




Surgical treatment for fragility hip fractures during the COVID-19 pandemic resulted in lower short-term postoperative functional outcome and a higher complication rate compared to the pre-pandemic period

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Abstract

Summary The COVID-19 pandemic adversely affected the functional outcomes of fragility hip fracture patients. This study revealed a higher in-hospital complication rate and lower postoperative function at 3 months among patients treated during the pandemic. Therefore, modified in-hospital and post-discharge protocols should be developed for implementation during pandemic crisis periods.

Introduction This study aims to investigate the in-hospital complication rate and short-term postoperative functional outcomes of fragility hip fracture (FHF) patients compared between during the COVID-19 pandemic and the same 14-month time period 1 year prior to the pandemic.

Methods Using data from the Siriraj Fracture Liaison Service registry, FHF patients treated during the COVID-19 pandemic (1 March 2020 to 30 April 2021) were time-matched with FHF patients treated during the pre-pandemic period (1 March 2018 to 30 April 2019). We collected the rate of in-hospital postoperative complications and the postoperative functional outcomes at discharge and 3 months as measured by the Barthel Index (BI) and EuroQoL visual analog scale (EQ-VAS). Functional outcome measures were compared between the pre-pandemic and pandemic periods.

Results There were 197 and 287 patients in the pre-pandemic and pandemic groups, respectively. At the 3-month postoperative follow-up, the mean postoperative BI score and change in BI score were both significantly lower in the pandemic group indicating poorer postoperative function. Moreover, FHF patients treated during the pandemic had significantly more in-hospital complications (36.6% vs. 22.8%, $p=0.002$). There was no significant difference in the 3-month EQ-VAS or change in the EQ-VAS between groups.

Conclusion The results of this study revealed a higher in-hospital complication rate and lower postoperative function at 3 months among FHF patients treated during the COVID-19 pandemic compared to the pre-pandemic period. Therefore, modified in-hospital and post-discharge protocols should be developed for implementation during pandemic crisis periods.

Keywords COVID-19 pandemic · Fragility hip fracture · In-hospital complication · Pre-pandemic · Short-term functional outcomes

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has disrupted healthcare systems, including orthopedic services [1]. Many elective/non-urgent procedures were postponed or cancelled to prevent disease transmission and to reserve hospital capacity for COVID-19-infected patients [2]. Urgent procedures, including surgical treatment for geriatric hip fracture, were also affected due to a shift in resources toward

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COVID-19 patient care, which resulted in reduced operating room capacity and personnel [3]. Since the volume of fragility hip fracture (FHF) patients remained unchanged during the COVID-19 pandemic [4], changes to the care program for patients with FHF during a pandemic crisis period are needed.

During the COVID-19 pandemic, FHF management was dramatically changed in many aspects. For instance, the time from arrival to operation significantly increased for COVID-19-infected patients, resulting in delaying hip surgery, which can contribute to reduced functional outcomes, increased postoperative complications, and increased mortality [5, 6]. Moreover, the length of hospital stay (LOS) tended to decrease during the outbreak period in order to minimize cross-infection and to create sufficient bed capacity [7]. For these reasons, patients undergoing FHF surgery had less time for inpatient rehabilitation, which may impact functional recovery. Social isolation and the lockdown policy also may have adversely impacted patient rehabilitation [8]. Proper postoperative rehabilitation is essential for restoring patient function to preoperative level [9]. Although several studies have investigated various effects of the COVID-19 pandemic on FHF management, no study has reported functional outcomes following FHF surgery during this pandemic era.

Accordingly, the aim of this study was to investigate the in-hospital complication rate and short-term postoperative functional outcomes of FHF patients compared between the COVID-19 pandemic period and the same 14-month time period 1 year prior to the pandemic.

Methods

This retrospective study enrolled FHF patients who underwent surgical fixation/hip arthroplasty at the Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. Patient data collected from the Siriraj Fracture Liaison Service (FLS) registry during 2018–2021 were reviewed. Patients aged ≥ 50 years with ≥ 3 months of follow-up were included. Patients with multiple fractures, who received conservative treatment, or who had insufficient data at baseline and/or the 3-month follow-up were excluded. Patients were categorized to either the pre-pandemic group or pandemic group. Since the COVID-19 pandemic erupted in Thailand during March 2020 [10], the pandemic group comprised FHF patients admitted to our center during 1 March 2020 to 30 April 2021. The pre-pandemic/control group comprised FHF patients admitted to our center during 1 March 2018 to 30 April 2019. The protocol for this study was approved by the Siriraj Institutional Review Board (735/2021). Informed consent was not obtained due to our study's retrospective design.

FHF protocol during pre-pandemic period

If surgical management was decided, we aimed to perform surgery within 48 h after hospitalization in both groups. Each patient was seen by a multidisciplinary care team that included an orthopedist, geriatrician, anesthesiologist, physiatrist, and physical therapist. Acute pain management protocol instruction was provided by an anesthesiologist who specializes in pain management. All operations were performed by orthopedic surgeons who specialize in geriatric FHF treatment. In general, physical therapy was started on postoperative day 1 if surgery was performed in the late afternoon/evening. The standing goal was to initiate physical therapy within 24 h after surgery unless contraindicated.

Following FHF surgery, all patients were enrolled in our center's FLS program. Osteoporosis education and investigation were performed by an FLS nurse coordinator. Patient profile was reviewed by a metabolic bone disease specialist team, and an appropriate anti-osteoporotic agent was recommended if indicated. A fall prevention protocol, including home modification, was developed by this multidisciplinary care team. Once a patient was deemed fit for discharge, an FLS nurse coordinator transferred the postoperative care plan to the treating physicians. Basic exercises and home physical therapy information were given to all patients and caregivers. In addition, a video-based osteoporosis education module that includes fall prevention exercises was given to all patients and caregivers before discharge from the hospital.

FHF during the COVID-19 pandemic

During the pandemic, FHF patients received the standard FHF protocol with some modifications. First, all FHF patients were initially admitted to an isolation unit and were screened for COVID-19 infection via nasopharyngeal swab and polymerase chain reaction (PCR) test. If SARS-CoV-2 was not detected, patients were transferred to a general orthopedic unit. If SARS-CoV-2 was detected, patients were transferred to a COVID-19 special unit. In COVID-19-infected patients requiring FHF surgery, the procedure was performed in a separate, negative-pressure operating room. All personnel wore full personal protective equipment and strictly followed the surgical treatment protocol proposed by the Centers for Disease Control and Prevention [11]. Second, during the perioperative period, only the minimum number of necessary staff was maintained to limit exposure potential. All interactions were minimized, and telephone interview was used for medical assessment, consultation, and medical reconciliation when possible. Third, only one family member/caregiver was allowed to stay with the patient. Regarding the postoperative physical therapy protocol, all patients received daily bedside therapy with a

focus on early ambulation. Patients were instructed to perform home physical therapy and were discharged as soon as all ambulation and discharge criteria were satisfied. Similar to the pre-pandemic period, home-based physical therapy information, including osteoporosis education and fall prevention exercises, was given to all patients and caregivers.

Outcome measurement

Patient data, including age, gender, body mass index (BMI), side of the operation, Charlson comorbidity index (CCI), pre-injury ambulatory status, fracture location, time from injury to admission, and time from admission to surgery, were collected. Pre-injury ambulatory status was categorized, as follows: non-ambulatory, ambulatory with wheelchair, ambulatory with walker, ambulatory with any type of cane, or ambulatory without assisting device [12]. Collected perioperative data included operative time, estimated blood loss (EBL), type of implant, LOS, and the number of patients who received osteoporosis treatment within 3 months after discharge.

Our primary outcomes were functional outcome measures (Barthel Index (BI), and EuroQol visual analogue scale (EQ-VAS)) at 3 months post-treatment. The secondary outcomes were in-hospital and 3-month postoperative mortality and in-hospital postoperative complications. Mortality information was collected from medical records and telephone interviews. All outcome measures were compared between the pre-pandemic and pandemic periods.

Barthel Index (BI)

The BI is a tool for assessing a person's ability to physically perform activities of daily living (ADLs) [13]. This tool consists of 10 ADL- or mobility-related items. Each item is rated from 1 to 10. A higher score (maximum 100) indicates better functional ability and a greater likelihood of living independently at home after hospital discharge. The BI was validated for its ability to reliably evaluate hip fracture patients [14].

EuroQol visual analogue scale (EQ-VAS)

The EQ-VAS is a patient-rated tool to assess health status that ranges from 0 to 100 points, with a higher score indicating better health status and vice versa [15]. The reliability of the EQ-VAS was validated in older adults with hip fractures [16].

Statistical analysis and sample size calculation

The sample size was calculated based on the estimated mean BI score of community-dwelling older adults [17]. Machón

et al. reported a mean BI score of 96.6 ± 4.7 during the pre-pandemic period and a mean BI score of 91.8 ± 11.1 during the COVID-19 lockdown period [17]. Based on a probability of a type I error of 0.01, a type II error of 20%, and a ratio of 1:1, at least 74 patients per group was required. That value was then increased by 10% to compensate for missing/inadequate data. Although that resulted in a minimum total study enrollment of 164 patients, we collected data from as many patients as possible from our FLS registry in order to minimize selection bias.

R software version 4.0.3 (The R Foundation for Statistical Computing, 2020, Vienna, Austria) was used for statistical analysis. Each outcome measure was assessed for normality using the Shapiro–Wilk test. Data are presented as mean \pm standard deviation for continuous variables and as number and percentage for categorical variables. Patient characteristics, operative information, postoperative complications, mortality rates, and functional outcomes between the pandemic and pre-pandemic groups were analyzed using two-sample *t* test, Wilcoxon rank-sum test or chi-square test were also used as appropriate. Multiple linear regression and multiple binary logistic regression were performed to identify factors significantly associated with BI score at 3-month post-hip fracture treatment and in-hospital complications, respectively. The results of multiple linear regression analysis are reported as regression coefficient (*b*), standard error (SE), and *p* value. The results of multiple logistic regression analysis are given as adjusted odds ratio (OR), 95% confidence interval (95%CI), and *p* value. A *p* value < 0.05 was considered statistically significant for all tests.

Results

A total of 197 and 287 patients in the pre-pandemic and pandemic groups, respectively, who had complete hospital discharge (baseline) and 3-month follow-up data were included in the final analysis (Fig. 1). Patient characteristics compared between groups are shown in Table 1. The average age was 79.3 ± 9.1 years, and 76.2% were female. Patients in the pandemic group were significantly older (80.2 vs. 77.9 years, respectively; $p < 0.001$). Duration from injury to hospital admission was significantly longer in pre-pandemic patients (2.7 ± 4.4 vs. 2.2 ± 7.1 days, respectively; $p = 0.008$).

Concerning perioperative data, the total operative cases during the pre-pandemic and pandemic periods were 5695 and 4855 cases, respectively. When calculated the number of cases per each faculty staff (cases/staff ratio), the ratio was markedly higher during the pre-pandemic period (158.2 and 127.8 cases per each faculty staff member during the pre-pandemic and pandemic, respectively) (Supplementary Table 1). Significantly more patients in the pandemic group received surgical treatment within 48 h after hospital

Fig. 1 Flow diagram of patient enrollment and the flow of patients in this study

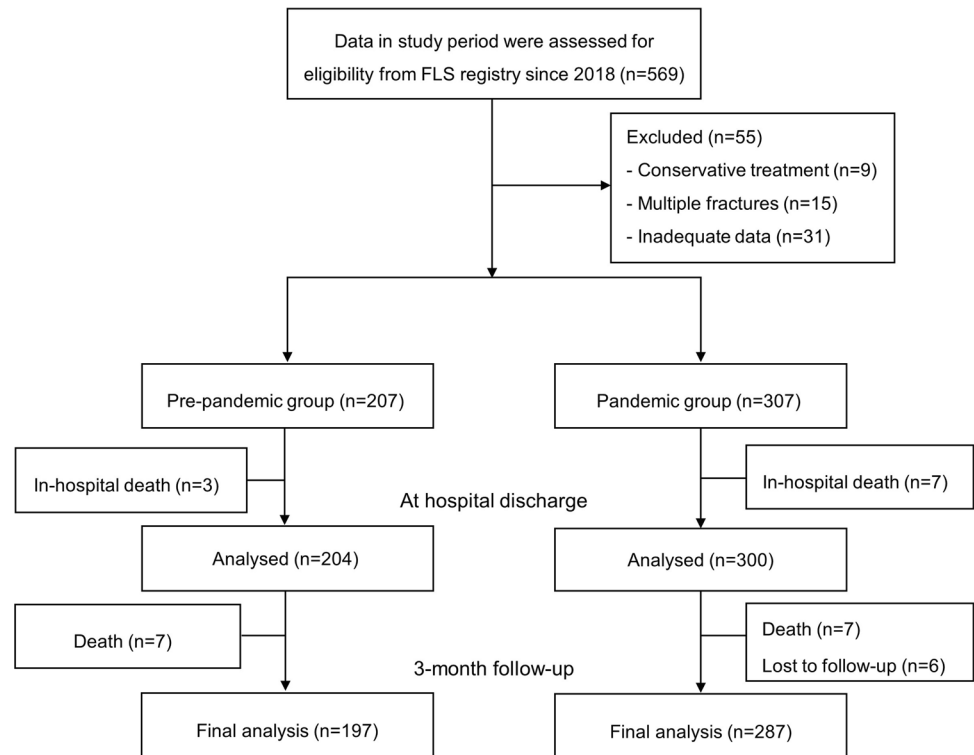


Table 1 Preoperative patient characteristics compared between the pre-pandemic and pandemic groups

Characteristics	Pre-pandemic (n = 197)	Pandemic (n = 287)	p value
Age (years)	77.9 ± 8.9	80.2 ± 9.1	< 0.001
Female gender	146 (74.1%)	223 (77.7%)	0.422
Right side	88 (44.7%)	133 (46.3%)	0.787
Body mass index (kg/m ²)	22.8 ± 4.1	22.3 ± 4.0	0.234
Charlson comorbidity index			0.763
0–3	41 (20.8%)	50 (17.4%)	
4–5	106 (53.8%)	161 (56.1%)	
6–7	41 (20.8%)	65 (22.6%)	
>7	9 (4.6%)	11 (3.8%)	
Pre-injury ambulatory status			0.116
Non-ambulatory	0 (0.0%)	4 (1.4%)	
Ambulatory with a wheelchair	1 (0.5%)	9 (3.1%)	
Ambulatory with a walker	35 (17.8%)	47 (16.4%)	
Ambulatory with a cane	49 (24.9%)	77 (26.8%)	
Ambulatory without an assisting device	112 (56.8%)	150 (52.3%)	
Time to admission (days)	2.7 ± 4.4	2.2 ± 7.1	0.008
Location of fracture			0.065
Femoral neck	106 (53.8%)	132 (46.0%)	
Intertrochanteric	90 (45.7%)	144 (50.2%)	
Subtrochanteric	1 (0.5%)	11 (3.8%)	

Data presented as mean ± standard deviation or number and percentage

A p value < 0.05 indicates statistical significance

Table 2 Perioperative data compared between the pre-pandemic and pandemic periods

Perioperative data	Pre-pandemic (<i>n</i> = 197)	Pandemic (<i>n</i> = 287)	<i>p</i> value
Number of patients whose time to surgery was within 48 h after hospital admission	142 (72.1%)	242 (84.3%)	0.002
Operative time (minutes)	76.3 ± 31.8	75.0 ± 27.1	0.858
Estimated blood loss (ml)	140.7 ± 91.5	161.1 ± 109.8	0.059
Length of hospital stay (days)	11.1 ± 5.6	9.6 ± 4.1	0.007
Initiation of anti-osteoporosis medication within 3 months	106 (53.8%)	170 (59.2%)	0.275

Data presented in mean ± standard deviation or number and percentage

A *p* value < 0.05 indicates statistical significance

admission (72.1% vs. 84.3%, respectively; *p* = 0.002). The average LOS was 11.1 ± 5.6 and 9.6 ± 4.1 days during the pre-pandemic and pandemic periods, respectively (*p* = 0.007) (Table 2). Thirty-one percent of patients had at least one postoperative complication. Postoperative complications were significantly higher in the pandemic group (36.6% vs. 22.8%, respectively; *p* = 0.002). The incidence of urinary tract infection (UTI) and sepsis/septic shock was significantly higher in the pandemic group (both *p* < 0.03). Among the 17 patients with sepsis/septic shock, 10 (58.8%) cases were related to UTI. Of those 10 patients, 2 and 8 cases were in the pre-pandemic and pandemic groups, respectively. Other causes of sepsis included pneumonia (6 patients and 1 of those had a positive PCR test for SARS-CoV-2) and cholecystitis (1 patient). During the pandemic period, only 1 patient (0.3%) had a positive PCR test for SARS-CoV-2. This 74-year-old woman presented with a femoral neck fracture and a low-grade fever without symptoms of

upper respiratory tract infection. She received hemiarthroplasty at approximately 38 h after admission. Postoperatively, the patient developed bilateral lung infiltration, so dexamethasone and favipiravir were given. Her clinical condition improved and was discharged on postoperative day 15. During the study period, 10 patients died during hospitalization (3 and 7 in the pre-pandemic and pandemic groups, respectively). An additional 14 patients died within the first 3 months after discharge from the hospital (7 deaths in each group). Therefore, a total of 24 deaths occurred during the first 3 months after FHF treatment (10 and 14 deaths in the pre-pandemic and pandemic groups, respectively). There was no significant difference in in-hospital or 3-month mortality between groups (Table 3).

Concerning functional recovery after FHF treatment, the mean BI score improved significantly from discharge/baseline to 3 months postoperatively. There was no significant difference in baseline BI score between groups. However, at

Table 3 Postoperative complications and mortality compared between the pre-pandemic and pandemic periods

Complications and mortality	Pre-pandemic (<i>n</i> = 197)	Pandemic (<i>n</i> = 287)	<i>p</i> value
Occurrence of postoperative complications	45 (22.8%)	105 (36.6%)	0.002
In-hospital complications			
Urinary tract infection	27 (13.7%)	64 (22.3%)	0.024
Pneumonia	10 (5.1%)	13 (4.5%)	0.952
Sepsis/septic shock	2 (1.0%)	15 (5.2%)	0.026
Acute renal failure	5 (2.5%)	9 (3.1%)	0.913
Heart failure	1 (0.5%)	4 (1.4%)	0.653
COPD with exacerbation	0 (0.0%)	1 (0.3%)	1.000
Deep vein thrombosis	1 (0.5%)	2 (0.7%)	1.000
Pulmonary embolism	0 (0.0%)	2 (0.7%)	0.516
Gastrointestinal bleeding	1 (0.5%)	2 (0.7%)	1.000
Acute myocardial infarction	2 (1.0%)	2 (0.7%)	1.000
Stroke	1 (0.5%)	1 (0.3%)	1.000
In-hospital mortality	3 (1.4%)	7 (2.3%)	0.747
3-month mortality	10 (4.8%)	14 (4.6%)	1.000

Data presented as mean ± standard deviation or number and percentage

A *p* value < 0.05 indicates statistical significance

Abbreviation: COPD, chronic obstructive pulmonary disease

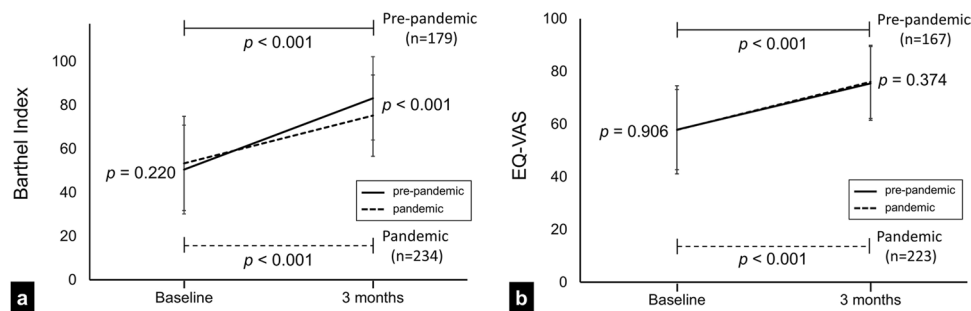


Fig. 2 Mean values of functional outcome measurement by Barthel Index (a) and EQ-VAS (b), within group p values to compare data between baseline and 3 months postoperatively during both the pre-pandemic and pandemic periods, and between group p values at base-

line and 3 months postoperatively. The numbers (n) of patients in each graph indicate the number of patients with complete data at both baseline and 3 months. The data were analyzed by using the t test

Table 4 Multiple linear regression analysis for factors significantly associated with 3-month postoperative Barthel Index score in fragility hip fracture patients

Factors	Barthel Index score at 3 months		
	Coefficient (b)	Standard error	p value
Age	-0.22	0.10	0.034
Body mass index	0.06	0.20	0.764
Charlson comorbidity index	-0.54	0.56	0.331
Independent ambulation before fracture	5.28	1.67	0.002
Time to admission	-0.20	0.17	0.237
Delayed surgery (> 48 h)	-3.15	2.13	0.140
Length of hospital stay	-0.31	0.19	0.099
Baseline Barthel Index score	0.27	0.04	< 0.001
Surgery performed during the pandemic	-9.34	1.70	< 0.001
Occurrence of complications	-1.81	1.89	0.339

A p value < 0.05 indicates statistical significance

the 3-month follow-up, the mean BI score was significantly higher in the pre-pandemic group (83.9 vs. 75.2 points, respectively; $p < 0.001$). Similarly, the mean change in BI score was significantly higher in the pre-pandemic group (32.9 vs. 21.7 points, respectively; $p < 0.001$) (Fig. 2A). The mean EQ-VAS improved significantly after FHF treatment; however, there were no significant difference at baseline, at 3 months, or in the mean change in EQ-VAS between the pre-pandemic and pandemic groups (Fig. 2B).

Our regression analyses to identify clinical variables significantly associated with 3-month postoperative BI score and the occurrence of in-hospital complications revealed age ($b = -0.22$, $p = 0.034$), independent ambulation before injury ($b = 5.28$, $p = 0.002$), baseline BI score ($b = 0.27$, $p < 0.001$), and surgery performed during the pandemic ($b = -9.34$, $p < 0.001$) to be significantly associated with 3-month postoperative BI score (Table 4) and prolonged LOS (adjusted OR, 1.20; 95%CI, 1.13–1.26; $p < 0.001$) and surgery performed during the pandemic (adjusted OR, 2.91; 95%CI, 1.76–4.28; $p < 0.001$) to be significantly associated with the occurrence of in-hospital complications (Table 5).

Table 5 Multiple binary logistic regression analysis for factors significantly associated with the occurrence of in-hospital complications in fragility hip fracture patients

Factors	Occurrence of in-hospital complications	
	Adjusted OR (95%CI)	p value
Age	1.02 (0.99–1.05)	0.177
Body mass index	1.03 (0.97–1.09)	0.303
Charlson comorbidity index	1.09 (0.94–1.27)	0.249
Independent ambulation before fracture	0.86 (0.55–1.34)	0.496
Time to admission	0.99 (0.95–1.02)	0.452
Delayed surgery (> 48 h)	1.45 (0.84–2.50)	0.184
Length of hospital stay	1.20 (1.13–1.26)	< 0.001
Baseline Barthel Index score	1.00 (0.99–1.01)	0.774
Surgery performed during the pandemic	2.91 (1.76–4.82)	< 0.001

A p value < 0.05 indicates statistical significance

Abbreviations: OR, odds ratio; CI, confidence interval

Discussion

The COVID-19 pandemic has disrupted the quality of care in many orthopedic diseases [18]. Due to social isolation and lockdown policies, a number of changes in patient care have emerged [3, 19], including shorter LOS [7] and reduced inpatient rehabilitation [20]. These factors may lead to lower postoperative functional recovery during the pandemic. MacDonald et al. [21] reported worse functional outcomes (Oxford Knee Score, EuroQoL five-domain score) following knee and hip arthroplasty due to limited rehabilitation during social restrictions. The fact that FHF treatment requires a multidisciplinary team approach portends inevitable adverse effect during the pandemic [22]. We found that the pandemic resulted in lower short-term functional outcomes and more complications compared to during the pre-pandemic period.

In contrast to previous studies [23–25], the number of FHF patients at our center was higher during the pandemic period compared to the pre-pandemic period. We postulate that a shortage of beds in primary/secondary care hospitals may have increased the number of referrals to our national tertiary care hospital. Regarding perioperative data, the proportion of FHF patients who underwent surgical treatment within 48 h was significantly greater during the pandemic. This may be due to improved availability of resources due to cancellation/postponement of elective procedures as demonstrated by the substantially reduction in the total number of elective cases and the cases/staff ratio during the pandemic period in our study. Conversely, many previous studies reported a significantly longer waiting time for surgery during the pandemic [26–28]. Reasons for delayed time to surgery include unavailability of the operating room due to reduced staff and operating theater availability, wait time for SARS-CoV-2 test results, and wait for anticoagulant wash-out in order to perform regional anesthesia to decrease the risk of viral contamination from aerosol generation [29]. Similar to previous studies [7, 23, 30], we found a significantly longer mean LOS in the non-pandemic group (11.1 vs. 9.6 days, respectively; $p=0.007$). Efforts to minimize cross-infection and to create sufficient bed capacity for new patients may explain the shorter LOS during the pandemic period.

Interestingly, we found both the mean postoperative BI score at 3 months and the mean change in BI score to be significantly lower in the pandemic group compared to the pre-pandemic group. Possible reasons include limited medical personnel, less intense rehabilitation, and shorter duration of physical therapy sessions. Although the physical therapists still provided physical therapy sessions during the pandemic, the focus of inpatient physical therapy was early ambulation and bedside training (getting in and out of bed and walking for a short distance). This means that any exercises that required direct patient contact were

avoided. Moreover, only one family member/caregiver was allowed to stay with the FHF patient, and this could affect functional recovery since many patients become dependent after FHF and require more caregiver assistance [31]. It is also important to disclose that our center does not routinely provide outpatient rehabilitation to all hip fracture patients. Since our hospital is located in one of the busiest areas of Bangkok, many patients find frequent visits to our center to be quite inconvenient. Alternatively, all patients and family or caregivers were given home physical therapy instruction, including a video-based osteoporosis education and fall prevention exercises. Nevertheless, we believe that in centers/countries where outpatient rehabilitation is routinely provided, the adverse impact on functional recovery after hip fracture treatment would have been greater during the pandemic period compared to the pre-pandemic period.

Similarly, previous study reported inferior functional outcome at 6 months after hip and knee arthroplasty during the pandemic [21]. In contrast, previous studies that investigated functional recovery after surgery of the upper extremities during the pandemic found no significant differences in postoperative functional outcomes when compared to those from patients treated during the pre-pandemic period [32, 33]. This suggests that changes in the rehabilitation protocol and in the patient management policies during the COVID-19 pandemic differently affect functional recovery after different types of surgery. Patients that undergo surgeries that require an intensive postoperative physical therapy program and extra patient support may be more adversely affected by COVID-19-related changes to patient management protocols.

Generally, functional recovery after hip fracture is multifactorial. Previous studies identified several clinical variables that affect functional recovery after hip fracture, including age, pre-injury functional status, pre-fracture comorbidities, cognitive impairment, and depressive symptoms [34–36]. Similar to our results, Cornwall et al. and Martín-Martín et al. reported patient age and pre-injury functional status to be apparent predictors of functional outcomes in hip fracture patients [34, 35]. Nevertheless, it is important to point out that the coefficient of age to predict the 3-month postoperative functional outcome in the study was small ($b = -0.22$, $p = 0.034$), whereas surgery performed during the pandemic was the strongest factor significantly associated with lowered functional recovery after hip fracture ($b = -9.34$, $p < 0.001$). In addition, the mean age difference between the pre-pandemic and pandemic groups was only 2 years, which may not be clinically significant. Therefore, we believe that the difference in mean age between the pre-pandemic and pandemic groups did not substantially contribute to the lowered functional outcome at the 3-month time point among patients in the pandemic group.

Regarding perioperative/postoperative complications, Sugand et al. [37] reported a higher proportion of perioperative/postoperative complications among acute orthopedic surgery patients during the pandemic. The present study had a similar finding. By way of example, the rate of UTI in our study compared between the pre-pandemic and pandemic periods was 27 (13.7%) versus 64 (22.3%) ($p=0.024$). Our overall rate of UTI was 18.8%, which is comparable with the rates reported from previous studies (range, 8.3–24.0%) [23, 38–40]. At our center, we do not routinely record the duration that an indwelling urinary catheter is retained; however, our hip fracture protocol during both the pre-pandemic and pandemic periods was to remove a urinary catheter on postoperative day 2 or when the hip fracture patient can ambulate out of bed. Although the explanation for the increase in complications during the pandemic period remains unclear, we postulate that less personnel and/or personnel spending less time taking care of these patients are likely contributing factors. Further study to understand the cause of the observed significantly increased incidence of in-hospital UTI during the pandemic period is warranted.

The effects of this pandemic are expected to persist for an indeterminate duration, so the development and implementation of innovative techniques to enhance patient care during crisis period are urgently needed. Previous studies demonstrated the benefit of “telemedicine” or “telerehabilitation” to treat various conditions, such as cancer, stroke, heart disease, and FHF treatment [41–44]. Ortiz-Piña et al. [44] and Gao et al. [45] reported the benefit of telerehabilitation for improving postoperative functional status, physical performance, and satisfaction in FHF patients. In addition to telerehabilitation, robotic-assisted rehabilitation could play a part in improving functional outcomes. Rehabilitation robots can detect patient movements and use them to deliver force feedback or to plan future movements. Robots can operate passively (patient-driven), actively (robot-driven), or interactively (resist the forces applied by patients) with patients [46]. Some robots have been developed specifically for home-based settings and have been successfully used to rehabilitate patients suffering from upper and/or lower extremity dysfunction [47]. By integrating robots into the telehealth patient care strategy, patients can perform robotic-assisted exercises while being remotely assessed and supervised by a therapist via an online platform. This allows a single therapist to observe, guide, and assess numerous patients within a defined rehabilitation time period. Ultimately, transitioning from a hospital-based rehabilitation program to a home-based robotic rehabilitation program would be expected to increase the number of treated patients, reduce the workload of therapists and other related health-care professionals, limit contact with therapists, and improve accessibility to rehabilitation during the pandemic-related crisis periods. As such, we encourage all FLS centers to

implement the telehealth patient care strategy as part of their postoperative follow-up and long-term patient care.

The main strength of this study is that it is the first to evaluate postoperative functional recovery of FHF patients during the COVID-19 pandemic. Regarding its limitations, although our study has a retrospective design, the fact that we collected data from our FLS registry minimizes potential biases. Second, this study collected data from only one center in Thailand, and our center is a high-volume hospital with an experienced team, so some aspects of our data/findings may not be generalizable to other centers, including those that provide a less sophisticated level of care. Third, there was only one COVID-19-infected patient (0.3%) in our study, so we could not evaluate the postoperative function of COVID-19-infected FHF patients. Nevertheless, this study aimed to evaluate whether changes in FHF management during the lockdown period affected the postoperative functional recovery of FHF patients. Fourth and last, Thailand experienced three COVID-19 outbreaks during the study period. Since the severity of each outbreak was different [10, 48], the hospital policies specific to each outbreak varied according to the magnitude of events. Although our results indicate a difference in outcomes between the two study periods, we must conclude that we do not yet have sufficiently robust data to draw conclusions regarding the full impact of the COVID-19 outbreak on the functional recovery of FHF patients.

Conclusion

This study revealed a higher in-hospital complication rate and lower postoperative function at 3 months after surgery among FHF patients treated during the COVID-19 pandemic compared to those of patients treated during the pre-pandemic study period. Since the incidence of geriatric hip fractures did not relent during the pandemic, modified in-hospital and post-discharge protocols should be developed for implementation during pandemic crisis periods.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s00198-022-06485-w>.

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Author contribution CA, conceptualization, methodology, investigation, formal analysis, and writing — original draft. EV, conceptualization, methodology, resources, and formal analysis. PC, conceptualization, investigation, and data curation. AU, conceptualization, methodology, formal analysis, writing — review and editing, and supervision. All authors have read and approved the final version of the manuscript to be submitted for journal publication.

Declarations

Ethics approval The protocol and consent forms used in this study were approved by the Siriraj Institutional Review Board (SIRB) of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (COA no. 735/2021).

Consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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