



Hip Fracture Management during the COVID-19 Pandemic in South Korea

Jin Won Chung, MD, Yong-Chan Ha, MD*, Mi-Kyung Lee, MD[†], Jin-Hak Kim, MD*,
Jung-Wee Park, MD[‡], Kyung-Hoi Koo, MD^{‡,§}

Department of Infectious Diseases, Chung-Ang University Hospital, Seoul,

**Department of Orthopaedic Surgery, Chung-Ang University Hospital, Seoul,*

†Department of Laboratory Medicine, Chung-Ang University College of Medicine, Seoul,

‡Department of Orthopedic Surgery, Seoul National University Bundang Hospital, Seongnam,

§Department of Orthopedic Surgery, Seoul National University College of Medicine, Seoul, Korea

Background: The purpose of this study was to introduce a screening system for coronavirus disease 2019 (COVID-19), to evaluate the overall orthopedic management in hip fracture patients during the COVID-19 pandemic in South Korea, and to compare the surgical results in hip fracture patients during the COVID-19 pandemic with those of the previous year.

Methods: Hip fracture patients who visited emergency rooms were screened at the screening clinics before admission. The medical management was carried out with the medical staff wearing surgical masks, meticulous hand hygiene observed, and a minimum distance of 2 m between patients maintained. The demographics, operative parameters, and surgical results of patients treated during the pandemic were compared with those from the previous year.

Results: From January 2020 to July 21, 2020, 119 patients with hip fractures (33 men and 86 women) were admitted to our institution for surgical treatment. Five patients showed symptoms of pneumonia, but no patient was positive for COVID-19. The mortality rate during the study period was 4.2%, and none of the patients died due to COVID-19. The interval between admission and surgery and the length of hospital stay were significantly shorter ($p = 0.008$, $p = 0.002$) and the proportion of spinal anesthesia was greater in hip fracture patients during the COVID-19 pandemic compared to those from the previous year ($p = 0.011$).

Conclusions: The COVID-19 screening system for hip fracture patients has proven to be effective in preventing intrahospital spread of the disease. Hip fracture surgery performed during the COVID-19 pandemic has shown comparable results without any COVID-19 infection and COVID-19-related mortality.

Keywords: COVID-19, Screening, Hip fracture, Treatment outcome

The novel coronavirus disease 2019 (COVID-19) has been rapidly spreading since December 2019, and the first con-

firmed case in South Korea was reported on January 20.^{1,2)} Some sporadic outbreaks occurred mostly among international travelers. However, in the middle of February, a massive outbreak of COVID-19 occurred in the Daegu region, which started with patient number 31 and was followed by nationwide outbreaks.²⁾ As of July 21, 2020, a total of 13,816 confirmed cases, including 296 deaths, were reported in South Korea.³⁾

The number of COVID-19 cases has increased tremendously and threatened the healthcare system including hospitals and public healthcare centers.⁴⁾ University hospitals are at the center of the risk of COVID-19 infections

Received July 20, 2021; Revised September 24, 2021;

Accepted September 24, 2021

Correspondence to: Jung-Wee Park, MD

Department of Orthopedic Surgery, Seoul National University Bundang Hospital,
82 Gumi-ro 173beon-gil, Bundang-gu, Seongnam 13620, Korea

Tel: +82-31-787-7204, Fax: +82-31-787-4056

E-mail: jwepark@snuh.org

Jin Won Chung and Yong-Chan Ha contributed equally to this study as co-first authors.

because those hospitals play a major role in providing medical treatment and surgical interventions to patients in medical emergency due to traffic accidents or other traumatic events. Therefore, screening systems for early detection of COVID-19 infection should be established to prevent intrahospital spread of COVID-19.⁵⁾

Hip fracture in elderly patients is the most common, serious injury and is related to high morbidity and mortality.^{6,7)} Recent studies recommend early surgery to minimize complications such as pressure sores, thromboembolic events, and infections and to prevent delayed rehabilitation, longer hospitalization, and high mortality.^{8,9)} Therefore, it is necessary for elderly patients with hip fractures to be screened for COVID-19 because in case they carry the virus, the closure of wards and emergency rooms (ERs) and quarantine of physicians can be needed. We have been operating a screening system and successfully preventing intrahospital spread of COVID-19 since March 2020.

The purpose of this study was (1) to introduce the operational process of screening clinics for COVID-19, (2) to evaluate the overall orthopedic management of hip fracture patients during the COVID-19 pandemic in South Korea, and (3) to compare the operative parameters and surgical results in hip fracture patients during the COVID-19 pandemic with those of the previous year.

METHODS

The current study was approved by the local Institutional Review Board on October 14, 2020 (IRB No. 2009-002-19330). Informed consent was exempted because of the retrospective nature of the study and no additional harm to the included patients.

Study Population

This prospective design study with retrospective review was conducted with a corresponding patient cohort from the past year used as the control group. We acquired the data of two groups of patients with hip fractures: first group operated from January 2020 to July 21, 2020, and second group from January 2019 to July 21, 2019. Patient demographics (sex, age, height, weight, body mass index, diagnosis, comorbidities, and ambulatory function) and operative parameters (type of surgery and anesthesia, operation time, blood loss, time from admission to surgery, hospital stay, and mortality) were compared between the two groups.

The number of total patients who underwent COVID-19 screening and patients confirmed with COVID-19

from January 2020 to July 21, 2020, was retrieved.

Screening and Transferring Routes during the COVID-19 Pandemic

Our hospital has two buildings (a main building and an attached building) with a total of 845 beds and patients arrive through four main gates—the south and north gates of the main building, entrance to the ER, and a gate in the attached building. We classify patients and visitors based on their purpose of visit, epidemiological risk factors, and symptoms. In front of the south gate and ER gate of the main building, screening clinics were established to acquire respiratory specimens from target patients. We designated the screening clinic in the ER as Screen-1 and the screening clinic in the south gate as Screen-2. The main clinical symptoms include fever ($\geq 37.5^{\circ}\text{C}$), cough, dyspnea, chills, myalgia, headache, sore throat, anosmia, ageusia, and pneumonia. Target patients are defined as symptomatic patients who have domestic epidemiological risk factors, a trip to a foreign country within 14 days, and suspected COVID-19 based on their doctor's opinion. All patients subject to screening are divided into two categories. The first group consists of symptomatic patients who have epidemiologic risk factors including a visit to a foreign or domestic COVID-19 risk area within 14 days or patients with symptoms that developed during self-isolation. They are all screened at Screen-1. The second group consists of symptomatic patients without epidemiologic risk factors and patients who are scheduled for admission, procedures, or ambulatory surgery. These patients are separately evaluated at Screen-2. Patients in these screening clinics undergo two nasopharyngeal swabs and one oropharyngeal swab to obtain respiratory specimens. Real-time polymerase chain reaction (RT-PCR) tests for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are performed with these specimens, and results are obtained within five hours.

At all the four gates, security personnel monitor all visitors' body temperature with thermal imaging cameras. Everyone, including medical staff, is required to fill out a questionnaire (Supplementary Fig. 1) prior to entering the building. The medical staff at the entrance receives the questionnaires and categorize all visitors into four groups. Only patients who do not show COVID-19-related symptoms and have no epidemiologic risk factors are directly permitted to enter the hospital for standard outpatient clinic consultation. If a patient does not present with any COVID-19 symptoms but reported epidemiologic risk factors, the medical staff at the questionnaire area calls the infection control team, and the patient has to be self-iso-

lated. If a patient shows clinical symptoms of COVID-19 but does not have any epidemiologic risk factors, the patient is classified as group 2 and allocated to Screen-2 with notification to the infection control team. If a patient has both COVID-19 symptoms and epidemiologic risk factors, the patient is classified into group 1 and sent to Screen-1 after notifying the infection control team. If COVID-19 is diagnosed in a patient from the ER, outpatient clinic, or screening clinic, the patient is moved from Screen-1 or Screen-2 to the first floor of the attached building via the outdoor path. Then the patient uses a separate elevator with an outdoor entrance to the eighth floor where the ward for COVID-19 patients is located.

Most hip fracture patients came through the ER route as they were mostly brought to the ER by an ambulance due to ambulation difficulty. If patients had fever or respiratory symptoms, they were isolated in a quarantine ward in the ER. When the evaluation and emergency treatment at the ER was finished, all patients scheduled for admission were screened for COVID-19 at Screen-1. When they were cleared with negative results of the screening tests, they were then transferred to the orthopedic ward located on the thirteenth floor of the main building. All beds on both the attached building and the main building were placed at a minimum distance of 2 m from each other.¹⁰⁾

The routes of patients from the questionnaire area to the screening clinic and the specific ward are presented in

Fig. 1. The outdoor routes passing the exterior of the main building are the east and west routes. Confirmed COVID-19 patients only use the west routes to the secluded elevator with the entrance outside the attached building. The west route is disinfected every time a confirmed patient is moved and admitted to the ward.

Perioperative Considerations

Preoperative medical management of hip fracture patients was carried out in the same manner as before the COVID-19 breakout to prevent pneumonia, deep vein thrombosis, pulmonary embolism, and pressure sore, but every patient, caretaker, and medical staff used surgical masks with meticulous hand sanitation.

As it is known that the risk of pulmonary complications is greater with general anesthesia than with regional anesthesia, we tried to use spinal anesthesia whenever possible for hip fracture surgery.¹⁰⁾ In all cases, surgery was performed in normal positive-pressure rooms by the participating staff wearing standard surgical attire with string hoods. Postoperatively, all patients were transferred to the wards after the vital signs stabilized in the post anesthesia care unit.

Routine follow-up visits were scheduled for 2 weeks, 6 weeks, 3 months, 6 months, 12 months, and every 12 months thereafter before the COVID-19 pandemic. During the study period, we scheduled the follow-ups at 4–6

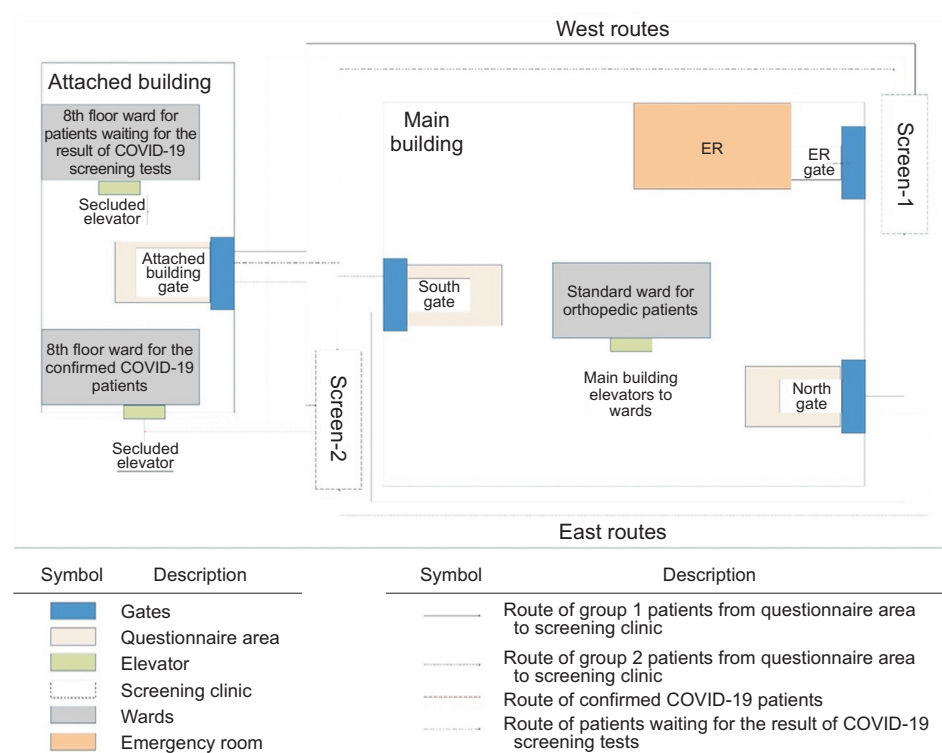


Fig. 1. Intrahospital patient transfer routes during the coronavirus disease 2019 (COVID-19) pandemic. ER: emergency room.

weeks, 3 months, and 12 months to minimize the risk of COVID-19 infection.

RESULTS

Patient Demographics

Between January 2020 and July 21, 2020, 119 patients with hip fractures were admitted at our institution for surgical treatment. There were 33 men and 86 women with a mean age of 78.1 years (range, 41–102 years) in the first group. The most common diagnosis was femoral neck fractures (60 patients), followed by intertrochanteric fractures (58 patients) and a subtrochanteric femoral fracture (1 patient). The number of patients capable of outdoor ambulation was 101 (85%). The severity of comorbidity was evaluated using the American Society of Anesthesiologists (ASA) score: classes 1 and 2 were categorized as the groups of relatively healthy patients, while classes 3 to 5 were classified as the groups with severe comorbidities. There were 48 patients (40%) with severe comorbidities among the study patients (Table 1).

In the second group, 115 patients were included as the hip fracture patients operated from January 2019 to July 21, 2019. Although the number and percentage of patients with severe comorbidities was significantly greater in hip fracture patients of 2019 than those of 2020 (62 [54%] vs. 48 [40%], $p = 0.037$), patient demographics showed similar characteristics (Table 1). The most common diagnosis in the second group was intertrochanteric

fractures (63 patients), followed by femur neck fractures (47 patients) and subtrochanteric fractures (5 patients).

Between January 2020 to July 2020, 9,592 patients were screened for COVID-19 in our hospital and four patients were diagnosed with COVID-19. Among the four diagnosed patients, there were no hip fracture patients. Among the 119 patients with hip fractures, five patients were diagnosed with pneumonia at the time of admission, but none of the patients showed positive results upon COVID-19 screening.

The most common surgical procedure in the first group was bipolar hemiarthroplasty (71 patients), followed by intramedullary nailing (18 patients), closed reduction and internal fixation of proximal femur (16 patients), and total hip arthroplasty (14 patients). The most common surgical procedure in the second group was bipolar hemiarthroplasty (75 patients), followed by intramedullary nailing (21 patients), closed reduction and internal fixation of proximal femur (13 patients), and total hip arthroplasty (6 patients) (Table 2). All operations in both groups were performed by a single high-volume hip surgeon (YCH).

Treatment Outcomes

The mean time of operation and estimated blood loss in the first group were 70.5 ± 24.4 minutes (range, 20–170 minutes) and 152.7 ± 152.3 mL (range, 10–1,500 mL), respectively, which showed no significant difference compared to the previous year. The mean interval between admission and surgery and the length of admission were

Table 1. Comparison of Demographic Features between Two Groups

Variable	2020 (n = 119)	2019 (n = 115)	p-value
Age (yr)	78.1 ± 11.4 (41–102)	78.9 ± 11.0 (32–100)	-
Sex (male : female)	33 (28) : 86 (72)	30 (26) : 85 (74)	0.777
Height (cm)	157.8 ± 8.5 (138.0–182.0)	157.2 ± 9.5 (130.0–180.0)	0.216
Weight (kg)	56.2 ± 10.9 (33.5–84.0)	54.7 ± 11.1 (30.5–80.0)	0.460
BMI (kg/m ²)	22.5 ± 3.6 (12.7–32.9)	22.0 ± 3.5 (15.6–30.7)	0.656
Outdoor ambulatory	101 (85)	93 (81)	0.416
Severe comorbidity (ASA score ≥ 3)	48 (40)	62 (54)	0.037
Diagnosis			0.112
Femur neck fracture	60 (50)	47 (41)	
Intertrochanteric fracture	58 (49)	63 (55)	
Subtrochanteric fracture	1 (1)	5 (4)	

Values are presented as mean ± standard deviation (range) or number (%). BMI: body mass index, ASA: American Society of Anesthesiologists.

Table 2. Comparison of Surgical Parameters between Two Groups

Variable	2020 (n = 119)	2019 (n = 115)	p-value
Operation time (min)	70.5 ± 24.4 (20–170)	68.2 ± 28.6 (25–185)	0.379
Blood loss (mL)	152.7 ± 152.3 (10–1,500)	142.8 ± 104.5 (10–800)	0.204
Spinal anesthesia	61 (51)	40 (35)	0.011
Interval between admission and surgery (day)	2.2 ± 2.9 (0–21)	3.2 ± 6.9 (0–55)	0.008
Length of admission (day)	14.6 ± 9.8 (2–51)	23.9 ± 19.4 (2–126)	0.002
Type of surgery			0.286
BHA	71 (60)	75 (65)	
IMN	18 (15)	21 (18)	
CRIF	16 (13)	13 (12)	
THA	14 (12)	6 (5)	

Values are presented as mean ± standard deviation (range) or number (%).

BHA: bipolar hemiarthroplasty, IMN: intramedullary nailing, CRIF: closed reduction and internal fixation, THA: total hip arthroplasty.

Table 3. Clinical Features of the Deceased Patients in the First Group

Age (yr)	Sex	Date of surgery	Type of surgery	ASA score	Anesthesia	Day from operation to death	Cause of death
75	Male	Feb 23, 2020	IMN	2	General	30	Renal cell carcinoma
80	Male	Apr 1, 2020	IMN	2	General	72	Myocardial infarction
77	Male	Apr 20, 2020	BHA	3	Spinal	28	Pneumonia
88	Female	May 4, 2020	BHA	3	Spinal	9	Heart failure
80	Female	Jun 16, 2020	BHA	2	General	12	Myocardial infarction

ASA: American Society of Anesthesiologists, IMN: intramedullary nailing, BHA: bipolar hemiarthroplasty.

both significantly shortened in the first group ($p = 0.008$ and $p = 0.002$, respectively) (Table 2). The percentage of patients undergoing spinal anesthesia was substantially greater in the first group ($p = 0.011$) (Table 2). Among the 119 patients treated for hip fractures in the first group, five patients died between January 2020 and July 2020. Among the deceased patients, pneumonia was the cause of death in only one patient, which had been diagnosed upon admission. The causes of death in the other patients were renal cell carcinoma, myocardial infarction, and heart failure. None of the patients was diagnosed with COVID-19 before or after the surgery. The clinical features of the deceased patients are presented in Table 3. The overall mortality rate of the hip fracture patients during the COVID-19 pandemic was 4.2%. The comparison between the high morbidity group (ASA score ≥ 3) and the low morbidity group (ASA score < 3) or the comparison among

diagnoses, type of surgery, type of anesthesia, and ambulatory function showed no significant statistical difference in mortality rates.

In the second group, which represents the hip fracture cohort from the previous year, four patients died between January 2019 and July 2019. The cause of death in those patients were rectal cancer in one patient, bladder cancer in one patient, and heart failure in two patients. No patient died of pneumonia. The mortality rate in the second group was 3.4%, which was not significantly different from that in the first group ($p = 0.521$).

DISCUSSION

In this study, we presented a COVID-19 screening system of a single tertiary hospital applied to hip fracture patients who mostly arrived at the hospital through the ER.

Through this thorough screening system, four patients were diagnosed with COVID-19, and there were no hip fracture patients among them. During the study period, the 119 patients treated for hip fractures using a COVID-19 screening system and screening procedure experienced no surgical delay. In addition, the interval between admission and surgery and the length of hospital stay were significantly shorter and the proportion of spinal anesthesia was greater in hip fracture patients during COVID-19 pandemic compared to those from the previous year. This may be due to the successful implementation of the COVID-19 screening system for hip fracture patients, thereby preventing intrahospital spread of the virus. Furthermore, general anesthesia was less preferred in the COVID-19 pandemic situation because of concerns of the COVID-19 infection, as well as pneumonia, which probably contributed to the increase of spinal anesthesia and consequently shorter hospital stay.

Screening of COVID-19 infection is an important process to prevent intrahospital spread in this pandemic. According to the guideline developed by the International Consensus Meeting on Musculoskeletal Infection, resuming orthopedic surgical procedures requires all patients to be screened for SARS-CoV-2 with thorough history-taking, physical examination, and RT-PCR testing before surgery.¹⁰⁾ This guideline emphasizes the use of personal protective equipment (PPE), RT-PCR as a screening test, quarantine, and deferral of elective surgery in patients with current COVID-19 infection, all of which are consistent with the current protocol of our institution.¹⁰⁾ However, it is crucial for each hospital to consider their unique situations of COVID-19 infection in terms of prevalence of the disease, PPE supply, and personnel capacities. To our knowledge, there has been no report on screening guidelines to proceed with the required operations, minimizing the risk of SARS-CoV-2 infection in the orthopedic field. The screening protocol of our institution introduced in this study could be beneficial in establishing screening guidelines for orthopedic surgery in Korea.

In the current study, the surgical outcomes and parameters of hip fracture patients during the COVID-19 pandemic showed comparable results with reference to the results of those before the pandemic. A previous multicenter prospective cohort study on Korean hip fracture patients reported a mean operation time of 74.1 minutes, estimated blood loss of 247.1 mL, time from admission to surgery of 3.7 days, length of hospital stay of 20.1 days, and mortality of 4.9%.⁷⁾ In the current study, the mean operation time, estimated blood loss, time from admission to surgery, length of admission, and mortality rate were 70.5

minutes, 152.7 mL, 2.2 days, 14.6 days, and 4.2%, respectively.

Previous studies reported a wide range of postoperative mortality of the patients who underwent hip fracture surgery. In a retrospective study of 1,734 patients who underwent hip fracture surgery, the 90-day postoperative mortality rate was 3.5%.¹¹⁾ In another retrospective study of 1,015 patients > 50 years of age who underwent hip fracture surgery, 3-month and 1-year mortality rates were reported to be 14.5% and 22.4%, respectively.¹²⁾ In the present study, the mortality rate of the patients who underwent hip fracture surgery during the COVID-19 pandemic was 4.2%, which was comparable to the previous mortality rates of hip fracture patients. Even when excluding 13 patients under the age of 65 years, the remaining 106 patients displayed a mortality rate of 4.7%. In contrast, the inpatient mortality of hip fracture patients in New York during the COVID-19 pandemic was reported to be 11.9% and the mortality rate was significantly greater in COVID-19-positive patients (56%) than in COVID-19-negative patients (4%).¹³⁾ Similar clinical results were reported during the same period in New York with an overall mortality rate of 12.3%. In this study, the mortality rates of COVID-19-positive, COVID-19-suspected, and COVID-19-negative patients were reported as 35.3%, 7.1%, and 0.9%, respectively.¹⁴⁾ According to another multicenter study conducted in Scotland, the 30-day survival rate was significantly different between the COVID-19-positive and COVID-19-negative groups (64.5% vs. 91.5%).¹⁵⁾

We acknowledge the limitations of this study. First, we screened all patients who were admitted for hip surgery, which could be cost-ineffective. However, by screening all patients who were admitted, we could detect the afebrile, asymptomatic patients who could be infected with SARS-CoV-2 as well. The cost of RT-PCR tests for SARS-CoV-2 vary among countries and regions. As the cost of screening test is approximately 60 dollars in Korea, we considered that the benefits of total inspection outweigh the cost. Second, we could not report the surgical outcome of hip fracture patients who were diagnosed with COVID-19 because there was no COVID-19-infected hip fracture patient in our hospital. To roughly estimate the cumulative number of hip fracture patients among COVID-19-diagnosed patients in Korea, we performed a simple calculation based on previously reported hip fracture incidence data. The cumulative number of COVID-19 patients > 50 years of age on July 21, 2020 was 5,740 in Korea.³⁾ The crude incidence rate of hip fracture patients > 50 years of age in Korea was previously reported

to be 171.3 per 100,000 from 2008 to 2012 in a nationwide claims study¹⁶⁾ and 128.0 per 100,000 from 1998 to 2002 and 183.7 per 100,000 in 2011 in cohort studies.^{17,18)} Even if we approximate the crude incidence rate of hip fracture patients as 200 per 100,000 in 2020, the estimate of hip fracture patients among COVID-19 patients is only about 6 patients for 6 months. Therefore, it could be natural that there was no COVID-19-diagnosed hip fracture patient at our hospital during the study period given that the total number of COVID-19-diagnosed hip fracture patients is as small as 6 patients nationwide. Third, the study was performed in a single tertiary hospital in South Korea. Therefore, our results could not be generalized to other countries. The cost of screening tests shows variations among countries, which is closely related to determining the range of screening. Fourth, the comorbidities of the patients included in two study groups were not controlled (ASA score ≥ 3 : 40% in 2020 vs. 54% in 2019, $p = 0.037$). This difference in underlying diseases or the higher proportion of spinal anesthesia due to the concern of droplet spread of COVID-19 might have caused the decrease of hospital stay or time to surgery in the first group. However, with the application of the elaborate COVID-19 screening process, the results of hip fracture surgery during the COVID-19 pandemic were comparable to those before the COVID-19 in the present study.

In conclusion, the COVID-19 screening system for hip fracture patients has proven to be an effective measure to prevent intrahospital spread of the disease. The outcomes of hip fracture surgery during the COVID-19 pandemic under the screening system were comparable to

those of hip fracture surgery before COVID-19. The COVID-19 screening system for hip fracture patients in our institution could be beneficial in establishing COVID-19 screening guidelines in the orthopedic field.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

This research was supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number: HI19C0481, HC20C0157).

ORCID

Jin Won Chung <https://orcid.org/0000-0003-4811-6056>
 Yong-Chan Ha <https://orcid.org/0000-0002-6249-0581>
 Mi-Kyung Lee <https://orcid.org/0000-0003-1824-476X>
 Jin-Hak Kim <https://orcid.org/0000-0003-0794-5835>
 Jung-Wee Park <https://orcid.org/0000-0002-4515-1895>
 Kyung-Hoi Koo <https://orcid.org/0000-0001-5251-2911>

SUPPLEMENTARY MATERIAL

Supplementary material is available in the electronic version of this paper at the CiOS website, www.ecios.org.

REFERENCES

1. Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med.* 2020;382(18):1708-20.
2. Jang JG, Hur J, Choi EY, Hong KS, Lee W, Ahn JH. Prognostic factors for severe coronavirus disease 2019 in Daegu, Korea. *J Korean Med Sci.* 2020;35(23):e209.
3. Engh CA, Griffin WL, Marx CL. Cementless acetabular components. *J Bone Joint Surg Br.* 1990;72(1):53-9.
4. Dawood FS, Ricks P, Njie GJ, et al. Observations of the global epidemiology of COVID-19 from the prepandemic period using web-based surveillance: a cross-sectional analysis. *Lancet Infect Dis.* 2020;20(11):1255-62.
5. Kwon YS, Park SH, Kim HJ, et al. Screening clinic for coronavirus disease 2019 to prevent intrahospital spread in Daegu, Korea: a single-center report. *J Korean Med Sci.* 2020;35(26):e246.
6. Bae G, Kim E, Kwon HY, et al. Burden of osteoporotic fractures using disability-adjusted life years in South Korea. *Asia Pac J Public Health.* 2020;32(2-3):111-7.
7. Ko Y, Baek SH, Ha YC. Predictive factors associated with mortality in Korean elderly patients with hip fractures. *J Orthop Surg (Hong Kong).* 2019;27(2):2309499019847848.
8. Cha YH, Ha YC, Yoo JI, Min YS, Lee YK, Koo KH. Effect of causes of surgical delay on early and late mortality in patients with proximal hip fracture. *Arch Orthop Trauma Surg.* 2017;137(5):625-30.
9. Sheikh HQ, Hossain FS, Aqil A, Akinbamijo B, Mushtaq V, Kapoor H. A comprehensive analysis of the causes and predictors of 30-day mortality following hip fracture surgery. *Clin Orthop Surg.* 2017;9(1):10-8.

10. Parvizi J, Gehrke T, Krueger CA, et al. Resuming elective orthopaedic surgery during the COVID-19 pandemic: guidelines developed by the International Consensus Group (ICM). *J Bone Joint Surg Am.* 2020;102(14):1205-12.
11. Kawai M, Tanji A, Nishijima T, et al. Association between time to surgery and 90-day mortality after hip fracture: a retrospective cohort study of 1734 cases. *J Orthop Sci.* 2018;23(6):987-91.
12. Vosoughi AR, Emami MJ, Pourabbas B, Mahdaviyazad H. Factors increasing mortality of the elderly following hip fracture surgery: role of body mass index, age, and smoking. *Musculoskelet Surg.* 2017;101(1):25-9.
13. LeBrun DG, Konnaris MA, Ghahramani GC, et al. Hip fracture outcomes during the COVID-19 pandemic: early results from New York. *J Orthop Trauma.* 2020;34(8):403-10.
14. Egol KA, Konda SR, Bird ML, 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(8):395-402.
15. Hall AJ, Clement ND, Farrow L, et al. IMPACT-Scot report on COVID-19 and hip fractures. *Bone Joint J.* 2020;102(9):1219-28.
16. Ha YC, Kim TY, Lee A, et al. Current trends and future projections of hip fracture in South Korea using nationwide claims data. *Osteoporos Int.* 2016;27(8):2603-9.
17. Ha YC, Park YG, Nam KW, Kim SR. Trend in hip fracture incidence and mortality in Korea: a prospective cohort study from 2002 to 2011. *J Korean Med Sci.* 2015;30(4):483-8.
18. Kim SR, Ha YC, Kim JR, Kim R, Kim SY, Koo KH. Incidence of hip fractures in Jeju Island, South Korea: a prospective study (2002-2006). *Clin Orthop Surg.* 2010;2(2):64-8.