospective study research. Thirty-seven patients did not have the result of serum 25(OH)D level at admission, 26 patients (5.86%) in the prepandemic, and 11 patients (2.98%) in the pandemic group. The analyses of vitamin D and calcium status (**Table 2**) were performed after excluding those 37 patients. Secondly, this study did not address the functional outcomes of both nonoperative and operative treatments, which the COVID-19 pandemic would influence. Additionally, the results may only be generalized for some regions due to the different management policies for nonCOVID diseases. We advocate further multicenter studies in the future.

In the future, if a further COVID-19 pandemic occurs again and because most of the population is vaccinated, we can use only rapid tests to screen for COVID-19 instead of RT-PCR. This will decrease waiting time for surgery and cause early ambulation among patients.

Conclusion

During the COVID-19 pandemic, the number and characteristics of patients with fragility hip fractures remained similar to those in the prepandemic period. Time to surgery was significantly delayed due to the allocation of medical personnel and limited medical resources. The overall mortality rate and one-year mortality rate increased during the pandemic but failed to reach statistical significance. The proportion of patients with insufficient and deficient vitamin D increased significantly. Osteoporosis treatment should be continued to prevent fractures and decrease mortality.

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