Hospital Courses Differ Amongst Hip Fracture Patients With or Without Coronavirus-19 Positive Status Upon Admission

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ABSTRACT

INTRODUCTION: The purpose of this study was to compare the hospital course and disposition of COVID-19 positive versus negative patients following an operatively managed hip fracture.

MATERIALS AND METHODS: This retrospective cohort study evaluated patients presenting to a university medical center with a hip fracture who underwent surgical management between February 1, 2020 and April 1, 2021. COVID-19 diagnosis was obtained using PCR testing. Hospital length of stay, disposition, readmission, and mortality were compared between patients with and without COVID-19.

RESULTS: 399 total patients were identified who met inclusion criteria, with 14 patients who were COVID-positive (3.1%). There was a 6.1 day increase in length of hospital stay for COVID-19 positive patients compared to those who were COVID negative ($p = 0.002$), without significant changes in disposition, readmission rates, or mortality.

CONCLUSIONS: A positive COVID-19 test at the time of admission can significantly increase hospital admission duration.

LEVEL OF EVIDENCE: III, Retrospective Cohort Study

KEYWORDS: COVID-19 outcomes, hip fractures, geriatric orthopedic surgery

INTRODUCTION

The Coronavirus disease 2019 (COVID-19) pandemic has had a profound impact on global healthcare systems, with effects felt from the local to the international level. As of January 2022, the World Health Organization has reported a cumulative total of over 346,000,000 confirmed cases and 5,584,000 confirmed deaths secondary to COVID-19 since the start of the pandemic.[1] First identified in Wuhan City, China in late 2019, the SARS-CoV-2 pathogen is capable of producing massive bilateral interstitial pneumonia with both acute and long-term cardiopulmonary and systemic sequelae.[2] Risk factors for developing severe COVID-19 symptoms have been extensively studied and include advanced age (>70 years old), obesity, underlying cardiovascular and respiratory disease, and immunocompromising conditions.[3] The risk of severe symptoms, rapid rates of transmission, and emergence of unique variants have placed substantial strain on hospital systems and societal institutions alike, pushing previously well-prepared hospitals to capacity and triggering lockdowns and increased restrictions from international governments.[4–6]

The impact of government lockdowns placed to reduce the spread of COVID-19 and mitigate overtaxing of challenged healthcare systems will remain the subject of ongoing investigation for the foreseeable future. Extensive global lockdowns demonstrated high efficacy in containing COVID-19 transmission, with limitation of social functions and communal gatherings removing many paths of disease spread.[7,8] Secondary effects of these lockdowns may prove more or less significant than expected, and include unforeseen economic, psychologic, and social impacts.[7] In the realm of orthopedics, such restrictions had unexpected yet unsurprising effects on patient injury patterns. Pediatric fractures were observed to decrease 2.5-fold during the pandemic, due largely to closure of playgrounds and cessation of organized sports.[9] Motor vehicle accidents and related trauma decreased significantly worldwide, trends likewise observed for homicide and suicide.[10–12] Lockdown initiatives, which decrease both social activities and social support, have been posited as either increasing or decreasing rates of fragility fractures, with different epidemiological studies reaching both conclusions.[13,14] Regardless, fragility fractures of the hip continue to occur in the general population, with the potential for COVID-19 to influence patient care once such an injury occurs.

Patient care following a hip fracture during the COVID-19 pandemic can be impacted by the presence of the disease in the individual patient, as well as the current state of the hospital system as a result of surging cases. Redirection of healthcare facility resources, such as beds and nursing staff, from orthopedic to urgent medical care was common in heavily challenged hospitals, with the CDC classifying musculoskeletal injuries as "less likely risk" for patient mortality if care is deferred compared to immediately life-threatening conditions.[15] This classification, in conjunction with limited resources, has the potential to both delay patient treatment and expedite important postoperative care and rehabilitation.[16] Likewise, risk factors for fragility fractures, such as

advanced age, smoking, and immunosuppression, are also risk factors for COVID-19 complications, suggesting that the overlapping patient population of COVID-19-positive fragility fracture patients may require more extensive care during their hospitalization, and may be at increased risk for short-term complications.[17,18]

The persistence of COVID-19 has had a considerable impact on both the development and management of hip fractures. At present, there is limited research examining management and outcomes of hip fractures in patients actively testing positive for COVID-19 at the time of injury. The present study seeks to examine the hospital course and disposition of all reported cases of hip fractures within a primary state healthcare system during a during the first year of the COVID-19 pandemic. We hypothesize that a positive COVID-19 diagnosis at the time of injury will result in increased hospital length of stay as well as readmission and mortality rates.

METHODS

This is a retrospective cohort study of all patients presenting to one of two university medical centers with a hip fracture who subsequently underwent surgical management between February 1, 2020 and April 1, 2021. All patients were grouped into two cohorts based on a lab confirmed positive or negative COVID-19 diagnosis using COVID-19 reverse transcription polymerase chain reaction (RT-PCR) testing. This study was started following Institutional Review Board approval (board reference number 221010).

Establishing the Cohorts

The cohort described was gathered using Current Procedural Terminology (CPT) codes for hip fracture repair (27130, 27125, 27235, 27236, 27244, 27245). To be included in the COVID-19 positive cohort, surgery had to occur during the patient's stay in which they received a lab-confirmed positive COVID-19 diagnosis using RT-PCR testing. A total of 399 patients presented with a hip fracture and subsequently underwent surgery. Of these, 15 patients were included in the COVID-19 positive cohort, while 384 patients with a lab-confirmed negative COVID-19 diagnosis were included in the COVID-19 negative cohort. Laboratory testing for COVID-19 was performed prior to surgical intervention.

Fracture types were identified as intertrochanteric, subtrochanteric, femoral neck fractures (including displaced and valgus-impacted) and basicervical femoral neck fractures. Basicervical, intertrochanteric, and subtrochanteric femur fractures are typically treated with cephalomedullary nailing at our institutions, while femoral neck fractures are treated with hemiarthroplasty, total hip arthroplasty, or closed versus open reduction and internal fixation, depending on surgeon preference and fracture pattern. Data from this study included that of 19 different attending surgeons.

Data included

For each patient, data regarding their demographic characteristics, past medical history, hip fracture procedure, and subsequent hospital stay were extracted via chart review. The primary outcomes were hospital length of stay, intensive care unit (ICU) admissions, blood transfusion requirements, discharge disposition, hospital readmission at 30 days and 90 days, and mortality. Each patient's past medical history was used to calculate their respective Charlson Comorbidity Index (CCI) that would be used, along with other specific diagnoses, to control for comorbidities when analyzing potential differences in the variables of interest between the two cohorts.

Statistics and Analyses

Patient demographics and surgical characteristics were analyzed for each cohort. **Table 1** shows the patient characteristics for each cohort, including CCI and rates of cardiovascular disease (CVD), cerebrovascular accident/transient ischemic attack (CVA/TIA), dementia, chronic obstructive pulmonary disease (COPD), connective tissue disease, liver disease, diabetes mellitus, chronic kidney disease (CKD), and cancer. An initial model comparing hospital courses between the two cohorts was done using chi-square and t-tests to assess for differences in categorical and continuous variables, respectively. Multivariate logistic regression was used to generate a second model to analyze for potential differences in hospital stay between the two cohorts, while controlling for patient demographics, anesthesia used during the procedure, individual comorbidities, and CCI.

A p-value < 0.05 was considered statistically significant. All analyses were performed using Stata (Version 15.1, StataCorp, Durham, NC, USA).

RESULTS

A total of 399 patients underwent surgical repair of a hip fracture in two university associated medical centers from February 1st, 2020 to April 1st, 2021. The study cohorts comprised of 15 laboratory-confirmed COVID-19-positive patients (3.8%) and 384 laboratory-confirmed COVID-19-negative patients (96.2%), with demographic findings and a comparison of the two cohorts located in **Table 1.** Aside from a diagnosis of COVID-19, there were no significant differences in sex, age, anesthesia type, surgery type, tobacco use, and comorbidities (including CCI) between the two cohorts. Patients in the COVID-19 positive cohort were more likely to have basicervical fractures rather than other types of femoral neck fractures; rates of peritrochanteric fractures were similar between the two cohorts (**Table 1**). The types of surgeries performed were similar between the two groups.

Bivariate analysis of hospital stay between the cohorts demonstrated a statistically significant 6.1 day increase in length of hospital stay in the COVID-19 positive cohort

Table 1. Characteristic Comparison between Cohorts

Variable	COVID-19 Negative (n = 384	COVID-19 Positive (n = 15)	p-value
Sex, female (%)	255 (66.4)	10 (66.7)	0.696
Age, mean +/– SD	79.2 +/– 13.7	75.8 +/– 16.85	0.363
Fracture Type			
Basicervical	7 (1.8)	2 (14.3)	**0.015**
Femoral Neck	183 (47.7)	4 (28.6)	
Intertrochanteric	172 (44.5)	7 (50.0)	
Subtrochanteric	21 (5.5)	1 (7.1)	
Surgery Performed			
Cephalomedullary Nail	190 (49.5)	10 (71.4)	0.355
Hemiarthroplasty	137 (35.7)	2 (14.3)	
Total Hip Arthroplasty	20 (5.2)	1 (7.1)	
Other	37 (9.6)	1 (7.1)	
Anesthesia Type, (%)			
General	204 (53.1)	5 (35.7)	0.256
Spinal	163 (42.7)	7 (50.0)	
MAC	16 (4.2)	2 (14.3)	
Smoker (%)	306 (79.7)	9 (64.3)	0.164
Comorbidities			
CCI, mean +/- SD	5.2 +/- 2.2	5.1 +/- 2.8	0.959
CVD, (%)	195 (50.8)	7 (50.0)	0.954
CVA/TIA, (%)	72 (18.8)	5 (35.7)	0.114
Dementia, (%)	48 (12.5)	12 (28.6)	0.080
COPD, (%)	43 (11.1)	1 (7.1)	0.635
Connective Tissue Disease, (%)	10 (2.6)	0 (0)	0.541
Liver Disease, (%)	7 (1.8)	0 (0)	0.61
Diabetes Mellitus, (%)	64 (16.7)	5 (35.7)	0.064
CKD, (%)	26 (6.8)	2 (14.3)	0.28
Cancer, (%)	86 (22.4)	2 (14.3)	0.473

Note: MAC, monitored anesthesia care; CCI, Charlston Comorbidity Index; CVD, cardiovascular disease; CVA/TIA, cerebrovascular accident, transient ischemic attack; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; "Other" includes dynamic hip screw, closed reduction percutaneous pinning, and open reduction internal fixation; Bold represents statistical significance, p < 0.05

compared to the COVID-19 negative cohort (p = 0.002). There were no significant differences in blood transfusion requirements, ICU admissions, discharge disposition, rates of hospital readmission at 30 and 90 days, or all-cause mortality between the two cohorts (**Table 2**).

In a multivariate logistic regression model controlling for age, sex, fracture morphology, surgery type, and comorbidities, hospital length of stay remained the only significant difference between the two cohorts (**Table 3**). COVID-19 positive patients were over 25 times more likely to experience a greater than 10-day hospital stay following hip fracture

Table 2. Hospital Course Comparison between Cohorts

Variable	COVID-19 Negative (n = 384)	COVID-19 Positive (n = 15)	p-value
Length of Stay, mean +/– SD	6.6 +/– 7.3	12.7 +/– 8.8	**0.002**
Required Transfusion, (%)	86 (17.7)	3 (21.4)	0.932
Intensive Care Unit Admission (%)	5 (1.3)	0 (0.0)	0.787
Discharge Disposition, (%)			
Skilled Nursing Facility	249 (64.8)	9 (64.3)	0.119
Acute Rehabilitation	35 (9.1)	0 (0)	
Home	89 (23.2)	5 (35.7)	
Hospice	11 (2.9)	0 (0)	
Readmitted within 30 days, (%)	67 (17.7)	4 (28.6)	0.286
Readmitted within 90 days, (%)	106 (27.6)	6 (42.9)	0.213
Mortality	16 (4.2)	1 (7.1)	0.589

Note: SD, standard deviation; Bold represents statistical significance, p < 0.05

Table 3. Multivariate Analysis of COVID-19 Status Effect on Hospital Course

Variable	Odds Ratio	95% CI	p-value
Length of Stay Greater than 10 Days	25.6	6.37–102.89	**<0.001**
Required Transfusion	0.92	0.23–3.77	0.913
Discharge Disposition			
Skilled Nursing Facility	1.20	0.33–4.30	0.780
Home	1.90	0.50–7.23	0.347
Readmitted within 30 days, (%)	1.89	0.53–6.68	0.323
Readmitted within 90 days, (%)	2.56	0.80–8.22	0.115
Mortality	2.53	0.24–27.07	0.442

Note: CI, confidence interval; Bold represents statistical significance, p < 0.05

repair compared to their COVID-19 negative counterparts (odds ratio (OR) 25.6, 95% confidence interval, 6.37–102.89). Akin to the bivariate analysis, there was no significant difference in the transfusion requirements, discharge disposition, rates of hospital readmission at 30 and 90 days, or all-cause mortality between the two cohorts (**Table 3**).

DISCUSSION

The present study examines cases of hip fractures occurring in the state of Rhode Island during statewide COVID-19 regulations, with the purpose of comparing demographic and hospital course data of patients diagnosed with COVID-19 at the time of injury versus those testing negative for the virus. In the examined patient population, no significant differences were observed in patient sex, age, tobacco use, type of surgery, and medical comorbidities, as well as anesthesia used during surgery. Length of stay was significantly increased in

patients testing positive for COVID-19, but there were no other observed associations between outcome variables and COVID-19 status. This investigation is unique in its examination of hip fractures in COVID-19 positive patients specifically and how these patients compare to others managed during the same period of healthcare strain and systemic change. The relatively small size of Rhode Island and predominant volume of patients within the state seen by the studied academic hospital network makes Rhode Island an optimal region for examining COVID-19-related health data.[19]

Studies examining fragility hip fractures in the context of COVID-19 have primarily focused on impacts to patient care secondary to hospital and healthcare system changes from COVID-19, regardless of individual patient disease status. Numerous investigations have sought to elucidate changes to the epidemiology of hip fractures brought on by society-level COVID-19 changes. In the United Kingdom, Arafa et al observed an increase in the number of patients admitted for hip fractures during a period of national lockdown, in contrast to findings by Italian researchers in Maniscalco et al and other UK researchers in Malik-Tabassum et al, both of whom saw relative decreases in case volume.[13,14,20] Arafa et al attributed the observed increase in cases to potentially decreased daily support of these patients by self-isolating caregivers, while limited time outside of the home was proposed as a means by which falls and consequent hip fractures were reduced during lockdowns.

Given the substantial variability in symptom severity associated with COVID-19, a wide range of average hospital length of stay in COVID-19 positive patients has been reported. A 2020 systematic review by Rees et al found reported median length of stay in patients admitted for COVID-19 to range between less than a week to almost 2 months, with a mean of 5 days in hospitals outside of China.[21] There is likewise variability in reported length of stay following surgeries during this time, with few studies differentiating between COVID-19-postive and negative patients. Dick et al reported no changes in general post-operative length of stay following emergency general surgery during COVID-19.[22] A study of fragility hip fractures amongst a cohort of Israeli patients during COVID-19 found that these patients, not stratified by COVID-19 status, had significantly shorter lengths of stay compared to similar data from 2017 and 2018 (7.2 ± 3.3 versus 8.9 ± 4.9 days).[23] This difference could be attributed to an increased effort to mobilize patients from the hospital, due in some combination to resource demand and fear of hospital-acquired infection. Similarly, Walters et al found a shorter mean length of stay across all patients managed for hip fractures in a major London hospital during the a 13-week peak of COVID-19 cases when compared to pre-COVID-19 data (11.6 vs. 19.6 days).[24] Length of stay amongst hip fracture patients was stratified by COVID-19 status by Arafa et al, who observed significantly longer hospital stays in COVID-19-positive patients compared to both negative patients and pre-COVID-19 patient cohorts.[13] The results of the present study support these findings, suggesting that COVID-19-positive postoperative patients require significantly longer periods of hospitalization than their negative-testing counterparts. Another possible reason for the prolonged lengths of stay of COVID-19 positive hip fracture patients may be due in part to the large portion of postoperative hip fracture patients that require placement in short to long-term care facilities at discharge. It is possible that policies put in place by the Department of Health or individual skilled nursing or long-term care facilities to prevent the spread of COVID-19 precluded the acceptance of COVID-19 positive patients, requiring them to remain in the hospital when they would have otherwise been discharged to such a facility.

Regardless of COVID-19, hip fractures are a major cause of morbidity and mortality in elderly patients worldwide, with an estimated fatality rate ranging from 15% to 30% in community-dwelling patients, and up to 55% amongst those in long-term care facilities.[25] Combine this risk with those inherent to COVID-19, which has been demonstrated in the literature to increase postoperative complication rates for major surgeries, and the potential for adverse outcomes in these patients is substantial.[26,27] Furthermore, there is significant overlap in the risk factors for both hip fractures and severe COVID-19 symptoms warranting hospitalization.[17,18] The present studied identified no significant difference in the transfusion requirements, discharge disposition, rates of hospital readmission at 30 and 90 days, or all-cause, in-hospital mortality between hip fracture patients with or without diagnosed COVID-19. In contrast, Arafa et al found a significantly higher rate of 30-day mortality in COVID-19-positive patients (36.8%) versus COVID-19-negative and pre-COVID-19 patients (11.5%, 11.7%).[13] All 7 COVID-19-positive patient deaths in this study were due to COVID pneumonitis, and postoperative falls was the only postoperative complicated observed to by higher in the COVID-19-positive cohort. A 2020 meta-analysis of 16 case series and retrospective cohort studies by Wang et al examining early mortality following hip fractures found that those with concomitant COVID-19 infections had an overall pooled mortality rate in the early postoperative period of 32.6%, with a 5.66 relative risk of postoperative mortality in COVID-19-positive versus negative patients.[28] Severity of COVID-19 symptoms is likely associated with risk of early postoperative mortality, with one case series reporting a mortality rate of 10% in a group of 10 positive patients, albeit with nearly all patients demonstrating little to no COVID-19 symptoms.[29] Konda et al observed a postoperative mortality rate of 12.5% in asymptomatic COVID-19-positive hip fracture patients versus a 30% mortality rate in symptomatic patients, further underscoring the significance of patient symptoms when assessing post-operative management risks.[30]

Patient COVID-19 status must undoubtedly be taken into consideration when evaluating a hip fracture, particularly in the context of postoperative planning. Suspected or confirmed COVID-19 necessitates adherence to strict contact precautions and personal protective equipment by all providers, and general surgical planning should best minimize exposures and predominantly focus on the most conservative approach, particularly one that lessens risk of reoperation.[31] COVID-19 has generated increased focus on conservative orthopedic management of fractures given the amplified attention towards resource management, though the necessity for surgery on a femur fracture limits the application of this approach.[32] Regarding postoperative management, COVID-19 should be considered an important factor when considering length of stay, with the potential for patients regardless of demographics to warrant increased medical attention. Standardized assessment scores can be modified for COVID-19, such as the Score for Trauma Triage in the Geriatric and Middle-Aged (STTGMA), which was modified by Konda et al to stratify risk in COVID-19-positive hip fracture patients, and provide valuable information for clinical decision making. As our collective understanding of COVID-19 continues to evolve, so too should our understanding of its role in postoperative outcomes.

There exist potential limitations to the present study inherent to its retrospective, single-system nature. The rapidly changing landscape of healthcare in the context of the global COVID-19 pandemic suggests that practices and patient management have the potential to vary greatly, both between hospital systems and even within a singular system depending on the current state of the pandemic. For example, the prolonged lengths of stay of COVID-positive patients may be directly related to SNF issues, such as losses in staffing and bed availability, causing providers to be unable to transfer patients to SNF even when medically cleared for discharge. Though the data was taken from the largest state healthcare system and two different facilities, it represents only a singular system in a single state, with a relatively low number of COVID-19 positive patients captured. Moreover, COVID-19 severity drastically ranges, and we were unable to assess for COVID-19-related illness severity. Unfortunately, we were unable to account for clinical and radiographic outcomes of our patients due to limitations within the data; this limitation also applies to mortality as we were only able to capture in-hospital mortality for our two cohorts. Importantly, we were also unable to capture patients who had not undergone operative intervention for their hip fracture; given some surgeons were treating COVID-19 positive individuals nonoperatively for their hip fractures, our study cannot account for these patients who may have been more systemically ill and at higher risk for complicated hospital courses. Additionally, advances in vaccine availability and the emergence of COVID-19 variants can impact the effects of the virus on patients and will necessitate frequent updates and expansion of research into COVID-19-related outcomes.

CONCLUSION

COVID-19 remains a significant variable to consider when developing treatment algorithms and individual treatment plans concerning hip fracture management, particularly in regards to patient length of stay. A positive COVID-19 test at the time of admission can significantly increase time spent in the hospital, though no increase in complications or mortality was observed in these patients. The ongoing global prevalence of COVID-19 and sustained rates of hip fracture necessitate continued research into the relationship of these conditions, and highlights new opportunities for improving the quality of patient care.

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