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Impact of COVID-19 Pandemic on Preoperative Optimization, Surgical Selection, and Complications in Patients with Hip Fracture

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Abstract

Study Objective: To assess the impact of the initial COVID-19 surge on preoperative optimization, anesthetic and surgical selection, and perioperative outcomes in patients undergoing urgent repair of hip fractures.

Design: Retrospective cohort study.

Setting: Two academic hospitals in New York City.

Patients: Fifty-five current (2020) and 51 historical control (2019) hip fracture patients.

Interventions: Patients diagnosed with hip fracture presenting from March 16th, 2020 to June 7th, 2020 and from the exact time period in 2019 were reviewed. The 2020 cohort were further stratified into COVID-positive and COVID-negative groups.

Measurements: Demographic variables, preoperative optimization time (from fracture diagnosis to operating room arrival), number and type of perioperative consult services obtained, intraoperative surgery and anesthesia variables, hospital quality measures, and 30-day mortality.

Main Results: Optimization time was shorter for the 2020 cohort compared to 2019 cohort (31.03 [22.48 to 44.18] h *vs*. 50.87 [28.92 to 66.47] h). More patients in 2020 cohort received subspecialty consults, including cardiology (29.09% *vs*. 9.80%), pulmonary/critical care (14.55% *vs*. 0%), infectious disease (14.55% *vs*. 0%) and palliative care (25.45% *vs*. 3.92%). The 2020 COVID positive cohort had an increased inpatient (25% *vs*. 0%) and 30-day (25% *vs*. 2.33%) mortality.

Conclusion: Hip fracture patients with COVID-19 infections were associated with a higher risk for mortality and complications. Despite limitations in resources and a greater disease burden in 2020, timely optimization and access to surgery with a multi-disciplinary team was exemplified. Perioperative outcomes and hospital quality measures were comparable between the 2019 and 2020 surgical cohorts.

Keywords: COVID-19 Pandemic; Hip fracture; Trauma anesthesia; Preoperative optimization; Perioperative outcomes

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Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), created a costly global pandemic and is a major public health issue in the United States. COVID-19 placed unprecedented strain on healthcare systems worldwide because of the immense rate of community spread as well as the lack of therapeutic treatment in the early phase of disease progression in our country [1]. From March to June 2020, New York City was the epicenter of the global pandemic and hospitals and emergency departments (EDs) were under tremendous production pressure to meet the needs of infected patients [2]. As a result, health system resources had to be diverted to meet increasing demands for critical care services.

During the initial COVID-19 surge, elective surgeries were postponed in most hospitals. However, emergent and urgent surgeries were inevitable. Elderly patients with hip fractures represented a particularly challenging patient population. Due to the need for hospitalization and limited mobility secondary to injury, patients with hip fractures are at high risk for infections, heart failure, deep vein thrombosis (DVT)/pulmonary embolus (PE) and other postoperative

complications [3]. In addition, these patients typically have a high cardiopulmonary morbidity burden, increasing their risk of mortality if they contract COVID-19, which was rampant in our hospitals [4,5]. Hence, cautious preoperative assessment, prompt medical optimization and early surgical intervention were imperative. The perioperative management of urgent orthopedic surgeries in the setting of a global pandemic has not been well studied.

In the initial surge, preoperative management was further hampered by requirements for additional COVID-19 diagnostic tests such as chest CT scan and SARS-CoV-2 nucleic acid testing. In addition, a limited workforce of non-exposed anesthesiologists, CRNAs, operating room nurses, and other healthcare professionals along with hospital resources were diverted to manage patients who were acutely ill from COVID-19 infections. Our post anesthesia care units were converted to COVID-19 intensive care units, further complicating issues about where our patients could be recovered after their procedures. All of these factors could potentially affect, delay and possibly complicate urgent orthopedic care, especially in patients with COVID-19 infection [6].

Intraoperatively, the safety of both patients and healthcare workers needed to be taken into consideration. The choice between general anesthesia (GA) and regional anesthesia (RA) for hip fracture repair, remains controversial in the setting of the COVID-19 pandemic. GA requires airway manipulation which may exacerbate the risk of COVID-19 transmission to medical staff *via* aerosol generation [6]. RA (spinal or epidural anesthesia) may provide some advantage over GA especially for those patients infected with COVID-19 and avoidance of airway manipulation, though unplanned conversion to GA during surgery is likely to further increase the risk of transmission [7].

Several studies comparing inpatient outcomes of hip fracture patients during the COVID-19 pandemic have shown that patients who were COVID-19 positive had increased mortality, increased hospital lengths of stay as well as higher major complication rates which included sepsis, pneumonia, acute respiratory failure and cardiac arrest [8-11]. However, these studies focused primarily on post-operative outcomes. In addition, two studies that included a pre-pandemic cohort from 2019 differed in their results. A study from the United Kingdom showed no statistically significant difference in time to surgery, type of treatment, complications and mortality rates, and a significant reduction in length of inpatient stay in the 2020 cohort [11]. In contrast, a study from the United States showed increased mortality rates, length of stay, and complication rates in their 2020 cohort [8].

In light of these conflicting studies, we sought to further assess the impact of the COVID-19 surge on patients undergoing repair of hip fractures in our institutions, with a focus on preoperative optimization, anesthetic and surgical selection, and perioperative complications. Specifically, we reviewed the differences in care delivered to hip fracture patients during the height of the COVID-19 pandemic as compared to the same period the previous year. Furthermore, we studied outcomes for patients who had operations during the surge comparing those hip fracture patients who were and those who were not COVID-19-positive. Our hypothesis was that patients infected with COVID-19 would have higher perioperative surgical risks and that preoperative optimization and time from hip fracture diagnosis to surgery would be adversely affected during the pandemic.

Materials and Methods

After receiving IRB approval, the electronic medical records of all patients who presented to the EDs at Mount Sinai Morningside (MSM) and Mount Sinai West (MSW) hospitals with diagnosis of any type of hip or femur fracture, during the height of the COVID-19 surge, from March 16th through June 7th, 2020 were retrospectively analyzed. Patients were excluded if they had multiple or high-energy traumas, underwent multiple surgeries during the study period, sustained periprosthetic fractures or pathologic fractures, or if they underwent revision surgery for prior hip surgeries. Hip fracture diagnosis was confirmed by the orthopedic service by history, physical examination, and radiographic imaging. The attending orthopedic surgeons determined surgical approach.

Patients were stratified into COVID-positive and COVID-negative cohorts based on preoperative SARS-CoV-2 RT-PCR testing status. We identified and recorded patient demographic data, time from ED presentation to orthopedic assessment, time from orthopedic assessment to surgery start time, number and type of consults required preoperatively, laboratory values, oxygen requirements, and delivery methods. Variables related to the injury and surgery were recorded as well.

Postoperative outcome data included length of stay, major complications, and discharge disposition. Major complications were considered ICU admission, PE, acute respiratory failure, pneumonia, myocardial infarction, cardiac arrest, atrial fibrillation, acute renal failure, end-stage renal disease, stroke, anemia, hypotension defined as twenty percent deviation from baseline blood pressure, sepsis, and surgical infection.

A similar retrospective review was conducted in a reference cohort of all patients undergoing surgery for the same injuries over the same time period in 2019. Identical data was obtained, excluding COVID status and COVID-related labs. Chi-square tests of association, Fischer's exact test, Wilcoxon test and t tests were used to assess differences between the 2019 and 2020 cohorts, as well as the COVID-19 positive and COVID-19 negative cohorts. Data is presented as mean (SD) if they are normally distributed, as median (first quartile, third quartile) if they are not normally distributed, and as a count (percentage) if they are categorical. All analyses were completed with SAS software, version 9.40 and were considered significant for $P<0.05$.

Results

2019 *vs.* 2020 cohorts

During 2020, 55 patients met the inclusion criteria for the study. In 2019, 51 patients presented with similar hip fracture diagnoses. Demographics and baseline characteristics are shown in Table 1. Groups were similar in regard to age, BMI, ASA score, smoking status and preoperative functional/ambulatory status. Similarly, an overall majority of patients were female in both groups. Preprocedural functional status and domiciles before the injury were alike. The comorbidities in each group were similar as well. The types of hip/femur fractures were not different between the 2019 and 2020 cohorts (Table 2).

The numbers of subspecialty consults, infectious disease, pulmonary, cardiology and palliative care were significantly increased in the 2020 group but general medicine consults were significantly

Table 1: Demographics and baseline characteristics for the 2019 versus 2020 cohort.

Demographics	2019 (n=51)	2020 (n=55)	P Values
Age (years) (mean ± SD)	80.6 ± 10.8	79.87±14.27	0.768
Sex, n (%)	(n=51)	(n=55)	0.294
Male	12 (23.53)	18 (32.73)	
Female	39 (76.47)	37 (67.27)	
BMI (kg/m^2) (mean ± SD)	23.27 ±4.48	23.72±5.23	0.633
ASA score	**(n=51)**	**(n=55)**	0.325
1	1 (1.96)	0 (0.00)	
2	8 (15.69)	14 (25.45)	
3	35 (68.63)	29 (52.73)	
3E	1 (1.96)	3 (5.45)	
4	6 (11.76)	9 (16.36)	
Smoking status	**(n=51)**	**(n=55)**	0.433
Current	4 (7.84)	1 (1.82)	
Former	16 (31.37)	15 (27.27)	
Never	22 (43.14)	26 (47.27)	
Unknown	9 (17.65)	13 (23.64)	
Functional/Ambulatory Status	**(n=51)**	**(n=55)**	0.609
Community ambulatory with assist	14 (27.45)	16 (29.09)	
Community ambulatory without assist	19 (37.25)	23 (41.83)	
Household ambulatory with assist	16 (31.37)	16 (29.09)	
Bed/Wheelchair bound	1 (1.96)	0 (0.00)	
Unknown	1 (1.96)	0 (0.00)	
Baseline Domicile, n (%)	**(n=51)**	**(n=55)**	0.485
Home	45 (88.24)	48 (87.50)	
Nursing Home	3 (5.88)	1 (1.82)	
Assisted Living Facility	3 (5.88)	5 (9.09)	
Skilled Nursing Facility	0 (0.00)	1 (1.82)	
Co-morbidities, n (%)			
Hypertension	37 (72.55)	36 (65.45)	0.431
Diabetes Mellitus	12 (23.53)	10 (18.18)	0.498
Chronic Obstructive Pulmonary Disease	2 (3.92)	5 (9.09)	0.44
Congestive Heart Failure	5 (9.80)	9 (16.36)	0.319
Coronary Artery Disease/Myocardial Infarction	5 (9.80)	11 (20.00)	0.143
Cerebrovascular Accident	12 (23.53)	12 (21.82)	0.833
Peripheral Vascular Disease	2 (3.92)	3 (5.45)	1
Dementia	18 (35.29)	14 (25.45)	0.27
Liver Disease	2 (3.92)	0 (0.00)	0.229
Kidney Disease	11 (21.57)	12 (21.82)	0.972
Malignancy	8 (15.69)	9 (16.36)	0.924
Chest X ray, n (%)	**(n=51)**	**(n=55)**	
Normal	20 (40.00)	24 (43.64)	0.233
Acute abnormal	10 (20.00)	6 (10.91)	
Chronic abnormal	18 (36.00)	25 (45.45)	

decreased during this time (Table 3 and Figure 1). The majority of patients in both groups required 1 to 2 consults while a larger

Table 2: Injury information for the 2019 versus 2020 cohort.

Injury Information	2019 (n=51)	2020 (n=55)	P Values
Type of hip fracture, n (%)			0.613
Acetabular	1 (1.96)	0 (0.00)	
Femoral neck	27 (52.94)	31 (56.36)	
Intertrochanteric	20 (39.22)	20 (36.36)	
Subtrochanteric	1 (1.96)	3 (5.45)	
Pertrochanteric	2 (3.92)	2 (3.64)	
Injury mechanism, n (%)			0.404
Fall	49 (96.08)	53 (96.36)	
Motor vehicle collision	0 (0.00)	1 (1.82)	
Atraumatic injury	0 (0.00)	1 (1.82)	
Worsening Arthritis	1 (1.96)	0 (0.00)	
Unknown	1 (1.96)	0 (0.00)	
Laterality, n (%)			0.441
Left	24 (47.06)	30 (54.55)	
Right	27 (52.94)	25 (45.45)	

Table 3: Consult service information and duration of optimization for the 2019 versus 2020 cohort.

Type of Consult, n (%)	2019 (n=51)	2020 (n=55)	P Values
Medicine	42 (82.35)	19 (34.55)	**<0.0001**
Cardiology	5 (9.80)	16 (29.09)	**0.013**
Pulmonary/Critical care	0 (0.00)	8 (14.55)	**0.006**
Infectious Disease	0 (0.00)	8 (14.55)	**0.006**
Psychiatry	0 (0.00)	4 (7.27)	0.119
Palliative Care	2 (3.92)	14 (25.45)	**0.002**
Surgery	3 (5.88)	3 (5.45)	1
Number of Consults, n (%)			0.149
0	9 (17.65)	14 (25.45)	
1	30 (58.82)	21 (38.18)	
2	9 (17.65)	9 (16.36)	
3	3 (5.88)	7 (12.73)	
4	0 (0.00)	3 (5.45)	
5	0 (0.00)	1 (1.82)	
Duration of optimization (hr)			
From presentation to surgery	50.87 [28.92-66.47]	31.03 [22.48-44.18]	**0.007**
From triage to orthopedic assessment	5.67 [4.62-7.45]	3.70 [2.10-5.03]	**0.002**
From orthopedic assessment to surgery	41.17 [24.63-56.85]	27.33 [18.93-40.93]	0.064

percentage of patients in the 2020 group received 3 to 5 consults.

The time from ED presentation to surgery was significantly lower for the 2020 group (Figure 2). Patients during the COVID-19 surge had surgery within 31 h on average after presentation to ED versus 51 h on average in the 2019 group. Time from ED presentation to orthopedic evaluation also shows a statistically significant decrease. Time from orthopedic assessment to surgery was also decreased in 2020 (27 h) *vs.* 2019 (41 h), though not statistically significant. Length of surgery (as defined by anesthesia start to anesthesia stop) was increased in 2020 (Figure 3). The type of anesthesia, GA *vs.* RA, was similar across both groups. In 2019, 69.4% of patients had surgery

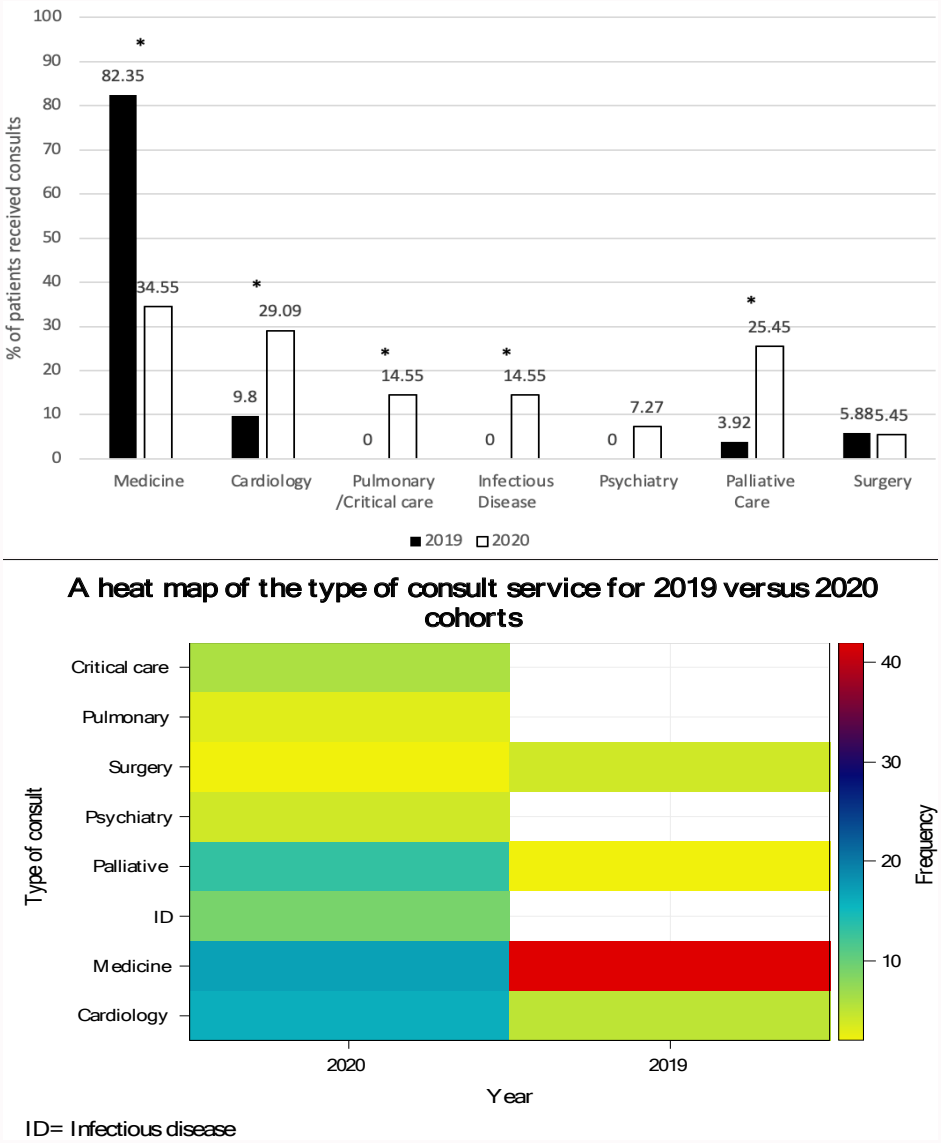

Figure 1: Bar chart and heat map of perioperative consult services for patients with hip fractures in 2019 versus 2020.

under GA whereas 58.3% had surgery under GA in 2020 (Table 4).

Comparing hospital quality measures between 2019 and 2020, inpatient and 30-day mortalities were increased in 2020 (Table 5). Four patients (7.3%) had a 30-day mortality, 3 of whom while inpatients (5.4%) and 1 within 30 days, while no patients died in the 2019 cohort. No patient in 2019 cohort and 3 patients in 2020 cohort required ICU care, respectively. Although not statistically significant, average length of stay decreased by 1 day in 2020. A similar number of patients had complications during their hospitalization in both groups.

2020 Cohort: COVID-positive versus COVID-negative

Each patient who was diagnosed with a hip fracture between March 16th and June 17th, 2020 had a COVID SARS-CoV-2 RT-PCR prior to surgery. Twelve patients (21.8%) were positive for COVID-19 and 43 patients (78.2%) were negative. The demographic and co-morbidity data for each subset were similar (Table 6). There was no significant difference with regard to type of fracture, injury mechanism and laterality between COVID positive and COVID negative group (Table 7). More patients in the COVID-19 positive group received infectious disease consults while consults to all other services were similar in both groups (Table 8 and Figure 4). Overall, 7 patients elected not to have surgery, 2 patients from the COVID-19 positive group and 5 patients from the COVID-19 negative group. Of the patients who had a surgical procedure, the time from presentation to surgery, 27.5 h for COVID-19 positive patients versus 34.6 h for COVID-19 negative patients, was similar. The length of surgery for the COVID-19 positive group was decreased (2.47 h *vs.* 2.67 h) but not statistically significant. More patients in COVID-19 positive group were tested for procalcitonin, C-reactive protein, D-dimer, ferritin, and lactate dehydrogenase as compared to COVID-19 negative group (Table 9). The CXR in the COVID-19 positive group was also more likely to be acutely abnormal, 16.67% in COVID-19 positive group *vs.* 9.30% in COVID-19 negative group (Table 9). Ten out of 12 (83.33%) and 38 out of 43 (88.37%) patients in the COVID-19 positive and COVID-19 negative groups, respectively, underwent surgery. The type of surgery performed was decided by the surgical attending performing the procedure (Table 10). Sixty percent of patients who

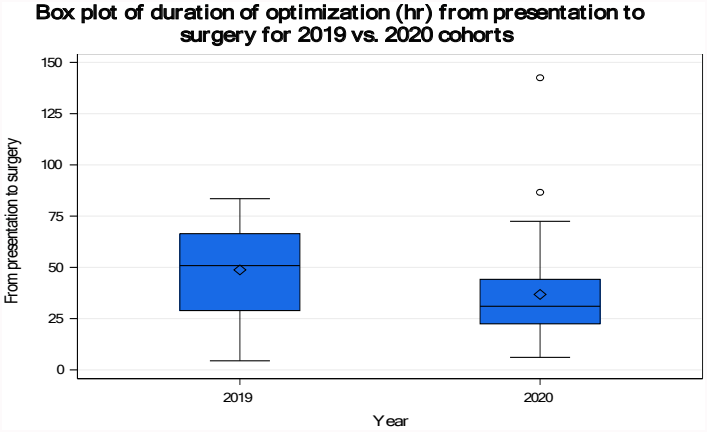

Figure 2: Time from ED presentation to hip fracture surgery in 2019 versus 2020.

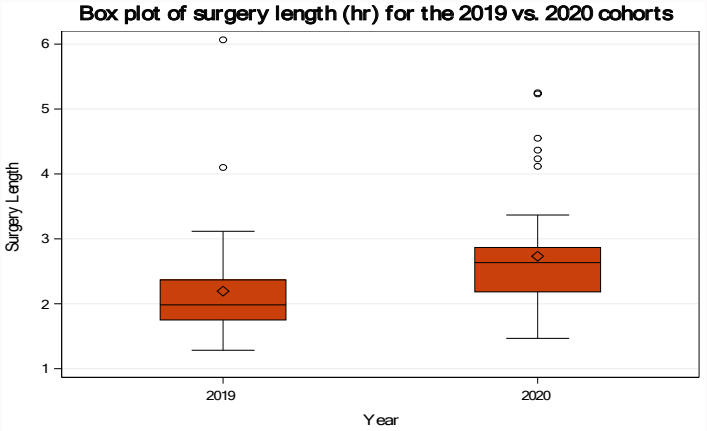

Figure 3: Duration of hip fracture surgery in 2019 versus 2020.

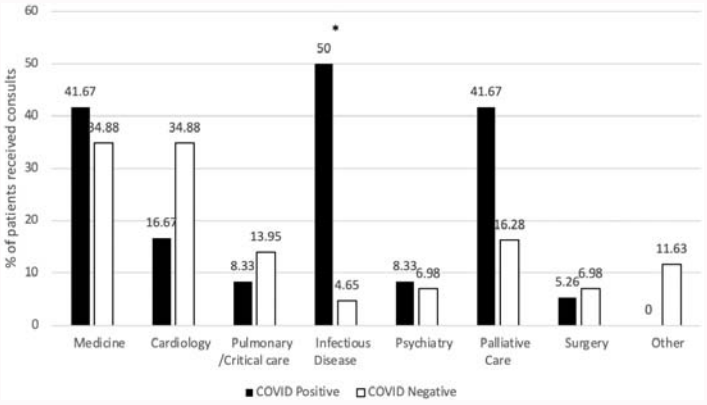

Figure 4: Bar chart of perioperative consult services for patients with hip fractures in COVID-19 positive versus COVID-19 negative cohort.

were COVID-19 positive received RA whereas 36.8% of patients received RA in the COVID-19 negative group.

Three of the 12 patients who tested positive for COVID-19 died during their hospitalization (Table 11). Two patients from that group were admitted to the ICU during the admission. In the COVID -19 negative group, no patient died while in the hospital and one patient had a 30-day mortality (Figure 5). One patient required ICU care. Of the complications analyzed in the study, the COVID-19 positive group had a higher likelihood of acute respiratory failure (33.33% *vs.* 6.98%), pneumonia (50.00% *vs.* 4.65%) and cardiac arrest (16.67% *vs.* 0.00%) during the hospitalization. Patients from the COVID-19 positive group were also more likely to be anemic while all other complications were similar. The average length of stay was decreased by one day for patients that were COVID-19 negative.

Discussion

In our surgical cohort of urgent hip fracture patients during the initial pandemic surge, our results highlighted a significantly higher number and complexity of consults that were requested as part of

Table 4: Surgical information for the 2019 versus 2020 cohort.

Surgical Information	2019	2020	P Values
Surgery, n (%)	**(n=51)**	**(n=55)**	0.18
Yes	49 (96.08)	48 (87.27)	
No	1 (1.96)	6 (10.91)	
Transfer	1 (1.96)	1 (1.82)	
	(n=49)	**(n=48)**	
Surgery length (hr)	1.98 [1.75-2.37]	2.63 [2.18-2.87]	**0.002**
Procedure, n (%)			0.226
Long intramedullary nailing	3 (6.12)	5 (10.42)	
Short intramedullary nailing	18 (36.73)	15 (31.25)	
Percutaneous pinning	5 (10.42)	0 (0.00)	
Total hip arthroplasty	3 (6.12)	3 (6.25)	
Hip hemiarthroplasty	18 (36.73)	22 (45.83)	
Sliding hip screw	1 (2.04)	3 (6.25)	
Closed reduction	1 (2.04)	0 (0.00)	
Anesthesia type, n (%)	**(n=49)**	**(n=48)**	0.257
General	34 (69.39)	28 (58.33)	
Regional	15 (30.61)	20 (41.67)	

Table 5: Hospital quality measures for the 2019 versus 2020 cohort.

Hospital Quality Measures, n (%)	2019 (n=51)	2020 (n=55)	P Values
Mortality	0 (0.00)	3 (5.45)	0.244
30-day mortality	0 (0.00)	4 (7.27)	0.119
Need for ICU	0 (0.00)	3 (5.45)	0.244
Patients experiencing complications, n (%)	46 (90.20)	48 (87.27)	0.635
Total Number of Complications, Median	2.00 [1.00 - 3.00]	2.00 [1.00 - 3.00]	0.968
Length of stay (d), Median	7.00 [4.00-9.00]	6.00 [4.00-9.00]	0.74
Disposition	**(n=51)**	**(n=52)**	0.324
Home	7 (13.73)	13 (25.00)	
Acute rehab	12 (23.53)	7 (13.46)	
Sub-acute rehab	29 (56.86)	31 (59.62)	
Hospice	2 (3.92)	0 (0.00)	

a preoperative optimization pathway. However, our study rejected the hypothesis that access to the OR was compromised. In fact, we reported a shorter time from presentation to surgical care for our patients in 2020, regardless of COVID status.

Patients who present to the ED with urgent hip fractures are likely advanced in age with a higher likelihood of co-morbidities. Timely medical optimization must occur in order to ensure patients have a safe and uneventful surgery. COVID-19 added an entirely different subset of challenges; protection for medical providers during preoperative assessments, extra testing required for optimization, and physician reassignment to alternative task and locations were just a small number of hurdles that we faced. All health care workers in our institution were asked to shift from their original duties to provide care for patients with COVID-19. Our analysis alludes to the fact that, our health care system was able to provide exemplary care in a safe and timely manner. The limitation on elective surgeries during this period may have helped allocate ample operating time, although almost all other stressors on the health care delivery system might have negatively impacted our time to treatment.

Table 6: Demographics and baseline characteristics for the 2020 cohort by COVID status.

Demographics	COVID Positive (n=12)	COVID Negative (n=43)	P Values
Age (years) (mean ± SD)	78.5 ± 11.89	80.26 ± 14.97	0.71
Sex, n (%)			0.96
Male	4 (33.33)	14 (32.56)	
Female	8 (66.67)	29 (67.44)	
BMI (kg/m2) (mean ± SD)	25.15 ± 5.82	23.33 ± 5.06	0.291
ASA, n (%)			0.968
2	3 (25.00)	11 (28.95)	
3	6 (50.00)	21 (55.26)	
3E	1 (8.33)	1 (2.63)	
4	2 (16.67)	5 (13.16)	
Smoking status, n (%)			0.393
Current	0 (0.00)	1 (2.63)	
Former	5 (41.67)	10 (26.32)	
Never	6 (50.00)	20 (46.71)	
Unknown	1 (8.33)	12 (27.31)	
Functional/ Ambulatory Status, n (%)			0.912
Community ambulatory with assist	3 (25.00)	13 (30.23)	
Community ambulatory without assist	5 (41.67)	18 (41.86)	
Household ambulatory with assist	4 (33.33)	12 (27.91)	
Bed/Wheelchair bound	0 (0.00)	0 (0.00)	
Hospital site, n (%)			0.23
Mount Sinai St Lukes	11 (91.67)	41 (95.35)	
Mount Sinai West	1 (8.33)	2 (4.65)	
Baseline Domicile, n (%)			0.67
Home	10 (83.33)	38 (88.37)	
Nursing Home	0 (0.00)	1 (2.33)	
Assisted Living Facility	2 (16.67)	3 (6.98)	
Skilled Nursing Facility	0 (0.00)	1 (2.33)	
Co-morbidities, n (%)			
Hypertension	8 (66.67)	28 (65.12)	0.921
Diabetes Mellitus	3 (25.00)	7 (16.28)	0.673
Chronic Obstructive Pulmonary Disease	2 (16.67)	3 (6.98)	0.298
Congestive Heart Failure	2 (16.67)	7 (16.28)	1
Myocardial Infarction/ Coronary Artery Disease	2 (16.67)	9 (20.93)	1
Cerebrovascular Accident	3 (25.00)	9 (20.93)	0.712
Peripheral Artery Disease	0 (0.00)	3 (6.98)	1
Dementia	4 (33.33)	10 (23.26)	0.477
Kidney Disease	2 (16.67)	10 (21.05)	1
Malignancy	3 (25.00)	6 (13.95)	0.392

Based on reports from abroad, we anticipated patients with COVID-19 infection having an increased mortality and that this would translate into a higher mortality for our surgical patients [6,10,11]. Palliative care consults were increased in our study between the cohorts in 2019 and 2020, in order for patients and families to

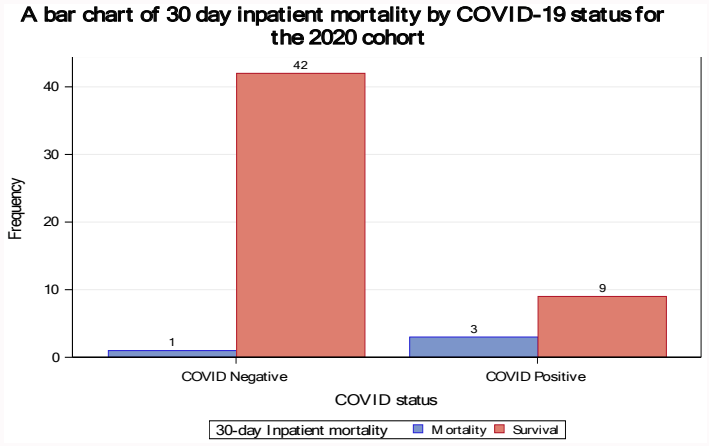

Figure 5: Bar chart of 30-day mortality for patients with hip fractures in COVID-19 positive versus COVID-19 negative cohort.

Table 7: Injury information for the 2020 cohort by COVID status.

Injury Information	COVID Positive (n=12)	COVID Negative (n=43)	P Values
Type of hip fracture, n (%)			0.13
Femoral neck	3 (25.00)	28 (65.12)	
Intertrochanteric	8 (66.67)	12 (27.91)	
Subtrochanteric	1 (8.33)	2 (4.65)	
Pertrochantreric	0 (0.00)	1 (2.33)	
Injury mechanism, n (%)			1
Fall	12 (100.00)	42 (97.67)	
Atraumatic injury	0 (0.00)	1 (2.33)	
Laterality, n (%)			0.721
Left	6 (50.00)	24 (55.81)	
Right	6 (50.00)	19 (44.19)	

Table 8: Consult service information and duration of optimization for the 2020 by COVID status.

Type of Consult, n (%)	COVID Positive (n=12)	COVID Negative (n=43)	P Values
Medicine	5 (41.67)	15 (34.88)	0.666
Cardiology	2 (16.67)	15 (34.88)	0.304
Pulmonary/Critical care	1 (8.33)	6 (13.95)	1.000
Infectious Disease	6 (50.00)	2 (4.65)	**0.0007**
Psychiatry	1 (8.33)	3 (6.98)	1.000
Palliative Care	5 (41.67)	7 (16.28)	0.060
Surgery	2 (5.26)	3 (6.98)	1.000
Other	0 (0.00)	5 (11.63)	0.215
Number of Consult, n (%)	**(n=12)**	**(n=43)**	0.400
0	3 (25.00)	11 (25.58)	
1	2 (16.67)	19 (44.19)	
2	3 (25.00)	5 (11.63)	
3	3 (25.00)	4 (9.30)	
4	1 (1.82)	3 (6.98)	
5	0 (0.00)	1 (2.33)	
Duration of optimization (hr)	**(n=10)**	**(n=38)**	
From presentation to surgery	27.50 [22.35-46.52]	34.63 [22.62 -44.12]	0.849
From triage to orthopedic assessment	3.70 [1.08-4.88]	3.70 [2.30 - 5.23]	0.528
From orthopedic assessment to surgery	24.99[18.17-42.85]	28.76 [18.93 -38.98]	0.889

have an opportunity to consider their options given the new risks associated with COVID-19. Palliative care was consulted to allow the patient and family to consider all possible outcomes and determine the best course for each individual patient. Going forward, we plan to continue our relationship with our palliative care colleagues to assist our patients in all matters whether or not related to COVID-19.

Certain demographic factors point to a higher risk of poorer outcomes in patients with COVID-19. Particular medications such as ace inhibitors and angiotensin receptor blockers are hypothesized to worsen infection although this is not proven as of yet [12]. It appears that the immune response to the virus causes similar problems associated with acute respiratory distress syndrome (ARDS). The hematologic system is also hypothesized to play a role as more and more patients appear to have higher incidence of PE, DVT, and arterial complications such as myocardial infarction and cerebral vascular events [13]. It is clear that while initial presentations frequently involved catastrophic pulmonary complications, multi-organ dysfunction usually follows. Our consult services provided invaluable guidance about COVID-19 in their respective fields but also never overlooked those patients who needed further optimization for other issues outside of COVID-19. Perioperative optimization for COVID-19 negative patients in 2020 appeared to be on par with patients in 2019 in regard to mortality and complication rate, though there appeared to be a shift from peri-operative general medicine consults to subspecialty consults. The number of all consults for various services was increased in 2020 except for general medicine possibly because these other services, including cardiology and pulmonology/critical care, primarily helped guide per-operative optimization as opposed to a general medicine team. The average number of consults per patient for the COVID-19 negative group in 2020 was similar to the average number of consults per patient in 2019.

Patients who presented with hip fracture that were infected with COVID-19 had a higher risk of mortality, consistent with the findings from other studies [8,9,10,14]. Twenty-five percent of those infected died within 30 days. The likelihood of complications such as acute respiratory failure, pneumonia and cardiac arrest were also higher in this group. The dysfunctional immune response with systemic inflammation in patients with COVID-19 in combination with the

Table 9: Preoperative lab values and imaging results for the 2020 cohort by COVID status.

Labs on admission, Median [INR]	Positive (n=12)	Negative (n=43)	P Values
White blood cell	8.60 [7.80-12.55]	10.20 [8.30-11.80]	0.521
Hemoglobin	13.50 [11.00-13.20]	13.10 [11.80-13.90]	0.237
Hematocrit	37.65 [32.90-39.35]	40.00 [36.70-43.10]	0.103
Platelet	210.00 [167.00-227.50]	220.00 [167.00-271.00]	0.333
Sodium	136.00 [132.00-138.00]	139.00 [136.00-141.00]	**0.015**
Potassium	4.25 [3.75-4.75]	4.20 [3.80-4.60]	0.854
Creatinine	0.75 [0.61-1.01]	0.88 [0.71-1.08]	0.298
INR	1.10 [1.05-1.15]	1.10 [1.00-1.20]	0.688
PTT	28.40 [25.05- 29.90]	28.80 [26.60- 30.50]	0.561
Inflammatory markers, Median [%]			
Procalcitonin	7 [58.33]	7 [16.28]	**0.013**
C-Reactive protein	8 [66.67]	5 [11.63]	**0.001**
D-dimer	8 [66.67]	7 [16.28]	**0.004**
Ferritin	8 [66.67]	5 [11.63]	**0.001**
Lactate Dehydrogenase	8 [66.67]	6 [13.95]	**0.001**
Chest X ray, n (%)			0.768
Normal	5 (41.67)	19 (44.19)	
Acute abnormal	2 (16.67)	4 (9.30)	
Chronic abnormal	5 (41.67)	20 (46.51)	
Not performed	0 (0.00)	0 (0.00)	

Table 10: Surgical information for the 2020 Cohort by COVID Status.

Surgical Information	COVID Positive	COVID Negative	P Values
Surgery, n (%)	**(n=12)**	**(n=43)**	0.68
Yes	10 (83.33)	38 (88.37)	
No	2 (16.67)	4 (9.30)	
Transfer	0 (0.00)	1 (2.33)	
Procedure, n (%)	**(n=10)**	**(n=38)**	0.133
Long intramedullary nailing	3 (30.00)	2 (5.26)	
Short intramedullary nailing	3 (30.00)	12 (31.58)	
Total hip arthroplasty	1 (10.00)	2 (5.26)	
Hip hemiarthroplasty	2 (20.00)	20 (52.63)	
Sliding Hip Screw	1 (10.00)	2 (5.26)	
Surgery length	2.48 [2.38-2.87]	2.65 [2.15-2.87]	0.886
Anesthesia type, n (%)	**(n=10)**	**(n=38)**	0.282
General	4 (40.00)	24 (63.16)	
Regional	6 (60.00)	14 (36.84)	

physiological stress secondary to anesthesia and surgery could make these patients more susceptible to postoperative complications [15,16]. At the time of this publication, no single treatment is widely accepted or proven in multiple studies to treat and help infected patients.

The choice of anesthetic technique for hip fracture surgeries is a source of debate and depends upon a number of factors [17]. COVID-19 is spread by close contact with infected patients *via* respiratory droplets. For patients who are COVID-positive, it may

Table 11: Hospital quality measures for the 2020 cohort by COVID status.

Hospital Quality Measures, n (%)	Positive (n=12)	Negative (n=43)	P Values
Inpatient mortality	3 (25.00)	0 (0.00)	0.008
30-day mortality	3 (25.00)	1 (2.33)	0.029
Need for ICU	2 (16.67)	1 (2.33)	0.117
Patients with Complications, n (%)	10 (83.33)	38 (88.37)	0.64
Total Number of Complications, Median	2.50 [1.00-4.00]	2.00 [1.00 - 3.00]	0.532
Pulmonary complications			
Pulmonary embolism	0 (0.00)	0 (0.00)	
Acute respiratory failure	4 (33.33)	3 (6.98)	0.034
Pneumonia	6 (50.00)	2 (4.65)	0.0007
Cardiac complications			
Myocardial Infarction	0 (0.00)	3 (6.98)	1
Cardiac arrest	2 (16.67)	0 (0.00)	0.044
Atrial fibrillation	1 (8.33)	1 (2.33)	0.392
Other complications			
Acute Kidney Injury	2 (16.67)	4 (9.30)	0.602
Stroke	0 (0.00)	0 (0.00)	
Anemia	5 (41.67)	6 (13.95)	0.034
Hypotension	3 (25.00)	5 (11.63)	0.245
Sepsis	1 (8.33)	1 (2.33)	0.392
Surgical site infection	0 (0.00)	0 (0.00)	
Length of stay (d), Median	7.00 [6.00-19.00]	6.00 [4.00 - 9.00]	0.064
Disposition	**(n=9)**	**(n=43)**	0.496
Home	2 (22.22)	11 (25.58)	
Acute rehab	1 (11.11)	6 (13.95)	
Sub-acute rehab	6 (66.67)	25 (58.14)	
Hospice	0 (0.00)	0 (0.00)	

be prudent to place an endotracheal tube in order to minimize aerosolization of droplet particles during the surgery for the safety of all OR personnel. The anesthesia provider, however, would be assumed to be at higher risk for infection during intubation and extubation. It can also be argued that a RA may prove safer for both patient and OR staff, if the patient was required to wear a surgical mask with supplemental oxygen provided beneath it. This would avoid manipulation of the airway and positive pressure ventilation which could complicate the respiratory status of infected patients and also prevent the airway maneuvers that place the anesthesia providers at a higher risk for infection. Our data did not highlight any particular method to be more beneficial although further studies may help to clarify.

Our study is not without its limitations. Being retrospective, our data and analysis was based on review of electronic medical records that may or may not have been accurate. Performance times may have been inflated secondary to the need to don personal protective equipment. Our data reflects activity at two specific sites that have a defined trauma pathway that may not be applied elsewhere. In addition, hospital guidelines and protocols as well as medical management for COVID-19 changed rapidly during our study period. The number of COVID-19 positive patients in this study was relatively low, and the classification of COVID-19 positive group was strictly based on SARS-CoV-2 RT-PCR testing results which has

been shown to have limited sensitivity. At the same time, some of the patients who had symptoms were classified into COVID-19 negative group as they tested negative on SARS-CoV-2 RT-PCR.

Conclusion

Hip fracture patients with COVID-19 infections who presented for orthopedic surgery were associated with a higher risk for mortality and complications. However, timely care while mitigating some of those risks with early interventions and a multi-disciplinary medical team was delivered. Overall, patients who sustained hip fractures during the initial COVID-19 surge were optimized without delay and received care in a timely and safe manner. Their outcomes were comparable to those in a cohort of patients undergoing the same procedures during the same period of time the previous year.

Author Contributions

SF: Primary investigator responsible for study design and planning, IRB approval, data collection, data analysis, and manuscript writing and preparation.

RP: Primary investigator responsible for study design and planning, IRB approval, data collection, data analysis, and manuscript writing and preparation.

DA: Investigator responsible for data collection and manuscript preparation.

MR: Senior investigator responsible for study design and planning, manuscript writing and preparation.

AO: Statistician involved in data analysis and manuscript preparation.

YL: Primary and senior investigator responsible for study design and planning, IRB approval, data collection, data analysis, and manuscript writing and preparation.

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