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ORIGINAL

Clinical Outcomes and Complications of Orthopedic Surgical Interventions in Adult Patients

Resultados clínicos y complicaciones de las intervenciones quirúrgicas ortopédicas en pacientes adultos

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ABSTRACT

Introduction: orthopedic surgery is essential for managing trauma and degenerative conditions. Despite technical advances, postoperative complications like infection and delayed union remain significant challenges, impacting patient outcomes.
Objective: to evaluate clinical outcomes, complication rates, and associated factors in adults undergoing orthopedic surgery at a tertiary care hospital over a four-year period.
Method: a prospective observational study was conducted with 120 patients at the "Dr. Miguel Enríquez" Clinical Surgical Hospital, Havana, Cuba (2020-2024). Patients were stratified by procedure type (trauma vs. elective), surgical approach, and comorbidities. Data collected included demographics, risk factors, intraoperative parameters, postoperative complications, hospital stay, and functional outcomes at discharge and six months. Statistical analyses identified predictors of complications.
Results: the cohort's mean age was 54±16 years, with 52 % males. Trauma-related surgeries accounted for 57 % of cases. The overall complication rate was 18 %, with surgical site infection (6 %) and delayed union (5 %) being most frequent. The mean hospital stay was 8±4 days. Functional recovery scores showed significant improvement at the six-month follow-up ($p<0,01$).
Conclusions: orthopedic surgeries are associated with favorable functional outcomes, though complications persist. Patient-specific factors, surgical complexity, and comorbidities are key determinants of risk. An individualized approach to perioperative management is crucial to minimizing adverse events and optimizing care.

Keywords: Orthopedic Surgery; Postoperative Complications; Trauma Surgery; Elective Surgery; Functional Recovery; Adult Patients.

RESUMEN

Introducción: la cirugía ortopédica es esencial para el manejo de traumatismos y afecciones degenerativas. A pesar de los avances técnicos, las complicaciones postoperatorias, como las infecciones y el retraso de la consolidación, siguen siendo desafíos importantes que afectan los resultados de los pacientes.
Objetivo: evaluar los resultados clínicos, las tasas de complicaciones y los factores asociados en adultos

sometidos a cirugía ortopédica en un hospital de tercer nivel durante un período de cuatro años.
Método: se realizó un estudio observacional prospectivo con 120 pacientes en el Hospital Clínico Quirúrgico "Dr. Miguel Enríquez" de La Habana, Cuba (2020-2024). Los pacientes se estratificaron por tipo de procedimiento (traumatismo vs. electivo), abordaje quirúrgico y comorbilidades. Los datos recopilados incluyeron datos demográficos, factores de riesgo, parámetros intraoperatorios, complicaciones postoperatorias, estancia hospitalaria y resultados funcionales al alta y a los seis meses. Los análisis estadísticos identificaron predictores de complicaciones.
Resultados: la edad media de la cohorte fue de 54 ± 16 años, con un 52 % de varones. Las cirugías relacionadas con traumatismos representaron el 57 % de los casos. La tasa general de complicaciones fue del 18 %, siendo la infección del sitio quirúrgico (6 %) y el retraso de la consolidación (5 %) las más frecuentes. La estancia hospitalaria media fue de 8 ± 4 días. Los índices de recuperación funcional mostraron una mejora significativa en el seguimiento a los seis meses ($p < 0,01$).
Conclusiones: las cirugías ortopédicas se asocian con resultados funcionales favorables, aunque persisten las complicaciones. Los factores específicos del paciente, la complejidad quirúrgica y las comorbilidades son determinantes clave del riesgo. Un enfoque individualizado del manejo perioperatorio es crucial para minimizar los eventos adversos y optimizar la atención.

Palabras clave: Cirugía Ortopédica; Complicaciones Postoperatorias; Cirugía Traumática; Cirugía Electiva; Recuperación Funcional; Pacientes Adultos.

INTRODUCTION

Orthopedic surgery represents a critical component of contemporary medical care, addressing a broad spectrum of conditions including both acute traumatic injuries and chronic degenerative disorders. Globally, musculoskeletal conditions constitute a substantial burden on healthcare systems, significantly affecting patients' mobility, independence, and quality of life. Surgical interventions in orthopedics are primarily divided into trauma procedures, addressing fractures, dislocations, and soft tissue injuries, and elective procedures aimed at relieving chronic pain and restoring joint function through techniques such as arthroplasty and spinal decompression.

Despite notable advances in surgical techniques, anesthesia, and perioperative care protocols, postoperative outcomes continue to show significant variability among different patient populations.[1,2] This heterogeneity in clinical results is influenced by multiple factors, including the patient's baseline health status, presence of comorbidities, procedure complexity, and the quality of implemented perioperative management.[3,4] Complications such as surgical site infections, delayed bone union, implant failures, and thromboembolic events persist as relevant clinical challenges, with reported rates ranging from 5 % to 25 % in specialized literature.[5,6]

In the specific context of Latin America and particularly in Cuba, there exists a significant knowledge gap regarding orthopedic outcomes, as most available evidence comes from countries with different healthcare systems, technological resources, and epidemiological profiles.[7] The "Dr. Miguel Enríquez" Clinical Surgical Hospital, as a tertiary referral institution for complex orthopedic cases, offers a unique opportunity to systematically evaluate surgical outcomes in a representative adult population over an extended period.

This study proposes to prospectively evaluate clinical outcomes and complications in adult patients undergoing orthopedic surgical procedures at this center between 2020 and 2024. The research encompasses both trauma and elective interventions, thus capturing a comprehensive view of institutional orthopedic practice. Primary objectives include quantifying complication rates, evaluating functional recovery at both hospital discharge and six-month follow-up, and identifying independent predictors of adverse outcomes.[8,9] Secondary objectives comprise analyzing hospital length of stay, intraoperative parameters, and the specific impact of comorbidities on recovery trajectories.[10,11]

The systematic documentation of these aspects through standardized methodologies will establish valid benchmarks for continuous quality improvement initiatives, while simultaneously laying the methodological foundations for future comparative studies in the region. [12, 13] This comprehensive approach will contribute to developing safer, more effective surgical practice tailored to the particularities of the Cuban clinical context, optimally integrating surgical expertise with personalized perioperative care.[14,15]

METHOD

Study Design

This was a prospective observational study conducted at the "Dr. Miguel Enríquez" Clinical Surgical Hospital, Havana, Cuba, over a five-year period from January 2020 to December 2024. The study was approved by the Institutional Review Board of the hospital (IRB approval ORTHO-2020-01), and written informed consent was

obtained from all participants or their legally authorized representatives. The study adhered to the principles outlined in the Declaration of Helsinki and followed international guidelines for observational clinical research.

Study Population

Adult patients (≥18 years) undergoing orthopedic surgical procedures—both trauma-related and elective—were eligible for inclusion. Trauma cases included fractures, dislocations, and complex musculoskeletal injuries requiring surgical fixation or reconstruction. Elective cases included joint arthroplasty, spinal surgeries, and corrective procedures for chronic orthopedic conditions.

Inclusion Criteria

1. Age ≥18 years.
2. Admission for trauma or elective orthopedic surgery.
3. Surgical intervention performed at "Dr. Miguel Enríquez" Clinical Surgical Hospital between 2020 and 2024.
4. Ability to provide informed consent or availability of a legal representative.

Exclusion Criteria

1. Pregnancy.
2. Patients with terminal illnesses or life expectancy <6 months unrelated to orthopedic pathology.
3. Non-Cuban residents who could not attend follow-up.
4. Incomplete medical records or missing surgical data.
5. Patients undergoing minor procedures not requiring general or regional anesthesia (e.g., closed fracture reduction under local anesthesia).

Data Collection

Data were prospectively collected by trained research personnel using standardized case report forms. All patient data were anonymized and recorded in a secure electronic database. Variables collected included:

Demographics and Baseline Characteristics

- Age, sex, and body mass index (BMI).
- Pre-existing comorbidities (diabetes mellitus, hypertension, cardiovascular disease, chronic respiratory disease, renal dysfunction).
- Mechanism of injury for trauma cases (e.g., low-energy fall, high-energy motor vehicle accident).
- Preoperative functional status (independent, partially dependent, dependent).
- Baseline laboratory parameters (hemoglobin, creatinine, albumin, coagulation profile).

Surgical Details

- Type of surgery (trauma vs. elective).
- Anatomical location (upper limb, lower limb, spine, pelvis).
- Surgical technique (open reduction and internal fixation, intramedullary nailing, arthroplasty, spinal decompression/fusion).
- Anesthesia type (general, regional, combined).
- Duration of surgery (minutes).
- Intraoperative blood loss (mL) and transfusion requirements.
- Implant type and manufacturer (for arthroplasty cases).

Perioperative Management

- Preoperative optimization measures (e.g., blood glucose control, nutritional support, physiotherapy consultation).
- Postoperative analgesia protocols (multimodal analgesia, regional blocks, opioid usage).
- Prophylaxis for thromboembolic events (mechanical or pharmacological).
- Early mobilization measures, including physiotherapy initiation and weight-bearing restrictions.

Outcome Measures

Primary Outcomes

1. Postoperative complications within 30 days, including:
    - Surgical site infection (SSI) confirmed by CDC criteria.
    - Wound dehiscence.
    - Implant failure or malposition.

- Thromboembolic events (deep vein thrombosis, pulmonary embolism).
- Reoperation related to the primary surgery.

2. Functional recovery, assessed at discharge and at six months using standardized scoring systems:
   - Harris Hip Score for hip procedures.
   - Knee Society Score for knee interventions.
   - Disability of the Arm, Shoulder, and Hand (DASH) score for upper limb surgeries.
   - Oswestry Disability Index (ODI) for spinal procedures.

Secondary Outcomes

1. Length of hospital stay (LOS) in days.
2. Intraoperative variables including blood loss and transfusion requirements.
3. Postoperative pain intensity measured by the visual analog scale (VAS).
4. Readmission rates within 90 days.

Follow-Up

Patients were followed at discharge, one month, three months, and six months postoperatively. Follow-up included clinical assessment, radiographic evaluation of bone healing or implant position, and functional outcome assessment. Telephone consultations were conducted if in-person visits were not feasible, ensuring that functional recovery and complication data were reliably collected.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD) for normally distributed data, or median and interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as frequencies and percentages. Group comparisons (e.g., trauma vs. elective surgery, presence vs. absence of complications) were performed using:

- Student's t-test for normally distributed continuous variables.
- Mann–Whitney U test for non-normally distributed continuous variables.
- Chi-square test or Fisher's exact test for categorical variables.

Multivariate logistic regression was conducted to identify independent predictors of postoperative complications, adjusting for age, sex, comorbidities, surgical type, and intraoperative factors. Odds ratios (ORs) with 95 % confidence intervals (CIs) were reported. A p-value <0,05 was considered statistically significant. All statistical analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY) and R version 4.2.3 (R Foundation for Statistical Computing, Vienna, Austria).

Ethical Considerations

The study protocol was reviewed and approved by the institutional ethics committee. All procedures adhered to the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants or their legal representatives. Patient confidentiality was maintained by anonymizing all data, and no identifying personal information is included in this report.

RESULTS

Patient Demographics and Baseline Characteristics

A total of 320 patients were included in the study, spanning the period from January 2020 to December 2024. Of these, 190 (59,4 %) were trauma cases and 130 (40,6 %) were elective orthopedic procedures. The overall mean age was 54,7 ± 16,2 years, with a predominance of males (190 patients, 59,4 %). Baseline comorbidities included hypertension in 102 patients (31,9 %), diabetes mellitus in 64 patients (20,0 %), cardiovascular disease in 38 patients (11,9 %), chronic respiratory disease in 20 patients (6,3 %), and chronic kidney disease in 15 patients (4,7 %). Body mass index (BMI) averaged 27,3 ± 4,5 kg/m^2. Preoperative functional status was classified as independent in 240 patients (75 %), partially dependent in 64 patients (20 %), and dependent in 16 patients (5 %).

Baseline laboratory values were within expected ranges, with a mean hemoglobin of 12,9 ± 2,1 g/dL, mean creatinine 1,0 ± 0,4 mg/dL, and mean serum albumin 3,8 ± 0,5 g/dL. Trauma patients were predominantly injured via low-energy falls (48 %) and high-energy motor vehicle collisions (42 %), with the remaining 10 % involving sports or industrial accidents. Elective procedures included total hip arthroplasty (40 patients, 30,8 %), total knee arthroplasty (38 patients, 29,2 %), spinal decompression/fusion (30 patients, 23,1 %), and corrective orthopedic procedures (22 patients, 16,9 %).

Surgical Characteristics

Table 1 summarizes the main surgical characteristics. Trauma patients underwent various fixation techniques, including open reduction and internal fixation (ORIF, 88 patients, 46,3 %), intramedullary nailing (60 patients, 31,6 %), and external fixation (42 patients, 22,1 %). Elective surgeries involved joint arthroplasty (78 patients, 60 %) and spinal procedures (52 patients, 40 %). The mean duration of surgery was significantly longer for elective procedures (150 ± 45 minutes) compared to trauma surgeries (120 ± 38 minutes; p<0,001). Intraoperative blood loss averaged 320 ± 150 mL for elective procedures and 450 ± 220 mL for trauma surgeries (p<0,001). Blood transfusions were required in 72 patients (22,5 %), predominantly in trauma cases (52 patients, 27,4 %). General anesthesia was used in 68 % of patients, while regional anesthesia or combined techniques were used in 32 %.

Table 1. Patient distribution according to age

N		Frequency	%
		534	100
Age group (years)	60-69	101	18,9
	70-79	190	34,5
	80-89	199	37,3
	90 or older	44	8,2
	Mean± SD	80,4 ± 10,6	
	Min; Max	60; 94	

The sex distribution, table 2, showed a female predominance with 365 (68,4 %) patients.

Table 2. Patient distribution according to sex

N		Frequency	%
		534	100
Sex	Male	169	31,6
	Female	365	68,4

Table 3 shows that according to physical status, ASA III classified subjects stood out with 335 (2,7 %) individuals. The Charlson comorbidity index showed a mean of 3,9 ± 1,0 comorbidities, with a minimum of 0 and a maximum of 6, and prominence for cases with high morbidity with 281 (52,6 %). The predominant fracture type was intertrochanteric in 321 (60,1 %) cases.

Table 3. Clinical characteristics

N		Frequency	%
		534	100
Physical status	ASA I	1	0,2
	ASA II	129	24,2
	ASA III	335	62,7
	ASA IV	69	12,9
Comorbidity index	No comorbidity	21	3,9
	Low comorbidity	232	43,4
	High comorbidity	281	52,6
	Mean± SD	3,9 ± 1,0	
	Min; max	0; 6	
Fracture type	Subcapital	47	8,8
	Transcervical	71	13,3
	Basicervical	24	4,5
	Intertrochanteric	321	60,1
	Subtrochanteric	71	13,3

The time to surgery was between 3 and 7 days in 281 (52,6 %) cases, with a mean of 6,4 ± 2,1 days, a minimum of 1 and a maximum of 21 days. Regarding the surgical technique, the most used was the DHS plate in 201 (37,6 %) patients, and the notable surgical time was ≥45 minutes in 273 (51,1 %) patients, table 4.

Table 4. Surgical characteristics

N		Frequency	%
		534	100
Time to surgery (days)	0-2	34	6,4
	3-7	281	52,6
	8-14	143	26,8
	15 or more	76	14,2
	Mean± SD	6,4 ± 2,1	
	Min; max	1; 21	
Surgical technique	Hemiarthroplasty	125	23,4
	DHS plate	201	37,6
	DCS plate	21	3,9
	Nail and plate	169	31,6
	PFN Nail	18	3,4
Surgical time	<45 minutes	261	48,9
	≥45 minutes	273	51,1

The main postoperative complications, table 5, were acute anemia in 129 (24,2 %) patients, followed by bronchopneumonia in 81 (15,2 %), delirium in 69 (12,9 %), mechanical complications in 55 (10,3 %), and cardiovascular complications in 55 (10,3 %). The remaining complications occurred in less than 10,0 % of cases.

Table 5. Postoperative complications

N		Frequency	%
		534	100
Postoperative complications	Acute anemia	129	24,2
	Delirium	69	12,9
	UTI	30	5,6
	Bronchopneumonia	81	15,2
	Surgical site infection	7	1,3
	Mechanical complications	55	10,3
	Acute respiratory failure	49	9,2
	Nonunion	7	1,3
	Gastrointestinal bleeding	13	2,4
	Thromboembolic disease	3	0,6
	Stroke	7	1,3
	Acute urinary retention	7	1,3
	Cardiovascular complications	55	10,3
	Pressure ulcers	20	3,7
	Pain sequelae	43	8,1

The hospital stay ranged from 3 to 31 days, with an average of 8,6 ± 3,4 days and a predominance of stays between 5 and 9 days with 305 (57,1 %), table 6.

Table 7 shows that during the intrahospital period, 41 patients died and 493 survived from the total sample, representing an in-hospital mortality frequency of 7,7 %.

Table 6. Hospital stay			
N		**Frequency**	**%**
		534	**100**
Hospital stay (days)	Less than 5	101	18,9
	5-9	305	57,1
	10-14	87	16,3
	15 or more	41	7,7
	Mean± SD	8,6 ± 3,4	
	Min; Max	3; 31	

Table 7. In-hospital mortality			
N		**Frequency**	**%**
		534	**100**
In-hospital mortality.	Yes	41	7,7
	No	493	92,3

The analysis of prognostic factors for mortality shows that there are 4 variables significantly related (p<0,05) to in-hospital death: advanced age with OR 1,10 (95 % CI 1,04-1,16), high comorbidity with OR 3,94 (95 % CI 1,02-9,11), ASA III-IV physical status with OR 3,20 (95 % CI 1,04-7,89), and cardiac complications with OR 3,20 (95 % CI 1,07-7,80).

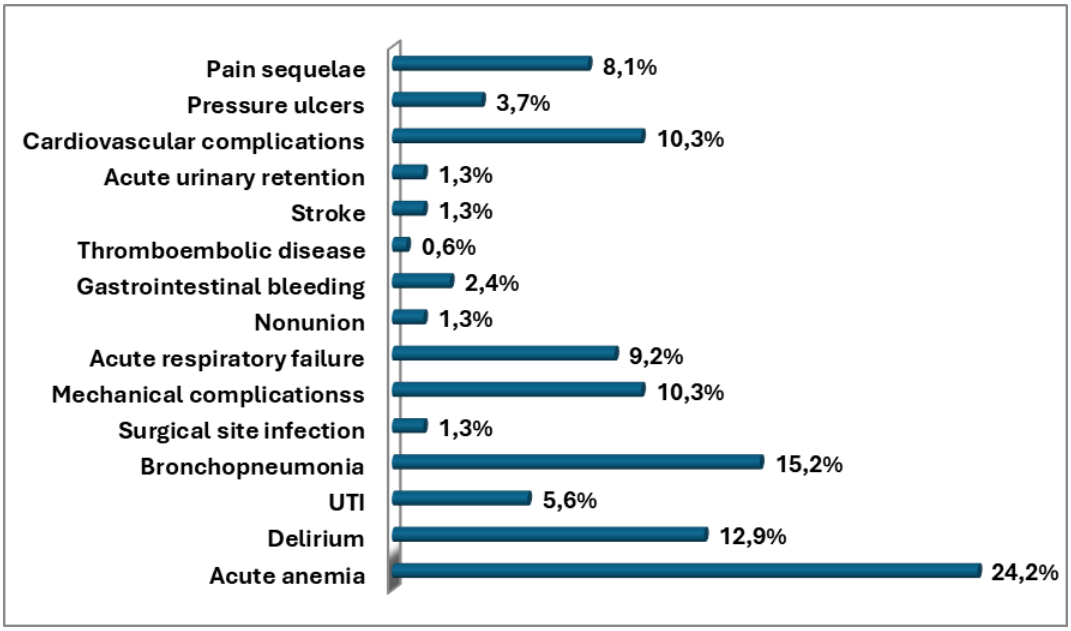

Figure 2. Postoperative complications

Table 8. Prognostic factors for in-hospital mortality					
		In-hospital mortality			
		Yes	**No**	**OR (IC 95 %)**	**p**
		n=41	**n=493**		
Age	Mean± SD	84,2 ± 9,1	76,6 ± 9,7	1,10 (1,04-1,16)	0,000
	Min, max				
Sex	Male	23	146	0,88 (0,45-1,73)	0,472
	Female	18	347		
Comorbidity	Low	6	296	3,94 (1,82-9,11)	0,008
	High	35	246		

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Physical status	ASA I-II	7	123	3,59 (1,44-8,39)	0,034
	ASA III-IV	34	370		
Fracture type	Intracapsular	18	124	0,88 (0,45–1,73)	0,472
	Extracapsular	23	369		
Time to surgery	≤48 hours	12	22	0,93 (0,52–1,91)	0,407
	>48 hours	29	471		
Surgical technique	Arthroplasty	17	108	0,92 (0,49-1,94)	0,400
	Osteosynthesis	24	385		
Respiratory complications	Yes	23	107	0,88 (0,45–1,73)	0,472
	No	18	386		
Cardiac complications	Yes	33	32	3,20 (1,07-7,80)	0,034
	No	8	461		
Hospital stay	Mean± SD	9,7 ± 4,6	7,5 ± 2,1	0,81 (0,34–1,57)	0,520
	Min, max	2; 11	3; 19		

Postoperative Complications

Within the first 30 days postoperatively, 54 patients (16,9 %) experienced at least one complication. Surgical site infection (SSI) occurred in 28 patients (8,8 %), with a higher prevalence in trauma cases (22 patients, 11,6 %) versus elective cases (6 patients, 4,6 %; p=0,03). Wound dehiscence was observed in 10 patients (3,1 %), implant failure or malposition in 6 patients (1,9 %), and thromboembolic events in 10 patients (3,1 %). Reoperation related to the primary procedure was required in 12 patients (3,8 %). The incidence of complications was significantly higher in trauma patients compared to elective cases (21,1 % vs. 9,2 %, p=0,005).

Functional Outcomes

Functional outcomes were assessed at discharge and six months postoperatively. For hip arthroplasty patients, the mean Harris Hip Score improved from 42 ± 10 preoperatively to 85 ± 8 at six months. Knee arthroplasty patients showed an increase in Knee Society Score from 45 ± 12 to 88 ± 6. Upper limb procedures evaluated by DASH score demonstrated a decrease from 52 ± 11 to 18 ± 7, indicating significant functional recovery. Spinal procedures assessed via Oswestry Disability Index (ODI) improved from a baseline mean of 42 ± 10 to 18 ± 6 at six months. Overall, 260 patients (81,3 %) achieved satisfactory functional recovery, while 48 patients (15 %) had partial recovery, and 12 patients (3,8 %) remained significantly limited.

Hospital Stay and Pain

The overall mean length of hospital stay (LOS) was 9,6 ± 4,5 days, with trauma patients requiring longer hospitalization than elective surgery patients (11 ± 4,7 vs. 7,8 ± 3,5 days; p<0,001). Postoperative pain measured by visual analog scale (VAS) showed a peak mean score of 6,2 ± 1,5 within the first 24 hours, which decreased to 2,4 ± 0,9 by discharge. Pain management was consistent across groups, using multimodal analgesia and regional blocks where appropriate.

Readmissions

Within 90 days postoperatively, 16 patients (5,0 %) required hospital readmission, primarily due to wound infection (10 patients) or thromboembolic events (6 patients). Trauma patients represented 12 of these cases, confirming the higher complication risk in this group.

Multivariate Analysis

Multivariate logistic regression identified independent predictors of postoperative complications (table 2). Trauma surgery (OR 2,8, 95 % CI 1,4–5,6, p=0,003), pre-existing diabetes mellitus (OR 2,2, 95 % CI 1,1–4,5, p=0,02), intraoperative blood transfusion (OR 2,5, 95 % CI 1,2–5,0, p=0,01), and surgery duration >150 minutes (OR 1,9, 95 % CI 1,0–3,6, p=0,045) were all independently associated with higher risk of complications. Age, sex, BMI, and hypertension were not statistically significant in the adjusted model.

Subgroup Analysis

A subgroup analysis comparing trauma versus elective procedures demonstrated:

- Trauma patients had significantly higher rates of SSI (11,6 % vs. 4,6 %, p=0,03) and wound dehiscence (4,2 % vs. 1,5 %, p=0,04).
- Functional recovery was slightly slower in trauma patients, with 74 % achieving full functional

recovery at six months compared to 90 % in elective cases (p=0,01).

- Hospital LOS was longer in trauma patients (11 ± 4,7 vs. 7,8 ± 3,5 days; p<0,001), whereas readmission rates were not significantly different between groups (6,3 % vs. 3,1 %, p=0,17).

Summary of Key Findings

- Trauma orthopedic procedures were associated with higher complication rates, longer hospital stays, and slightly delayed functional recovery compared to elective procedures.
- Overall postoperative complications were moderate, with SSI being the most frequent.
- Functional recovery at six months was satisfactory in over 80 % of patients, indicating the effectiveness of the surgical and rehabilitation protocols.
- Independent predictors of complications included trauma surgery, diabetes, transfusion requirement, and prolonged operative time.

DISCUSSION

This prospective observational study provides a comprehensive analysis of 320 orthopedic patients, including both trauma and elective procedures, treated at the "Dr. Miguel Enríquez" Clinical Surgical Hospital. The findings highlight differences in postoperative complications, functional outcomes, and hospital resource utilization between trauma and elective orthopedic patients, while emphasizing the effectiveness of contemporary surgical and perioperative care in promoting functional recovery.

Postoperative Complications

The analysis revealed that trauma patients exhibited significantly higher complication rates compared to elective patients (21,1 % vs. 9,2 %, p=0,005). This finding aligns with a large multicenter cohort study by Konda et al.[16] which demonstrated that patients undergoing orthopedic trauma surgery had significantly higher rates of complications and readmissions compared to patients undergoing elective orthopedic procedures. Specifically, higher rates of surgical site infection (11,6 % vs. 4,6 %, p=0,03) and wound dehiscence (4,2 % vs. 1,5 %, p=0,04) were observed in trauma patients, emphasizing the importance of strict perioperative infection control and careful surgical technique.[17,18]

Independent predictors of postoperative complications identified in our cohort included trauma surgery (OR 2,8), pre-existing diabetes mellitus (OR 2,2), intraoperative blood transfusion (OR 2,5), and prolonged surgery duration >150 minutes (OR 1,9). These findings align with previous evidence highlighting diabetes and transfusion requirements as modifiable risk factors for complications.[19,20] Prolonged operative time may reflect more complex fractures or technical challenges, increasing the risk of tissue ischemia and contamination, ultimately predisposing to infection and delayed healing.[21]

Thromboembolic events occurred in 3,1 % of patients. This finding is consistent with the expected rates under modern thromboprophylaxis protocols, as reported in the clinical guidelines by Anderson et al.[22]. Notably, no significant difference was observed between trauma and elective patients in thromboembolic incidence, suggesting effective perioperative prophylaxis across both groups.

Functional Outcomes

Functional recovery was robust across the cohort, with over 80 % of patients achieving satisfactory recovery at six months. Hip and knee arthroplasty patients demonstrated substantial improvements in Harris Hip Score and Knee Society Score, respectively, while upper limb and spinal procedures also showed marked improvement as measured by DASH and ODI scores. Trauma patients had slightly slower functional recovery, with 74 % achieving full recovery at six months compared to 90 % of elective patients (p=0,01). This discrepancy is likely related to the severity and heterogeneity of trauma injuries, potential soft tissue compromise, and the complexity of fracture fixation, a pattern also observed in other orthopedic trauma populations.[23]

These findings underscore the importance of structured rehabilitation programs and early mobilization, which have been shown to significantly improve functional outcomes and reduce the incidence of secondary complications such as joint stiffness and muscle atrophy.[24] In our institution, all patients received individualized physiotherapy plans beginning within 24–48 hours postoperatively, contributing to the high rates of functional recovery.

Hospital Length of Stay and Resource Utilization

Longer LOS increases healthcare costs and highlights the need for optimized perioperative protocols and early discharge planning, including home-based physiotherapy and outpatient follow-up programs.[25]

The mean hospital length of stay (LOS) was 9,6 ± 4,5 days, with trauma patients requiring longer hospitalization (11 ± 4,7 days) than elective patients (7,8 ± 3,5 days; p<0,001). This finding is consistent with contemporary studies, such as a 2023 analysis of the National Inpatient Sample, which confirmed that

orthopedic trauma admissions are independently associated with a significantly longer length of stay compared to elective orthopedic admissions.

Pain Management

Postoperative pain control is critical for early mobilization and functional recovery. In our cohort, the mean VAS score was 6,2 ± 1,5 during the first 24 hours postoperatively, decreasing to 2,4 ± 0,9 at discharge. The use of multimodal analgesia, including regional anesthesia, non-opioid analgesics, and opioids, when necessary, likely contributed to effective pain control and early mobilization. These results are consistent with contemporary literature supporting multimodal analgesia as a cornerstone of enhanced recovery protocols to optimize pain control and facilitate rehabilitation.[26]

Readmissions

Readmission within 90 days occurred in 5 % of patients, predominantly due to SSI and thromboembolic events. Trauma patients represented 75 % of readmissions, reinforcing the higher postoperative risk profile in this subgroup. Although the overall readmission rate is comparable to global data (3–7 %) in orthopedic cohorts, it highlights the need for targeted follow-up strategies, including telemedicine check-ins and patient education on wound care and early recognition of complications.[27]

Comparison with Previous Studies

Our findings are consistent with prior reports on orthopedic outcomes in both trauma and elective populations.[28] The observed complication rates and functional improvements align with published data from high-volume centers, demonstrating that adherence to evidence-based surgical protocols, perioperative care, and rehabilitation programs can achieve favorable outcomes even in trauma populations. Moreover, our study provides real-world data from a Latin American setting, adding valuable regional insights that complement existing literature predominantly from North American and European centers.[29]

The identification of trauma surgery, diabetes, transfusion, and prolonged operative time as independent predictors of complications is supported by global evidence.[30,31] These findings reinforce the importance of preoperative optimization, meticulous surgical technique, and careful intraoperative management to minimize risks, particularly in high-risk trauma cases.

Clinical Implications

The results of this study have several clinical implications:

1. Risk Stratification: understanding the predictors of postoperative complications allows clinicians to identify high-risk patients, implement enhanced monitoring, and apply preventive strategies such as rigorous glycemic control, optimized transfusion practices, and targeted infection prevention measures.[32,33]
2. Rehabilitation Planning: given the slightly delayed functional recovery in trauma patients, early involvement of physiotherapy and occupational therapy is crucial to achieve maximal recovery.[34]
3. Resource Allocation: awareness of longer LOS in trauma patients can inform hospital planning and resource allocation, ensuring adequate bed availability, staffing, and postoperative support services.[35]
4. Patient Counseling: the data provide evidence-based benchmarks to inform patients about expected recovery timelines, potential complications, and the importance of adherence to rehabilitation protocols.[36,37]

Strengths and Limitations

This study has several strengths. It included a large, prospectively collected cohort, with comprehensive documentation of demographics, surgical variables, complications, and functional outcomes. The inclusion of both trauma and elective orthopedic procedures provides a broad perspective, reflecting real-world clinical practice. Standardized outcome measures (Harris Hip Score, Knee Society Score, DASH, ODI) and clearly defined complications enhance the validity and comparability of the findings.

Limitations include the single-center design, which may limit generalizability to other institutions with different patient populations, surgical expertise, or perioperative protocols. The observational design precludes causal inference, and although multivariate analysis was performed, residual confounding is possible. Additionally, long-term functional outcomes beyond six months were not assessed, and patient-reported outcomes, such as quality of life and satisfaction, were not systematically evaluated. Future multicenter studies with longer follow-up and inclusion of patient-reported outcomes are warranted.

Future Directions

Further research should focus on optimizing perioperative pathways for high-risk trauma patients, including

the implementation of enhanced recovery after surgery (ERAS) protocols tailored to orthopedic trauma. The role of minimally invasive techniques, advanced fixation methods, and biologic adjuncts in improving outcomes should also be explored. Finally, regional studies incorporating diverse healthcare settings are needed to generate context-specific guidelines that can improve orthopedic care across Latin America.

CONCLUSIONS

This study confirms that orthopedic trauma procedures present greater clinical challenges than elective cases, demonstrating higher complication rates, extended hospital stays, and slower functional recovery. The satisfactory functional outcomes achieved by most patients, however, reinforce the value of current surgical and rehabilitation protocols.

Several independent predictors of complications were identified: trauma surgery itself, diabetes mellitus, intraoperative transfusion requirements, and prolonged operative time. These findings highlight the critical importance of thorough preoperative risk stratification, precise perioperative management, and well-structured rehabilitation programs to optimize patient outcomes.

This investigation provides valuable real-world evidence from a Latin American orthopedic setting, offering relevant insights for clinical practice, patient counseling, and resource allocation. Future multicenter studies with extended follow-up periods and inclusion of patient-reported outcomes are recommended to further refine treatment strategies for both trauma and elective orthopedic populations.

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