Evaluation of Complications, Incidence, Mortality, and Predictive Factors of Surgical Outcomes for Proximal Femur Fractures in Patients with and without COVID-19: A Prospective Observational Study

Abstract

Background: Despite a reduction in the global transmission and mortality rates of the coronavirus (COVID-19), the infection continues to pose significant challenges for orthopedic surgeons. The present study aims to assess the impact of COVID-19 infection on complications, incidence, mortality, and predictors of surgical outcomes for proximal femur fractures.

Methods: This prospective observational study was conducted on 611 patients with proximal femur fractures (PFF) and potential COVID-19, who underwent surgery at Teaching hospital, between 2019 and 2021. The patients of these, 59 patients were definitively diagnosed with COVID-19, using frequency matching, were compared for 30-day mortality. The hip function, average length of hospital stay, and the probability of ICU admission between COVID-19-positive and COVID-19-negative patients were studied.

Results: 611 patients with proximal femur fracture had been treated, out of which 59 had definite diagnosis of Covid. The 30-day mortality rate was significantly higher in the COVID-19-positive group (28.8% vs. 10.2%, p=0.018). At the last follow-up, the mean Harris Hip Score (HHS) was lower in COVID-19-positive patients. Multivariate analysis revealed that infection rates, average hospital stay duration, and ICU admissions were significantly higher among COVID-19 patients. Older age, hypertension, and smoking significantly increased the risk of postoperative complications in PFF patients.

Conclusion: COVID-19 infection increases mortality, length of hospital stay, and the likelihood of ICU admission, while decreasing the mean HHS score in the target population. These results are particularly significant in older patients, smokers, and those with hypertension.

Keywords: Proximal Femur Fracture - Mortality Rate - Coronavirus Disease 2019 - COVID-19 – Treatment Outcome

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Introduction

The global transmission crisis and the impact of COVID-19 infection are more pronounced compared to other syndromes, such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS)[1, 2]. Previous studies have shown that COVID-19 is associated with increased complications and mortality in orthopedic surgeries[5]. Mortality and complication rates also vary depending on the fracture location and type of surgery[6-8]. Hip fractures are among the most common orthopedic injuries, especially in elderly individuals who often suffer from comorbidities[9]. A 2023 review estimated a 30-day mortality rate of 12.6% in COVID-19 patients with hip fractures[10].

Proximal femur fractures (PFF) in the elderly are considered emergency surgeries. Prior studies report an annual mortality rate of 14–36% for PFF before the COVID-19 pandemic[13]. Postoperative mortality for PFF has been reported to range from 14.8% to 60%[13-15].

Previous studies suggest that early-stage surgery reduces mortality, pneumonia, and pressure ulcers in elderly patients[11]. However, undergoing surgery while infected with COVID-19, even during early-stage interventions, is associated with increased mortality and postoperative complications[16, 17].

Given these issues, the treatment of such fractures during the COVID-19 pandemic remains a challenge for orthopedic surgeons. In light of the importance of this matter, this study was conducted to compare complications, incidence, mortality, and predictors of surgical outcomes in PFF patients with and without COVID-19.

Materials and Methods

This prospective cohort study, approved by the Ethics Committee of Iran University of Medical Sciences (Code: IR.IUMS.FMD.1400.344), was conducted on 611 patients with proximal femur fractures who underwent surgery between 2019 and 2021 at Firouzgar Hospital in Tehran, affiliated with Iran University of Medical Sciences. Based on diagnostic testing, patients were divided into COVID-19-positive and COVID-19-negative groups. A total of 59 PFF patients with COVID-19 were identified. Real-time PCR was used to confirm COVID-19 diagnosis in patients. To maintain balance, 59 COVID-19-negative PFF patients were randomly selected from those with negative PCR tests. Informed consent was obtained from all patients.

The surgeries were performed as usual, and the researchers did not intervene in the treatment process. Typically, surgeries for patients with positive PCR tests were delayed by 10 days, based on the anesthesiologist's decision and clearance from a pulmonologist until the patient's general condition improved. All COVID-19 patients followed the same treatment protocol. All surgeries were performed by a senior orthopedic surgeon at the same hospital.

Inclusion and Exclusion Criteria

Inclusion criteria included patients over 18 years old, those with PFF requiring surgery, a minimum follow-up of 30 days post-surgery, and informed consent. Exclusion criteria included concurrent musculoskeletal diseases (severe osteoarthritis, rheumatoid arthritis, fibromyalgia, etc.), severe psychiatric disorders (psychosis, mania, suicidality, severe depression, or cognitive disorders like dementia), other co-infections (hepatitis B and C, HIV), antiviral drug use, cancer or immunosuppressive therapy, chemotherapy, or radiotherapy, chronic kidney disease (CKD), ischemic heart disease, and cirrhosis.

Data Collection Tools

Patient information was recorded at admission and during the study using an inclusion/exclusion checklist. The two groups were matched for age, smoking status, gender, type of treatment, fracture type, type of implant, comorbidities, intraoperative blood loss, and comorbidities such as diabetes, hypertension, and hyperlipidemia. Data were recorded in two parts: demographic information at the time of admission (age, gender, body mass index [BMI], PCR test result, comorbidities, and smoking) and clinical outcomes 30 days post-surgery (final status [death/survival], occurrence of complications, need for blood transfusion, need for mechanical ventilation, ICU admission, length of hospital stay, myocardial infarction, and infection).

Outcome Measures

Primary outcomes were defined as 30-day mortality, hip function, and length of hospital stay. Secondary outcomes included the need for ventilation, blood transfusion, ICU admission, and postoperative complications such as deep vein thrombosis (DVT), infection rates, and myocardial infarction (MI). Thirty-day mortality was defined as any death within 30 days post-surgery. The Harris Hip Score (HHS) was used to evaluate hip function at the final follow-up six months post-surgery. Each patient received a score between 0 and 100, with higher scores indicating better function. The validity and reliability of the Persian version of this questionnaire have been confirmed for the Iranian population[18].

Sample Size Calculation

The appropriate sample size for this study was estimated based on an effect size of 0.41 for differences in mortality rates between COVID-19-positive and COVID-19-negative PFF patients, according to a study by B Kayani et al., with an alpha error of 5%, a 95% confidence interval (CI), and 80% study power. Using G Power software version 3.1, an epidemiologist estimated 53 patients per group[19].

Statistical Analysis

Data analysis was conducted using SPSS software version 23. Descriptive statistics (frequency and percentage) were used for qualitative variables. Qualitative variables were reported with means and standard deviations. The normality of the variables' distribution in the two groups was assessed using the Kolmogorov-Smirnov test. Assuming normal distribution, the t-test was used to compare variables between the two groups; otherwise, the nonparametric Mann-Whitney test was applied. The chi-square test was used to analyze qualitative variables between the two groups. To control for confounding variables, multivariate analysis was performed in addition to frequency matching. Variables with a significance level below 0.20 in the univariate analysis were entered into the multivariate logistic regression analysis using the Backward method. Multivariate logistic regression analysis was used to determine the most important predictors of outcomes in the two groups. The adjusted odds ratio (OR) with a 95% confidence interval (CI) was reported to indicate effect size. A p-value below 0.05 was considered statistically significant.

Results

The mean age of COVID-19-positive and COVID-19-negative patients was 65.3 ± 5.7 years and 65.8 ± 5.7 years, respectively. In the COVID-19-positive group, 31 (52.5%) were men, compared to 34 (57.6%) in the COVID-19-negative group. The mean follow-up period was longer in the COVID-19-positive group (8.1 ± 2.2 vs. 7.9 ± 2.1; p=0.31). No significant differences were observed in the demographic characteristics of the two groups (Table 1).

Table 1. Comparison of base features for the two study groups

Variables		Groups compared		Significance level
		COVID-19 Positive Patients (n:59)	COVID-19 Negative Patients (n:59)	
Age (years)		65.3 ± 5.7	65.3 ± 5.7	87.0
Gender	Male Female	31 (52.5%) 34 (57.6%)	31 (52.5%) ; 34 (57.6%)	39.0
BMI		27.4 ± 1.9	27.4 ± 1.9	43.0
History of Type 2 Diabetes	Yes No	9 (3.15) 50 (7.84)	11 (6.18) 48 (4.81)	77.0
History of Hypertension	Yes No	10 (9.16) 49 (1.83)	14 (7.23) 45 (3.76)	46.0
History of Hyperlipidemia	Yes No	4 (8.6) 55 (2.93)	8 (6.13) 51 (4.86)	21.0
Smoking	Yes No	6 (2.10) 53 (8.89)	6 (2.10) 53 (8.89)	98.0
Follow-up Duration (months)	Yes No	1.8±2.2	9.7±1.2	31.0

Table 2. Comparison of features for the study groups (univariate analysis)

Variables	Comparison Groups	Significance Level	COVID-19 Positive Patients (n:59)	COVID-19 Negative Patients (n:59)
Length of Hospital Stay (days)		0.001	17.1 ± 1.7	13.4 ± 2.2
30-Day Mortality Rate	Yes No	0.018 42 (71.2%)	17 (28.8%) 53 (89.8%)	6 (10.2%)
ICU Admission	Yes NO	0.002 39 (66.2%)	20 (33.8%) 53 (89.8%)	6 (10.2%)
Need for Respiratory Ventilation	Yes NO	0.17 50 (84.7%)	9 (15.3%) 48 (81.4%)	11 (18.6%)
Need for Blood Transfusion	Yes NO	0.022 49 (83.1%)	10 (16.9%) 45 (76.3%)	14 (23.7%)
Deep Vein Thrombosis	Yes NO	0.25 55 (93.2%)	4 (6.8%) 51 (86.4%)	8 (13.6%)
Infection	Yes NO	0.024 45 (76.3%)	14 (23.7%) 54 (91.5%)	5 (8.5%)
HHS Score		0.001	58.8 ± 5.9	72.9 ± 8.8

Univariate analysis revealed that the 30-day mortality rate was significantly higher in the COVID-19-positive group (28.8% vs. 10.2%; p=0.018). The mean hospital stay was significantly longer in COVID-19-positive patients (17.1 vs. 12.8 days). Additionally, ICU admissions, need for mechanical ventilation, blood transfusion requirements, and infection rates were significantly higher in the COVID-19-positive group. At the last follow-up six months post-surgery, the mean HHS for COVID-19-positive patients was significantly lower (58.8 ± 5.9) compared to the COVID-19-negative group (72.9 ± 8.0). No significant differences were observed in DVT rates between the two groups (Table 2).

Multivariate logistic regression analysis showed that COVID-19-positive patients had a significantly higher risk of mortality compared to COVID-19-negative patients (adjusted OR: 1.71, 95% CI: 1.11–2.63; p=0.001). Other predictors of mortality included age, hypertension, and smoking (Table 3).

Table 3. Results of multivariate analysis

Variables	Adjusted Odds Ratio	95% Confidence Interval	Significance Level
Prolonged Hospitalization	1.89	1.11 – 2.68	0.001
30-Day Mortality	3.51	2.28 – 4.81	0.001
ICU Admission	2.11	1.15 – 3.08	0.001
Infection	2.03	1.13 – 2.94	0.04
Decreased HHS Score	1.35	1.08 – 1.63	0.001

Table 4. Prediction of Complications and Mortality Based on Multivariate Logistic Regression Analysis

Variables	Adjusted Odds Ratio	95% Confidence Interval	Significance Level
COVID-19 Infection (Yes vs No)	9.88	3.58 – 16.18	0.001
Age (in years)	1.12	1.03 – 1.21	0.02
Hypertension (Yes vs No)	2.01	1.11 – 3.12	0.001
Smoking (Yes vs No)	1.54	1.02 – 2.07	0.024

Discussion

This study demonstrates that the mortality and complication rates for proximal femur fracture (PFF) patients with COVID-19 are significantly higher than for non-COVID-19 patients. The most important predictive factors for mortality and surgical outcomes were age, hypertension, and smoking status. The findings are consistent with previous research and support the conclusion that COVID-19 infection exacerbates surgical risks in PFF patients, increasing the need for ICU admission, mechanical ventilation, and blood transfusions. Despite frequency matching and controlling for confounding variables, COVID-19 remained a significant risk factor for poor surgical outcomes in PFF patients.

Conclusion

COVID-19 infection significantly increases the risk of mortality, postoperative complications, and reduced hip function in patients undergoing surgery for proximal femur fractures. These results highlight the importance of specialized care and preoperative planning for COVID-19-positive patients, particularly older individuals, smokers, and those with hypertension.

Conflict of Interest

This research does not have any direct or indirect conflict of interest with any individual or organization.

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