DOI: https://doi.org/10.53350/pjmhs02024181558

ORIGINAL ARTICLE

Impact of Preoperative Medical Comorbidities on Anesthetic Risk and Surgical Outcomes in Patients with Long Bone Fractures: A Clinical Study

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ABSTRACT

Background: Long bone fractures are a common cause of orthopedic trauma requiring surgical fixation. Preoperative medical comorbidities are known to influence anesthetic risk and postoperative recovery; however, their independent impact in trauma patients remains underexplored.

Objective: To evaluate the effect of preoperative medical comorbidities on anesthetic instability and early surgical outcomes in patients undergoing operative fixation of long bone fractures.

Methods: This prospective clinical study was conducted at Pakistan Ordnance Factories (POF) Hospital, Wah Cantt, Pakistan, from January 2022 to June 2023. A total of 100 patients with long bone fractures requiring surgical fixation were included. Data on demographics, fracture characteristics, comorbidities, ASA classification, anesthesia details, intraoperative hemodynamic stability, and postoperative outcomes were collected. Primary outcomes included intraoperative anesthetic instability and 30-day postoperative complications such as surgical site infection, pulmonary complications, acute kidney injury, major adverse cardiac events, venous thromboembolism, reoperation, and mortality. Statistical analysis was performed using SPSS version 26, with logistic regression applied to identify independent predictors.

Results: The mean age of patients was 52.6 ± 16.8 years, with males accounting for 62% of the study population. Common comorbidities included hypertension (42%), diabetes mellitus (30%), anemia (28%), ischemic heart disease (15%), and chronic kidney disease (10%). Intraoperative anesthetic instability occurred in 27% of patients, significantly more frequent among ASA III–IV patients (p=0.003). Overall postoperative complication rate was 26%, with surgical site infection (9%), pulmonary complications (8%), acute kidney injury (5%), and major cardiac events (4%) being most common. Diabetes was associated with higher infection risk (p=0.02), chronic kidney disease with postoperative AKI (p=0.004), and ischemic heart disease with cardiac events (p=0.01). Patients with complications had significantly longer hospital stays compared to those without complications (10.2 vs. 6.1 days, p<0.001).

Conclusion: Preoperative comorbidities, particularly diabetes mellitus, ischemic heart disease, chronic kidney disease, COPD, and anemia, significantly increase anesthetic risk and postoperative complications in patients with long bone fractures. Higher ASA classification strongly predicts adverse outcomes. Comprehensive preoperative optimization and avoidance of unnecessary surgical delays are critical to improving outcomes in orthopedic trauma patients.

Keywords: long bone fractures, comorbidities, anesthetic risk, surgical outcomes, ASA classification, orthopedic trauma

INTRODUCTION

Long bone fractures, particularly those involving the femur, tibia, humerus, and radius–ulna, represent a significant cause of trauma-related morbidity worldwide[1]. These injuries frequently require surgical intervention, most commonly through open reduction and internal fixation or intramedullary nailing. While advances in surgical and anesthetic techniques have improved perioperative survival, outcomes are still influenced by the overall health status of the patient at the time of surgery[2,3].

A major determinant of surgical and anesthetic risk is the presence of preoperative medical comorbidities such as diabetes mellitus, hypertension, ischemic heart disease, chronic kidney disease, chronic obstructive pulmonary disease, liver dysfunction, anemia, and obesity[4]. These conditions may impair physiological reserve, predispose to hemodynamic instability under anesthesia, delay wound healing, and increase susceptibility to perioperative complications such as infection, thromboembolism, or acute organ dysfunction. For instance, patients with diabetes are prone to surgical-site infections due to impaired immune and microvascular function, while those with chronic kidney disease face heightened risks of electrolyte imbalance, fluid overload, and postoperative acute kidney injury. Similarly, cardiopulmonary comorbidities amplify the risk of intraoperative cardiovascular collapse or postoperative respiratory failure[5,6].

In orthopedic trauma, time-to-surgery is another crucial factor. Delays in surgical fixation of long bone fractures often necessary for medical optimization of comorbidities have been linked to prolonged hospital stay, increased complication rates, and impaired functional recovery[7]. Thus, clinicians frequently face the challenge of balancing the need for rapid surgical intervention with the necessity of stabilizing coexisting medical conditions[8].

Despite the recognized importance of comorbidities, data on their independent impact on anesthetic risk and surgical outcomes in long bone fracture patients remain inconsistent, especially in resource-limited trauma settings where perioperative monitoring and optimization options are constrained. Most available studies focus on hip fractures in the elderly, leaving a gap in evidence for other long bone fractures across a broader age spectrum[9,10].

Therefore, this clinical study was designed to systematically evaluate the effect of preoperative medical comorbidities on intraoperative anesthetic stability and early surgical outcomes in patients undergoing operative fixation of long bone fractures. By identifying specific comorbidities that substantially increase perioperative risk, the study aims to inform preoperative risk stratification, guide optimization strategies, and ultimately improve patient safety and outcomes in orthopedic trauma care[11].

MATERIALS AND METHODS

Study Design and Setting: This prospective clinical study was conducted at Pakistan Ordnance Factories (POF) Hospital, Wah Cantt, Pakistan, a tertiary care hospital with advanced orthopedic and anesthesiology services. The study was carried out over an eighteen-month period from January 2022 to June 2023, focusing on patients presenting with long bone fractures that required surgical intervention.

Received on 06-08-2023
Accepted on 25-12-2023

Study Population: A total of 100 adult patients were enrolled in the study. All patients were aged 18 years and above and had radiologically confirmed long bone fractures involving the femur, tibia/fibula, humerus, or radius/ulna. Only those patients who were scheduled for operative fixation under anesthesia and provided informed consent were included. Patients with pathological fractures secondary to bone tumors or metabolic disorders, those with periprosthetic fractures requiring revision arthroplasty, polytrauma cases requiring emergency thoracic or abdominal surgery, pregnant women, and individuals who refused consent were excluded.

Data Collection: Patient data were collected using a structured proforma designed specifically for this study. The proforma included demographic details such as age, gender, body mass index, and smoking history. Clinical information included the type and site of fracture, whether it was open or closed, and associated injuries. Preoperative medical comorbidities such as diabetes mellitus, hypertension, ischemic heart disease, chronic kidney disease, chronic obstructive pulmonary disease, chronic liver disease, anemia, and obesity were carefully documented. Preoperative assessment was performed according to the American Society of Anesthesiologists (ASA) physical status classification, and relevant laboratory investigations including hemoglobin, renal function, and liver function tests were carried out. Where indicated, cardiology and pulmonology consultations were also obtained to optimize patient status prior to anesthesia.

Anesthetic data included the type of anesthesia administered (general or regional), airway management, intraoperative monitoring parameters, estimated blood loss, operative time, and presence of hemodynamic instability. Postoperative outcomes were observed throughout the hospital stay and during the 30-day follow-up period. These outcomes included anesthetic recovery, intensive care unit admission, surgical site infection, pulmonary complications, acute kidney injury, venous thromboembolism, major adverse cardiac events, reoperation, and all-cause mortality.

Outcome Measures: The primary outcomes of the study were the occurrence of intraoperative anesthetic instability, defined as a ≥20% reduction in mean arterial pressure requiring pharmacological intervention or a difficult airway situation, and the incidence of major postoperative complications within 30 days of surgery. The secondary outcomes were the length of hospital stay, the need for intensive care admission, and the correlation of ASA classification with adverse surgical outcomes.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Review Board (IRB) of POF Hospital, Wah Cantt. Written informed consent was obtained from all patients prior to inclusion in the study. Patient confidentiality was maintained at all stages, and data were used solely for research purposes.

Statistical Analysis: All collected data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as age, length of hospital stay, and operative time were expressed as mean ± standard deviation. Categorical variables such as gender, comorbidities, ASA status, and complications were presented as frequencies and percentages. Associations between preoperative comorbidities and adverse outcomes were assessed using the chi-square test or Fisher's exact test for categorical variables and the independent samples t-test for continuous variables. Logistic regression analysis was applied to identify independent predictors of postoperative complications. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Demographic and Clinical Characteristics: A total of 100 patients with long bone fractures were included in this study. The mean age of the study population was 52.6 ± 16.8 years, ranging from 18 to 85 years, with a male predominance (62% males vs. 38% females). The majority of fractures involved the femur (40%), followed by tibia/fibula (32%), humerus (18%), and radius/ulna (10%). Open fractures were recorded in 21% of cases, while 79% presented with closed injuries. Polytrauma was identified in 15% of patients. Baseline demographic and clinical details are summarized in Table 1.

Table 1. Baseline Characteristics of Patients with Long Bone Fractures (n=100)

Variable	Frequency (%) or Mean ± SD
Age (years)	52.6 ± 16.8
Male sex	62 (62%)
Female sex	38 (38%)
Fracture site	
Femur	40 (40%)
Tibia/Fibula	32 (32%)
Humerus	18 (18%)
Radius/Ulna	10 (10%)
Fracture type	
Open	21 (21%)
Closed	79 (79%)
Polytrauma	15 (15%)

Preoperative Comorbidities: Preoperative medical comorbidities were common in this cohort. Hypertension was the most prevalent (42%), followed by diabetes mellitus (30%), anemia (28%), ischemic heart disease (15%), chronic kidney disease (10%), and chronic obstructive pulmonary disease (12%). Chronic liver disease was observed in 6%, and 20% of patients were classified as obese. According to ASA classification, 58% of patients were ASA I–II, while 42% were ASA III–IV. Details of comorbidities are shown in Table 2.

Table 2. Preoperative Comorbidities and ASA Status

Comorbidity	Frequency (n=100)	Percentage (%)
Hypertension	42	42%
Diabetes mellitus	30	30%
Anemia	28	28%
Ischemic heart disease	15	15%
Chronic kidney disease	10	10%
COPD	12	12%
Chronic liver disease	6	6%
Obesity (BMI ≥30)	20	20%
ASA I–II	58	58%
ASA III–IV	42	42%

Postoperative Complications: The overall 30-day complication rate was 26%. The most frequent complications were surgical site infection (9%), pulmonary complications (8%), acute kidney injury (5%), and major adverse cardiac events (4%). Delirium was noted in 3%, venous thromboembolism in 2%, and reoperation was required in 3% of cases. The overall mortality rate was 2%.

When comorbidities were analyzed, diabetes was strongly associated with surgical site infections (p=0.02), chronic kidney disease with postoperative acute kidney injury (p=0.004), and ischemic heart disease with major adverse cardiac events (p=0.01). Complications were significantly more common in ASA III–IV patients compared with ASA I–II (40% vs. 16%, p=0.001) (Table 3).

Table 3. Association of Comorbidities with Postoperative Complications

Comorbidity	SSI (%)	Pulmonary (%)	AKI (%)	MACE (%)	Overall Complications (%)
Diabetes (n=30)	6 (20%)	3 (10%)	2 (6.7%)	1 (3.3%)	12 (40%)
CKD (n=10)	1 (10%)	2 (20%)	3 (30%)	1 (10%)	7 (70%)
IHD (n=15)	2 (13.3%)	1 (6.7%)	1 (6.7%)	3 (20%)	7 (46.7%)
COPD (n=12)	1 (8.3%)	3 (25%)	0	1 (8.3%)	5 (41.7%)
Anemia (n=28)	2 (7.1%)	3 (10.7%)	1 (3.6%)	1 (3.6%)	7 (25%)
No comorbidity (n=29)	1 (3.4%)	1 (3.4%)	0	0	2 (6.9%)

Intraoperative Findings: General anesthesia was administered to 68% of patients, while regional anesthesia (spinal/epidural ± sedation) was used in 32%. Intraoperative anesthetic instability, defined as a ≥20% fall in mean arterial pressure requiring pharmacological intervention, was observed in 27% of cases.

Instability was more frequent among patients with ASA III–IV status (40.5%) compared with ASA I–II (17.2%) (p=0.003). Patients with ischemic heart disease and chronic kidney disease also had a significantly higher risk of intraoperative instability (p<0.05).

Hospital Stay and ICU Admission: The mean length of hospital stay was 7.4 ± 3.2 days. Patients who developed complications had significantly longer stays compared to those without complications (10.2 ± 3.8 vs. 6.1 ± 2.5 days, p<0.001). Intensive care unit admission was required in 14% of patients, predominantly among those with ASA III–IV classification or multiple comorbidities (Table 4).

Table 4. Length of Stay and ICU Admission by ASA Class

ASA Class	Mean Hospital Stay (days)	ICU Admission (%)
ASA I–II (n=58)	6.2 ± 2.4	7 (12.1%)
ASA III–IV (n=42)	9.0 ± 3.5	7 (16.7%)

In summary, the study demonstrated that preoperative comorbidities, particularly diabetes mellitus, ischemic heart disease, and chronic kidney disease, significantly increased anesthetic risk and postoperative complications in patients with long bone fractures. Higher ASA classification was strongly associated with intraoperative instability, prolonged hospital stay, increased ICU admission, and overall adverse outcomes.

DISCUSSION

This prospective clinical study conducted at POF Hospital, Wah Cantt, Pakistan, evaluated the impact of preoperative medical comorbidities on anesthetic risk and surgical outcomes among 100 patients with long bone fractures[10]. The results demonstrated that comorbidities such as diabetes mellitus, ischemic heart disease, chronic kidney disease, chronic obstructive pulmonary disease, and anemia significantly contributed to both intraoperative anesthetic instability and adverse postoperative outcomes. Moreover, patients with higher ASA classification (III–IV) were found to be at substantially increased risk of complications, prolonged hospitalization, and ICU admission[11].

Our findings are consistent with previous studies that highlight the role of comorbidities in determining perioperative outcomes[12]. Diabetes mellitus has been widely associated with impaired wound healing and increased susceptibility to surgical site infections due to compromised immune function and microvascular changes. In this study, diabetic patients exhibited a markedly higher incidence of SSIs, supporting existing evidence that strict perioperative glycemic control is essential to reduce infection risk[13].

Chronic kidney disease emerged as a strong predictor of acute kidney injury, with 30% of CKD patients developing postoperative renal complications[14]. This aligns with international reports indicating that impaired renal reserve predisposes patients to perioperative fluid and electrolyte imbalance, nephrotoxic insults, and poor recovery after major orthopedic surgery. These findings underscore the importance of careful perioperative renal protection strategies, including optimization of hydration status, avoidance of nephrotoxic drugs, and close monitoring of renal function[15].

Ischemic heart disease was strongly linked to major adverse cardiac events in the postoperative period. Patients with underlying coronary artery disease are vulnerable to myocardial ischemia during the stress of surgery and anesthesia, particularly when hypotension or anemia coexists[16]. Our results reinforce the role of preoperative cardiac risk assessment and perioperative cardiology consultation for fracture patients with known ischemic heart disease[17].

Similarly, patients with chronic obstructive pulmonary disease had a higher frequency of postoperative pulmonary complications[18]. This reflects their reduced pulmonary reserve, susceptibility to hypoxemia, and higher likelihood of postoperative respiratory infections. Preoperative optimization through bronchodilators, chest physiotherapy, and cautious anesthetic planning may reduce pulmonary morbidity in this subgroup[19].

Anemia was another significant comorbidity, associated with increased intraoperative hemodynamic instability and higher complication rates. Low hemoglobin reduces oxygen-carrying capacity and compromises tissue oxygenation, which is critical in surgical trauma patients. Early detection and correction of anemia, either through iron supplementation, erythropoiesis-stimulating agents, or transfusion when necessary, can improve perioperative outcomes[20,21].

The correlation between ASA classification and adverse outcomes in this study was particularly strong. Patients in ASA III–IV categories not only had a higher incidence of anesthetic instability but also experienced longer hospital stays and greater ICU admission rates. This reinforces the validity of ASA status as a practical predictor of surgical risk in orthopedic trauma patients[22,23].

Another important finding was the association of delayed surgery with worse outcomes and prolonged length of stay. Patients who underwent surgery more than 48 hours after admission had significantly higher complication rates[24]. While optimization of comorbidities often necessitates delays, unnecessary postponements should be avoided. Early stabilization of long bone fractures, wherever possible, is a key strategy to reduce morbidity and facilitate early mobilization[19,21].

The strengths of this study include its prospective design, structured data collection, and focus on a clinically important trauma population in a tertiary care setting. However, certain limitations should be acknowledged. The study was conducted in a single center with a modest sample size of 100 patients, which may limit generalizability. Furthermore, functional outcomes and long-term mortality were not assessed beyond 30 days. Future multicenter studies with larger cohorts and longer follow-up are warranted to validate these findings and explore strategies to mitigate risk in high-risk subgroups[25].

CONCLUSION

This study highlights that preoperative comorbidities significantly influence anesthetic risk and surgical outcomes in patients with long bone fractures. Diabetes mellitus increased the likelihood of surgical site infections, chronic kidney disease predisposed to acute kidney injury, ischemic heart disease was strongly associated with major adverse cardiac events, and COPD increased pulmonary complications. Anemia further contributed to hemodynamic instability and postoperative morbidity. Higher ASA classification was a reliable predictor of intraoperative instability, postoperative complications, prolonged hospital stay, and ICU admission. These findings emphasize the need for comprehensive preoperative assessment, timely optimization of comorbid conditions, and careful anesthetic planning in fracture patients. Wherever feasible, surgery should not be delayed beyond 48 hours, as unnecessary postponements increase the risk of adverse outcomes. Implementation of structured perioperative care pathways, focusing on early recognition and management of comorbidities, has the potential to improve patient safety, reduce complications, and shorten hospital stay in orthopedic trauma care.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions:

- **FT:** Conceptualization, study design, manuscript drafting.
- **SHA:** Data collection, methodology, critical revision of the manuscript.
- **MAS:** Statistical analysis, data interpretation.
- **MYM:** Literature review, manuscript editing.

- **KMY:** Clinical supervision, patient recruitment.
- **S:** Data acquisition, manuscript proofreading.All authors read and approved the final manuscript.

Acknowledgements: The authors would like to thank the surgical, anesthesiology, and nursing teams at POF Hospital, Wah Cantt, for their invaluable assistance during the study.

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This article may be cited as: Toheed F, Abbasi SH, Saeed MA, Memon MY, Yaqub KM, Saifullah; Impact of Preoperative Medical Comorbidities on Anesthetic Risk and Surgical Outcomes in Patients with Long Bone Fractures: A Clinical Study. Pak J Med Health Sci, 2023;18(1):558-561.