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Surgical outcomes among internally displaced persons during armed conflict in Sudan: a retrospective study from a referral emergency hospital

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Abstract

Background

The ongoing armed conflict in Sudan has resulted in widespread internal displacement and severe disruption of healthcare services, limiting access to timely surgical care. Internally displaced persons (IDPs) frequently present with advanced surgical conditions and are at increased risk of adverse postoperative outcomes. However, evidence describing surgical outcomes among IDPs in Sudan remains limited. This study aimed to evaluate the pattern of surgical disease, postoperative outcomes, and factors associated with poor surgical outcomes among internally displaced persons undergoing surgery at Rabak Teaching Hospital during the armed conflict in Sudan.

Methods

A retrospective hospital-based observational study was conducted at Rabak Teaching Hospital, White Nile State, Sudan. Medical records of 206 internally displaced patients who underwent surgical procedures between April 2023 and September 2024 were reviewed. Additional postoperative follow-up and patient satisfaction data were collected through telephone interviews with all participants. Descriptive statistics were used to summarize the data. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test where appropriate. Multivariable binary logistic regression analysis was performed to identify independent predictors of poor surgical outcomes, with statistical significance set at $p < 0.05$.

Results

Among the 206 patients included in the study, 125 (60.7%) underwent emergency surgery. Benign surgical conditions (28.6%), acute abdominal conditions (21.8%), infection-related conditions (20.4%), and trauma (20.3%) were the most common surgical presentations. Postoperative complications occurred in 83 (40.3%) patients, with surgical site infection being the most frequent complication (16.0%). At postoperative follow-up, 122 (59.2%) patients achieved full recovery, whereas 84 (40.8%) experienced a poor surgical outcome. Increasing age, emergency surgery, and the occurrence of postoperative complications were independently associated with poor surgical outcomes.

Conclusion

Internally displaced persons undergoing surgery during the armed conflict in Sudan experienced a high burden of emergency surgical disease and postoperative complications. Increasing age, emergency surgery, and postoperative complications were independently associated with poor surgical outcomes. Strengthening emergency surgical services, infection prevention and control measures, perioperative

care, and referral systems may improve surgical outcomes for displaced populations in humanitarian settings.

Introduction

Armed conflict is one of the leading causes of population displacement and disruption of healthcare systems worldwide. Since the outbreak of armed conflict in Sudan in April 2023, millions of people have been forcibly displaced within the country, creating one of the world's largest humanitarian crises. Internally displaced persons (IDPs) frequently experience overcrowding, poor sanitation, food insecurity, and limited access to essential healthcare services, all of which contribute to increased morbidity and mortality. The destruction of healthcare infrastructure, shortages of medical personnel and supplies, and disruption of referral systems have further reduced access to timely surgical care.

Surgical conditions represent a substantial but often overlooked component of the disease burden in humanitarian emergencies. In conflict-affected settings, delayed presentation and restricted access to healthcare frequently result in advanced disease requiring emergency surgical intervention. In addition to conflict-related injuries, displaced populations continue to experience a wide range of common surgical conditions, including benign surgical diseases, acute abdominal emergencies, infections, malignancies, and intestinal obstruction. These conditions may be associated with increased postoperative complications and poorer clinical outcomes when definitive surgical care is delayed.

Although surgery is increasingly recognized as an essential component of humanitarian health responses, evidence regarding surgical outcomes among internally displaced populations remains limited, particularly in low-resource and conflict-affected countries. Most published studies have focused on trauma surgery or refugee populations outside Sudan, while information describing the broader spectrum of surgical disease and postoperative outcomes among Sudanese IDPs is scarce. This lack of evidence limits the ability of healthcare providers and policymakers to plan surgical services, allocate resources effectively, and improve the quality of care during humanitarian crises.

Rabak Teaching Hospital is the principal referral hospital in White Nile State and has continued to provide emergency and essential surgical services despite the challenges imposed by the ongoing conflict. The hospital serves a large population of internally displaced persons referred from displacement camps and host communities across several Sudanese states. Evaluating surgical outcomes in this setting provides valuable insight into the burden of surgical disease and the performance of surgical services under conditions of prolonged conflict.

Therefore, this study aimed to evaluate the pattern of surgical disease, operative characteristics, postoperative complications, and surgical outcomes among internally displaced persons undergoing surgery at Rabak Teaching Hospital during the armed conflict in Sudan. In addition, the study sought to identify factors independently associated with poor surgical outcomes to inform strategies for improving surgical care in humanitarian settings.

CHAPTER 3 — METHODS

3.1 Study Design and Setting

Study Design and Setting

This study was a retrospective hospital-based observational study conducted at Rabak Teaching Hospital, the principal referral and teaching hospital in White Nile State, Sudan. The hospital provides emergency and elective surgical services to residents of White Nile State and neighboring regions and has served as a major referral center for internally displaced persons (IDPs) throughout the ongoing armed conflict in Sudan.

The study reviewed the medical records of internally displaced patients who underwent surgical procedures between April 2023 and September 2024. During this period, Rabak Teaching Hospital continued to provide essential surgical services despite significant challenges, including shortages of medical supplies, limited healthcare personnel, increased patient volume, and disruption of referral pathways resulting from the armed conflict.

Study Population and Participant Selection

The study population comprised internally displaced persons (IDPs) who underwent surgical procedures at Rabak Teaching Hospital between April 2023 and September 2024. During the study period, 425 IDP patients underwent surgery at the hospital.

Medical records were reviewed retrospectively, and 206 patient records that met the study eligibility criteria and contained complete information on the study variables were included in the final analysis. Records with incomplete or insufficient clinical information required for the study were excluded.

Obstetric and gynecological procedures were excluded because these patients were managed in a separate department and were outside the scope of the present study.

Data Collection

Data were collected retrospectively using a structured data collection form developed specifically for this study. Eligible patients were initially identified through a review of medical records at Rabak Teaching Hospital. Demographic characteristics, clinical presentation, surgical diagnosis, type and urgency of surgery, type of anesthesia, length of hospital stay, postoperative complications, intensive care unit (ICU) admission, and discharge information were extracted from the patients' medical records.

To obtain information that was not routinely available in the medical records, particularly postoperative follow-up outcomes and patient satisfaction, all eligible patients were contacted successfully by telephone. Telephone interviews were conducted using the structured data collection form to ensure

standardized data collection. This approach enabled complete follow-up information to be obtained for all 206 participants included in the study.

The collected variables included age, sex, occupation, state of displacement, current residence, type of surgical condition, urgency of surgery, type of anesthesia, length of hospital stay, postoperative complications, postoperative ICU admission, surgical outcome at follow-up, and patient satisfaction with the surgical care received.

Surgical diagnoses were classified according to the International Classification of Diseases, Tenth Revision (ICD-10) to ensure consistency in disease classification. Before the main data collection, the data collection form was reviewed by experts from the Department of General Surgery at El Imam El Mahdi University to assess its content validity, clarity, and relevance. A pilot study was subsequently conducted, and minor modifications were made before the commencement of the main study.

Study Variables

The primary outcome of this study was the surgical outcome at postoperative follow-up. Based on the follow-up assessment, outcomes were categorized into good and poor surgical outcomes. A good surgical outcome was defined as complete recovery, while a poor surgical outcome included patients who were still receiving treatment, had been referred to a higher-level hospital for further management, or had died.

The independent variables included demographic characteristics (age, sex, occupation, state of displacement, and current residence), clinical characteristics (type of surgical condition and length of hospital stay), operative characteristics (type and urgency of surgery, and type of anesthesia), postoperative variables (postoperative complications and intensive care unit [ICU] admission), and patient satisfaction with surgical care.

For the multivariable logistic regression analysis, the dependent variable was coded as good surgical outcome (0) and poor surgical outcome (1). Variables considered clinically relevant and those showing an association with the outcome in the univariable analysis were entered into the multivariable model to identify independent predictors of poor surgical outcomes.

Statistical Analysis

Data were entered, cleaned, coded, and analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp., Armonk, NY, USA). Data quality was assessed before analysis by checking for completeness, consistency, and data entry errors.

Descriptive statistics were used to summarize the study variables. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using appropriate measures of central tendency and dispersion.

Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test, where appropriate. Variables considered clinically relevant and those showing an association with the outcome in the univariable analysis were entered into a multivariable binary logistic regression model to identify independent predictors of poor surgical outcomes.

The results of the logistic regression analysis were presented as adjusted odds ratios (AORs) with their corresponding 95% confidence intervals (95% CIs). A two-sided p-value of less than 0.05 was considered statistically significant for all analyses.

Ethical Considerations

Ethical approval

and administrative permission to conduct this study were obtained from Rabak Teaching Hospital, White Nile State, Sudan, through the Office of the General Medical Director before the commencement of the study (Approval letter dated 2 February 2023).

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. As the study involved a retrospective review of medical records supplemented by telephone follow-up interviews, all participants contacted by telephone were informed about the purpose of the study, and verbal informed consent was obtained before collecting additional follow-up information. Participation was voluntary, and all information was treated confidentially.

To protect participants' privacy, all data were anonymized before analysis, and no personal identifiers were included in the study database or in the final manuscript.

Results

4.1 Participant Characteristics

A total of 206 internally displaced persons (IDPs) who underwent surgical procedures at Rabak Teaching Hospital between April 2023 and September 2024 were included in the study.

The majority of participants were aged 18–35 years (80, 38.8%), followed by those aged 36–50 years (54, 26.2%), while 48 (23.3%) were older than 50 years and 24 (11.7%) were younger than 18 years. There were 107 (51.9%) males and 99 (48.1%) females.

Regarding occupation, students constituted the largest group (46, 22.3%), followed by housewives (40, 19.4%) and free workers (31, 15.0%). Most participants had been displaced from Khartoum State (128, 62.1%), followed by Gezira State (23, 11.2%), Sennar and Blue Nile States (19, 9.2%), and the Western States (19, 9.2%). At the time of the study, 117 (56.8%) participants were residing in internally displaced persons (IDP) camps, whereas 89 (43.2%) were living in host communities.

The duration of hospital stay was most commonly days (106, 51.5%), followed by hours (46, 22.3%), one week (29, 14.1%), and more than one week (25, 12.1%) (Table 1).

Table 1
Demographic and Hospitalization Characteristics (N = 206)

Characteristic	Category	n (%)
Age	< 18	24 (11.7)
	18–35	80 (38.8)
	36–50	54 (26.2)
	> 50	48 (23.3)
Sex	Male	107 (51.9)
	Female	99 (48.1)
Residence	IDP camp	117 (56.8)
	Host community	89 (43.2)
Hospital stay	Hours	46 (22.3)
	Days	106 (51.5)
	1 week	29 (14.1)
	> 1 week	25 (12.1)

4.2 Surgical Presentations

The pattern of surgical diseases among the study participants is presented in Table 2. Benign surgical conditions were the most common indication for surgery, accounting for 59 (28.6%) cases. These conditions mainly included hernias and lipomas. Acute abdominal conditions were the second most common presentation, occurring in 45 (21.8%) patients.

Infection-related surgical conditions, including abscesses, surgical site infections, and diabetic foot infections, accounted for 42 (20.4%) cases. Traumatic conditions represented 20.3% of surgical presentations and comprised accidental trauma (31, 15.0%) and violent trauma (11, 5.3%). Malignant conditions were identified in 13 (6.3%) patients, while intestinal obstruction was the least common presentation, occurring in 5 (2.4%) patients (Table 2)

Table 2
Clinical Presentation of Surgical Conditions (N = 206).

Clinical presentation	n (%)
Benign surgical conditions	59 (28.6)
Acute abdominal emergencies	45 (21.8)
Infection-related conditions	42 (20.4)
Accidental trauma	31 (15.0)
Malignant conditions	13 (6.3)
Violent trauma	11 (5.3)
Intestinal obstruction	5 (2.4)
Total	206 (100.0)

4.3 Operative Characteristics

The operative characteristics of the study participants are summarized in Table 3. Of the 206 surgical procedures performed, 125 (60.7%) were emergency surgeries, while 81 (39.3%) were elective procedures.

Regarding anesthetic management, general anesthesia was the most frequently used technique, administered to 103 (50.0%) patients. Spinal anesthesia was used in 68 (33.0%) patients, whereas 35 (17.0%) patients underwent surgery under local anesthesia (Table 3).

Table 3
Operative Characteristics (N = 206)

Variable	Category	n (%)
Type of surgery	Emergency	125 (60.7)
	Elective	81 (39.3)
Type of anesthesia	General	103 (50.0)
	Spinal	68 (33.0)
	Local	35 (17.0)
Postoperative ICU admission	Yes	9 (4.4)
	No	197 (95.6)

4.4 Postoperative Complications and Intensive Care Unit (ICU) Admission

Postoperative complications occurred in 83 (40.3%) of the 206 patients included in the study, while 123 (59.7%) experienced no postoperative complications. Surgical site infection (SSI) was the most frequently reported complication, affecting 33 (16.0%) patients. Other postoperative complications included other complications (26, 12.6%), atelectasis/pneumonia (11, 5.3%), deep vein thrombosis/pulmonary embolism (DVT/PE) (7, 3.4%), and anastomotic leak (6, 2.9%) (Table 4).

Table 4
Postoperative Complications and ICU Admission (N = 206)

Variable	Category	n (%)
Complications	No complications	123 (59.7)
	SSI	33 (16.0)
	Other complications	26 (12.6)
	Atelectasis/Pneumonia	11 (5.3)
	DVT/PE	7 (3.4)
	Anastomotic leak	6 (2.9)
ICU admission	Yes	9 (4.4)
	No	197 (95.6)

Postoperative admission to the intensive care unit (ICU) was required for 9 (4.4%) patients, whereas 197 (95.6%) patients were managed without ICU admission (Table 4).

4.5 Surgical Outcomes and Patient Satisfaction

The surgical outcomes of the study participants are presented in Table 5. At postoperative follow-up, 122 (59.2%) patients achieved full recovery, 53 (25.7%) were still receiving treatment, 18 (8.7%) were referred to higher-level hospitals for further management, and 13 (6.3%) died.

Regarding patient satisfaction with the surgical care received, 70 (34.0%) participants reported being satisfied, 60 (29.1%) were very satisfied, and 58 (28.2%) expressed a neutral opinion. A smaller proportion of participants reported dissatisfaction, with 15 (7.3%) being dissatisfied and 3 (1.5%) being very dissatisfied (Table 5).

Table 5
Surgical Outcomes and Patient Satisfaction (N = 206)

Variable	Category	n (%)
Surgical outcome	Full recovery	122 (59.2)
	Ongoing treatment	53 (25.7)
	Referred	18 (8.7)
	Death	13 (6.3)
Patient satisfaction	Satisfied	70 (34.0)
	Very satisfied	60 (29.1)
	Neutral	58 (28.2)
	Dissatisfied	15 (7.3)
	Very dissatisfied	3 (1.5)

4.6 Factors Associated with Poor Surgical Outcomes

The association between selected clinical variables and surgical outcomes was initially assessed using univariable analysis. Variables considered clinically relevant and those associated with surgical outcomes were subsequently entered into a multivariable binary logistic regression model to identify independent predictors of poor surgical outcomes.

The multivariable analysis demonstrated that increasing age, emergency surgery, and the presence of any postoperative complication were independently associated with poor surgical outcomes. Patients who underwent emergency surgery had significantly higher odds of experiencing a poor surgical outcome than those who underwent elective surgery. Likewise, patients who developed postoperative complications were at substantially increased risk of poor surgical outcomes.

In contrast, sex, current residence (IDP camp versus host community), and postoperative ICU admission were not independently associated with poor surgical outcomes after adjustment for potential confounding variables.

The results of the multivariable logistic regression analysis are presented in Table 6.

Table 6
Multivariable Logistic Regression (n = 206)

Variable	AOR	95% CI	P-value
Age	1.60	1.10–2.33	0.014
Male sex	1.18	0.61–2.28	0.622
Residence	0.86	0.44–1.67	0.654
Emergency surgery	2.21	1.07–4.56	0.032
ICU admission	1.91	0.54–6.77	0.315
Postoperative complications	6.88	3.50–13.54	< 0.001

Discussion

5.1 Principal Findings

This study provides important evidence on the spectrum of surgical disease and postoperative outcomes among internally displaced persons (IDPs) receiving surgical care during the ongoing armed conflict in Sudan. To our knowledge, few studies have comprehensively evaluated surgical outcomes in this highly vulnerable population. The findings demonstrate that most patients underwent emergency surgery, benign surgical conditions and infection-related diseases accounted for a substantial proportion of the surgical workload, postoperative complications were common, and approximately three-fifths of patients achieved full recovery following surgery. Furthermore, multivariable analysis identified increasing age, emergency surgery, and the occurrence of postoperative complications as independent predictors of poor surgical outcomes.

These findings highlight the considerable challenges faced by healthcare systems operating in conflict-affected settings, where delayed presentation, disruption of referral pathways, shortages of medical resources, and limited access to timely surgical care may adversely affect patient outcomes. Despite these constraints, the overall recovery rate observed in this study suggests that essential surgical services can continue to achieve favorable outcomes when maintained within functioning referral hospitals.

5.2 Pattern of Surgical Disease

The present study demonstrated that benign surgical conditions, particularly hernias and lipomas, constituted the largest proportion of surgical presentations, followed by acute abdominal conditions, infection-related surgical diseases, and trauma. These findings suggest that, despite the ongoing armed conflict, the surgical burden among internally displaced persons extends well beyond war-related injuries and includes a substantial number of common general surgical conditions requiring timely operative management.

The predominance of benign surgical conditions is consistent with previous evidence indicating that untreated elective surgical diseases often accumulate during humanitarian crises because access to routine surgical services becomes severely disrupted. A community-based survey among internally displaced persons in West Darfur, Sudan, similarly reported a high prevalence of untreated surgical conditions, particularly hernias and chronic swellings, reflecting delayed access to definitive surgical care. These findings highlight the importance of maintaining essential surgical services during armed conflicts to prevent otherwise treatable conditions from progressing to more advanced disease.

Acute abdominal conditions represented the second most common indication for surgery in the present study. Similar observations have been reported in other resource-limited and conflict-affected settings, including Yemen, where emergency laparotomies for intestinal obstruction, perforated viscus, and generalized peritonitis constituted a major proportion of emergency surgical admissions. Delayed presentation, interrupted referral pathways, and limited access to primary healthcare services are likely contributors to the high burden of acute abdominal emergencies observed in humanitarian settings.

Infection-related surgical conditions, including abscesses, surgical site infections, and diabetic foot infections, accounted for one-fifth of all surgical presentations. This finding is consistent with reports from displaced populations and refugee settings, where overcrowding, poor sanitation, limited access to clean water, malnutrition, and delayed healthcare seeking contribute to an increased burden of severe soft-tissue and wound infections. Strengthening infection prevention, improving wound care services, and ensuring early access to surgical evaluation may help reduce this burden among internally displaced populations.

Although trauma represented an important component of the surgical workload, it accounted for only approximately one-fifth of all surgical presentations. This observation suggests that surgical planning in conflict-affected settings should not focus exclusively on trauma care. Health systems must also maintain the capacity to manage common general surgical conditions, acute abdominal emergencies, and infection-related diseases, which together constitute the majority of surgical cases among internally displaced persons.

5.3 Emergency Surgery and Operative Characteristics

The present study found that 60.7% of all surgical procedures were performed as emergency operations, indicating that emergency surgery constituted the predominant component of surgical care among internally displaced persons during the study period. This finding reflects the profound impact of armed conflict on healthcare access, where insecurity, population displacement, disruption of transportation, and limited availability of healthcare services frequently delay patients' presentation until urgent surgical intervention becomes necessary.

Comparable findings have been reported from other conflict-affected settings. Médecins Sans Frontières (MSF) reported that emergency surgical procedures accounted for a substantial proportion of surgical activity in Syria, while hospitals in Gaza also experienced a marked increase in emergency surgical

workload due to the overwhelming burden of trauma and delayed access to definitive care. Similarly, studies from low-resource settings have demonstrated that a high emergency-to-elective surgery ratio is an important indicator of limited access to timely surgical services and reduced health system capacity.

In the present study, emergency surgery was independently associated with poor surgical outcomes in the multivariable analysis. This finding is consistent with previous studies demonstrating that patients requiring emergency operations generally present with more advanced disease, greater physiological instability, and limited opportunities for adequate preoperative optimization. Furthermore, emergency procedures are often performed under significant time constraints and resource limitations, factors that may increase the risk of postoperative morbidity and mortality.

These findings emphasize the need to strengthen emergency referral systems, improve access to timely surgical assessment, and enhance the capacity of hospitals serving displaced populations. Earlier diagnosis and prompt referral may reduce the need for emergency surgery and contribute to improved postoperative outcomes in conflict-affected settings.

5.4 Postoperative Complications

Postoperative complications occurred in 40.3% of patients, representing a substantial burden of morbidity among internally displaced persons undergoing surgery during the armed conflict in Sudan. The occurrence of postoperative complications was also the strongest independent predictor of poor surgical outcomes, emphasizing the critical importance of perioperative care in improving surgical outcomes within humanitarian settings.

Surgical site infection (SSI) was the most frequently reported postoperative complication, affecting 16.0% of patients. Similar findings have been reported in other low-resource and conflict-affected settings, where surgical site infection remains the leading postoperative complication because of limited availability of sterile equipment, overcrowded hospital wards, inadequate infection prevention measures, shortages of antibiotics, and challenges in postoperative wound care. These factors are frequently intensified during armed conflicts, where healthcare systems operate under severe resource constraints.

Respiratory complications, including atelectasis and pneumonia, were observed in 5.3% of patients. Although this proportion was lower than that reported in some studies from sub-Saharan Africa, it remains clinically important because postoperative pulmonary complications are associated with prolonged hospitalization, increased healthcare costs, and higher postoperative mortality. The relatively lower frequency observed in the present study may reflect underdiagnosis related to limited diagnostic facilities rather than a genuinely lower incidence.

Deep vein thrombosis and pulmonary embolism (DVT/PE) occurred in 3.4% of patients. Although less common than surgical site infections, thromboembolic complications remain preventable causes of postoperative morbidity and mortality. In many conflict-affected and resource-limited settings, routine

venous thromboembolism risk assessment and pharmacological thromboprophylaxis are not consistently available, potentially increasing patients' risk of these complications.

Anastomotic leakage was identified in 2.9% of patients. Although relatively uncommon, anastomotic leak is recognized as one of the most serious postoperative complications because it is associated with sepsis, prolonged hospitalization, reoperation, and increased mortality. Early recognition and timely surgical intervention remain essential for improving outcomes in affected patients.

The strong association between postoperative complications and poor surgical outcomes observed in this study highlights the need to strengthen perioperative care throughout the surgical pathway. Improving infection prevention and control practices, ensuring adherence to the World Health Organization (WHO) Surgical Safety Checklist, optimizing perioperative antibiotic prophylaxis, strengthening postoperative monitoring, and implementing standardized complication surveillance systems may substantially reduce postoperative morbidity and improve surgical outcomes among internally displaced populations receiving care in humanitarian settings.

5.5 Intensive Care Unit (ICU) Admission and Mortality

Only 4.4% of patients in the present study required postoperative admission to the intensive care unit (ICU). Although this proportion appears relatively low, it is unlikely to reflect a low demand for critical care. Instead, it probably reflects the limited availability of ICU beds, equipment, and trained personnel within a healthcare system operating under the severe constraints imposed by armed conflict. Similar challenges have been described in other humanitarian settings, where shortages of critical care resources often restrict access to postoperative intensive care for patients with severe surgical conditions.

The overall postoperative mortality rate was 6.3%. Although this mortality rate is lower than that reported in some conflict-affected settings managing predominantly major trauma, it remains substantial considering that the study population included patients with a broad range of surgical conditions rather than exclusively life-threatening injuries. Mortality in conflict settings is influenced by multiple factors, including delayed presentation, advanced disease at admission, limited opportunities for preoperative optimization, postoperative complications, shortages of essential surgical supplies, and restricted access to critical care services.

An important finding of this study was that patients requiring referral to higher-level hospitals represented 8.7% of the study population. These referrals most likely reflected the need for specialized surgical services or advanced postoperative care that was not available at Rabak Teaching Hospital. This finding highlights the essential role of an effective referral system in ensuring continuity of care for patients with complex surgical conditions in humanitarian settings. Strengthening referral pathways and improving coordination between primary referral hospitals and specialized centers may contribute to improved patient outcomes.

Overall, the findings emphasize that improving surgical outcomes in conflict-affected settings requires not only strengthening surgical services but also expanding access to postoperative critical care, improving referral networks, and ensuring timely management of patients who require specialized interventions.

5.6 Patient Satisfaction

Despite the challenging circumstances under which surgical services were delivered, the majority of participants reported positive experiences with the care they received. More than sixty percent of patients described themselves as either satisfied or very satisfied with the surgical care provided, while fewer than one in ten reported dissatisfaction. These findings suggest that patients generally perceived the care they received positively, despite the considerable resource limitations faced by the hospital during the conflict.

Similar observations have been reported in humanitarian and resource-limited settings, where patients often express high levels of satisfaction with healthcare services despite significant constraints. This may reflect appreciation for having access to surgical care in environments where healthcare services are severely disrupted or unavailable. In conflict settings, receiving timely surgical treatment may itself be perceived as a positive experience, particularly among displaced populations with otherwise limited access to healthcare.

However, patient satisfaction should be interpreted with caution. Satisfaction is influenced by multiple factors, including patients' expectations, communication with healthcare providers, cultural beliefs, and the availability of healthcare services. Therefore, high satisfaction scores should not be interpreted as direct evidence of high-quality surgical care. Instead, patient satisfaction should be considered a complementary measure of healthcare delivery that reflects patients' experiences alongside objective clinical outcomes.

Overall, these findings indicate that maintaining accessible surgical services during humanitarian crises can positively influence patients' perceptions of care. Continued efforts to improve communication, patient-centered care, and the quality of surgical services may further enhance patient experience while simultaneously improving clinical outcomes.

5.7 Strengths of the Study

This study has several important strengths. First, it provides one of the earliest comprehensive evaluations of surgical outcomes among internally displaced persons during the ongoing armed conflict in Sudan, addressing an important gap in the humanitarian surgery literature. Second, the study included a relatively large sample of surgically treated IDPs and evaluated a broad spectrum of surgical conditions rather than focusing exclusively on trauma. This provides a more comprehensive understanding of the surgical burden in conflict-affected populations.

Another notable strength is the use of multiple data sources, combining retrospective review of medical records with telephone follow-up interviews, which enabled complete postoperative follow-up and patient satisfaction data to be obtained for all participants. This approach improved the completeness and reliability of the collected data.

Finally, the study identified independent predictors of poor surgical outcomes using multivariable analysis, generating evidence that may assist clinicians, hospital administrators, and humanitarian organizations in planning and improving surgical services for displaced populations living in resource-constrained settings.

5.8 Limitations

This study has several limitations that should be considered when interpreting its findings. First, the retrospective observational design depended on the accuracy and completeness of existing medical records, which may have resulted in incomplete documentation of some clinical variables. Second, the study was conducted at a single referral hospital, which may limit the generalizability of the findings to other hospitals or humanitarian settings within Sudan.

Although all participants were successfully contacted for postoperative follow-up, the duration of follow-up varied between patients, preventing assessment of long-term surgical outcomes beyond the postoperative period. In addition, patients who were referred to higher-level hospitals could not be followed after referral; therefore, their final clinical outcomes were unavailable.

Finally, the study included only internally displaced persons who underwent surgery at Rabak Teaching Hospital. Consequently, the findings may not be generalizable to displaced individuals who were unable to access surgical services or who received care at other healthcare facilities.

5.9 Clinical and Public Health Implications

The findings of this study have important implications for the delivery of surgical care during humanitarian emergencies. The high proportion of emergency surgical procedures and the strong association between postoperative complications and poor surgical outcomes emphasize the importance of strengthening emergency surgical services, improving infection prevention and control measures, and ensuring timely access to perioperative care.

Healthcare systems serving internally displaced populations should prioritize early identification and referral of surgical conditions to reduce delays in treatment and minimize the need for emergency operations. Expanding surgical capacity, improving access to critical care services, and strengthening referral networks between district hospitals and specialized centers may further improve patient outcomes in conflict-affected settings.

At the policy level, these findings support greater investment in essential surgical services as an integral component of humanitarian health responses. Future multicenter prospective studies are recommended

to evaluate long-term surgical outcomes and to identify effective strategies for improving the quality and accessibility of surgical care for displaced populations.

Conclusion

This study provides important insights into the surgical outcomes of internally displaced persons undergoing surgery during the ongoing armed conflict in Sudan. The findings demonstrate that emergency surgical procedures constituted the majority of operations, while benign surgical conditions, acute abdominal emergencies, infection-related diseases, and trauma represented the principal indications for surgery. Postoperative complications were common, with surgical site infection being the most frequent complication.

Multivariable analysis identified increasing age, emergency surgery, and the occurrence of postoperative complications as independent predictors of poor surgical outcomes. These findings highlight the importance of early diagnosis, timely referral, effective perioperative management, and strengthened infection prevention and control practices in improving surgical outcomes among displaced populations.

Despite the considerable challenges imposed by armed conflict, Rabak Teaching Hospital continued to provide essential surgical services, and most patients achieved a favorable postoperative outcome and reported positive experiences with the care they received. These findings underscore the resilience of healthcare providers working under humanitarian conditions while emphasizing the continuing need to strengthen surgical capacity, critical care services, and referral systems.

Future multicenter prospective studies are recommended to evaluate long-term surgical outcomes and to guide evidence-based strategies for improving surgical care for internally displaced populations in Sudan and other conflict-affected settings.

Declarations

Ethics approval and consent to participate

Ethical approval and administrative permission to conduct this study were obtained from Rabak Teaching Hospital, White Nile State, Sudan, through the Office of the General Medical Director before commencement of the study (Approval letter dated 2 February 2023). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

As the study involved a retrospective review of medical records, informed consent for the retrospective record review was not required. For the postoperative telephone follow-up, participants were informed about the purpose of the study and verbal informed consent was obtained before collecting follow-up and patient satisfaction information. Participation was voluntary, and all information was treated confidentially.

Consent for publication

Consent for publication declaration: not applicable.

Competing interests

The authors declare that they have no competing interests.

Clinical trial number :

Not applicable

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Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

Aladdin Yousif Ibrahim Humdan contributed to study conceptualization and design and data collection. Mohammed E. H. Azoz contributed to study supervision and manuscript revision. Aseel E. B. Abdhameed contributed to data collection and manuscript writing. Omer Faiz Omer Mohamed performed data analysis and contributed to manuscript editing and revision. Elfadil Shaaeldin Elfadil Yassin contributed to study conceptualization, data collection, and manuscript writing. Elaf Hatim Akasha Mohammed contributed to data collection and manuscript writing. Israa Abdon Ibrahim Abdon contributed to manuscript writing and revision. Hadeel Abdelrahim Mohamed MohamedKhier contributed to manuscript editing, final checks, and approval of the manuscript. Deyaaldeen Abdelaziz Abdelkarim Nahar contributed to manuscript review and revision. All authors read and approved the final manuscript

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Figures

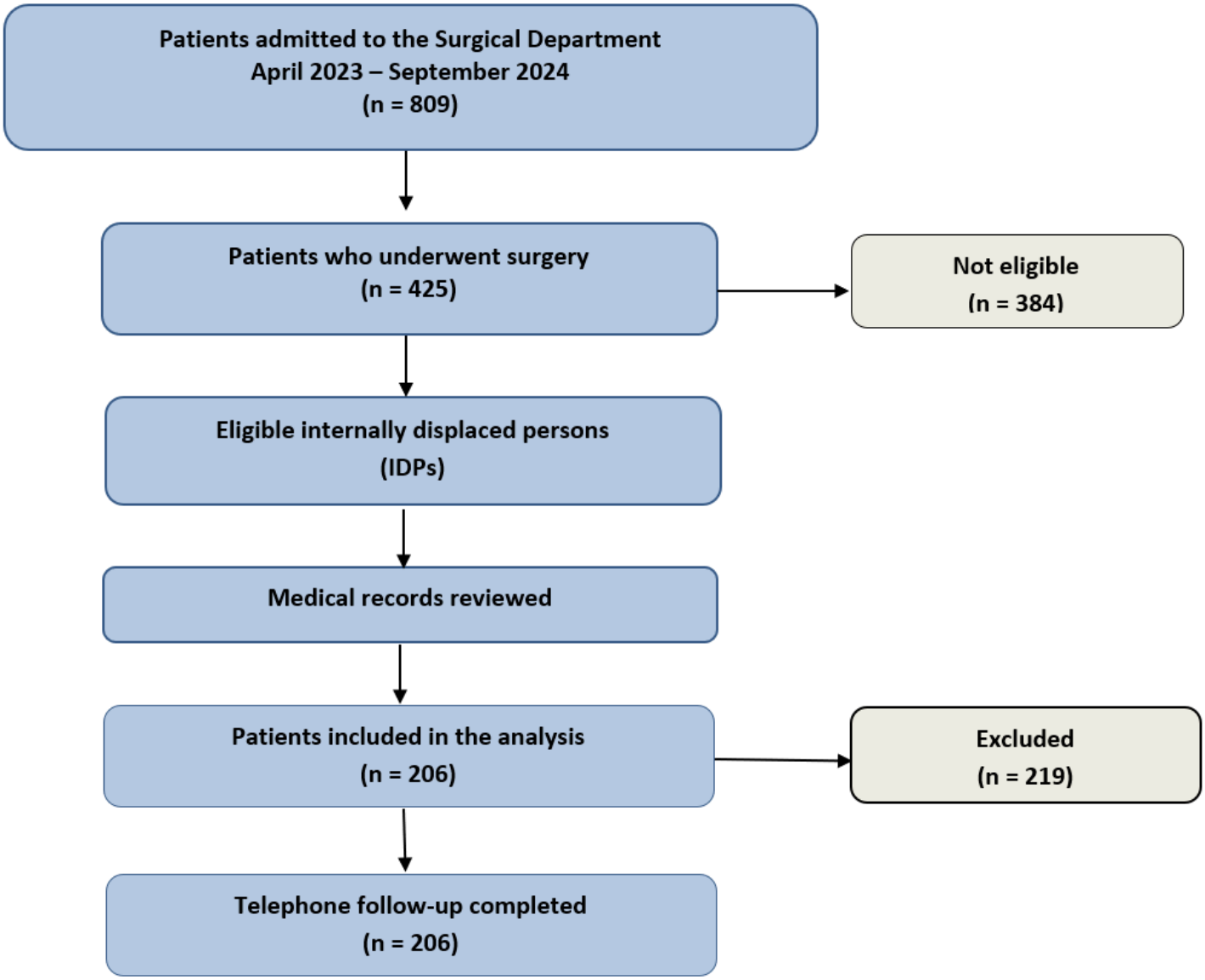


Figure 1

Study Flow Diagram (STROBE)

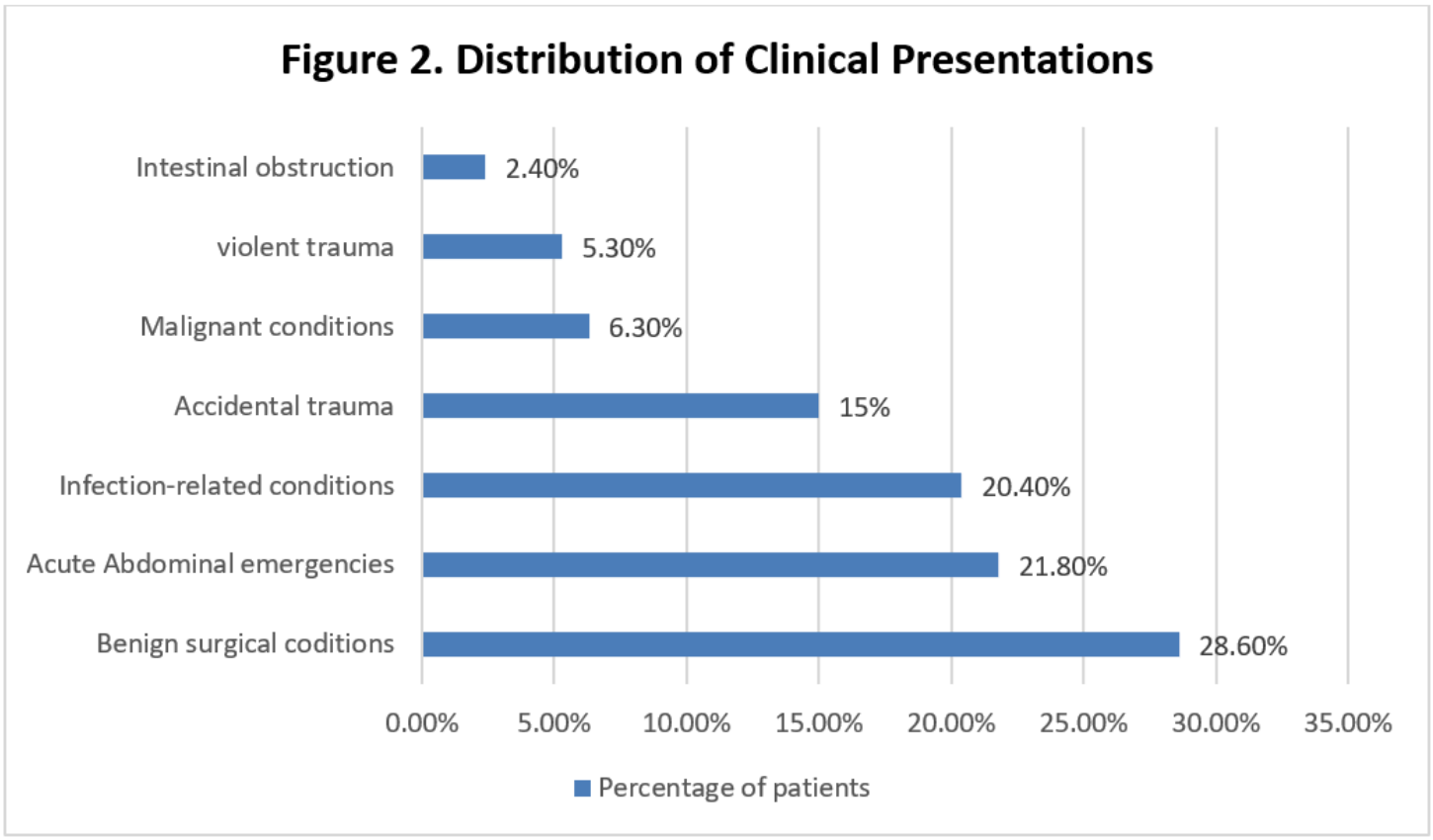


Figure 2

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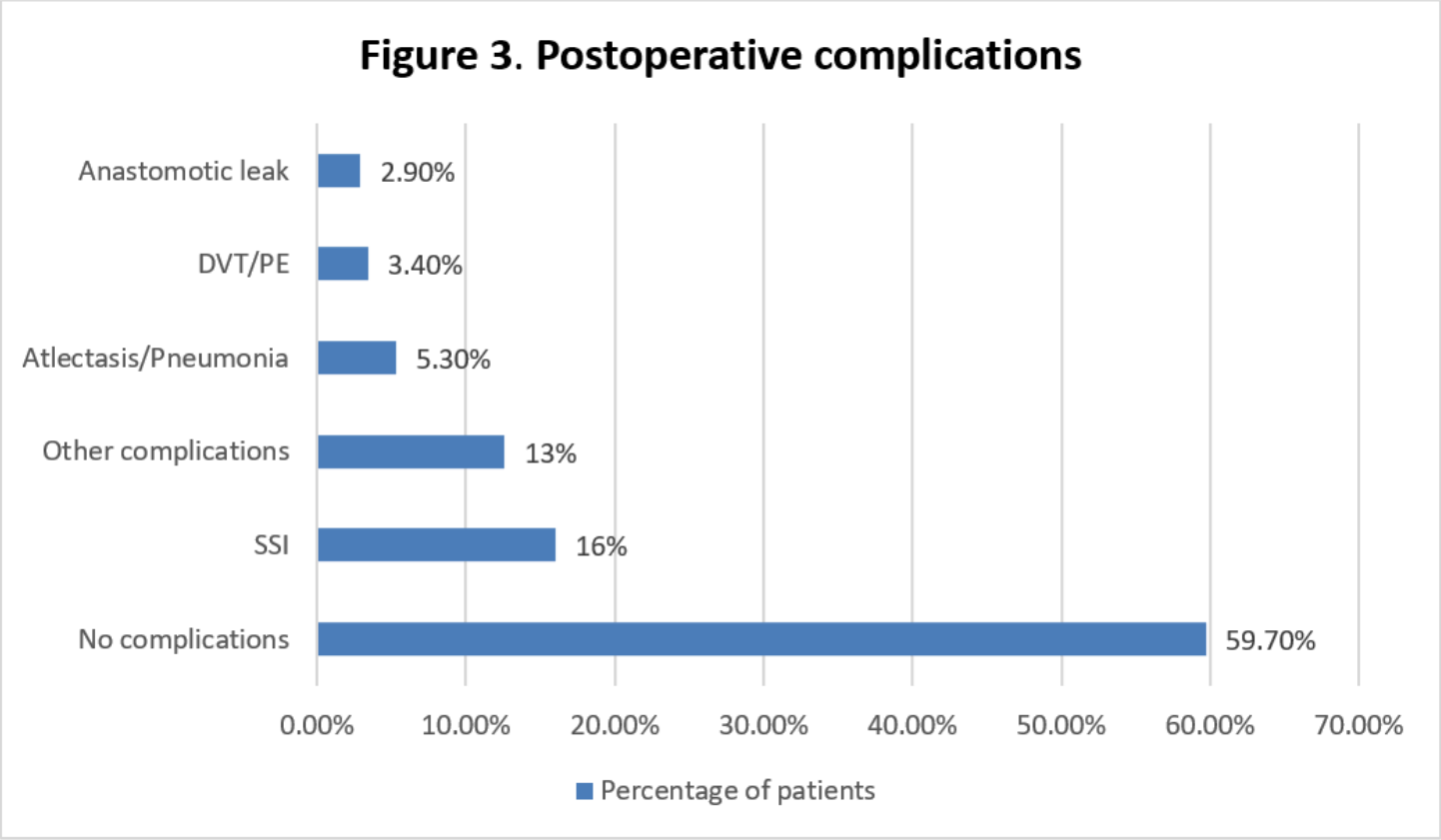


Figure 3

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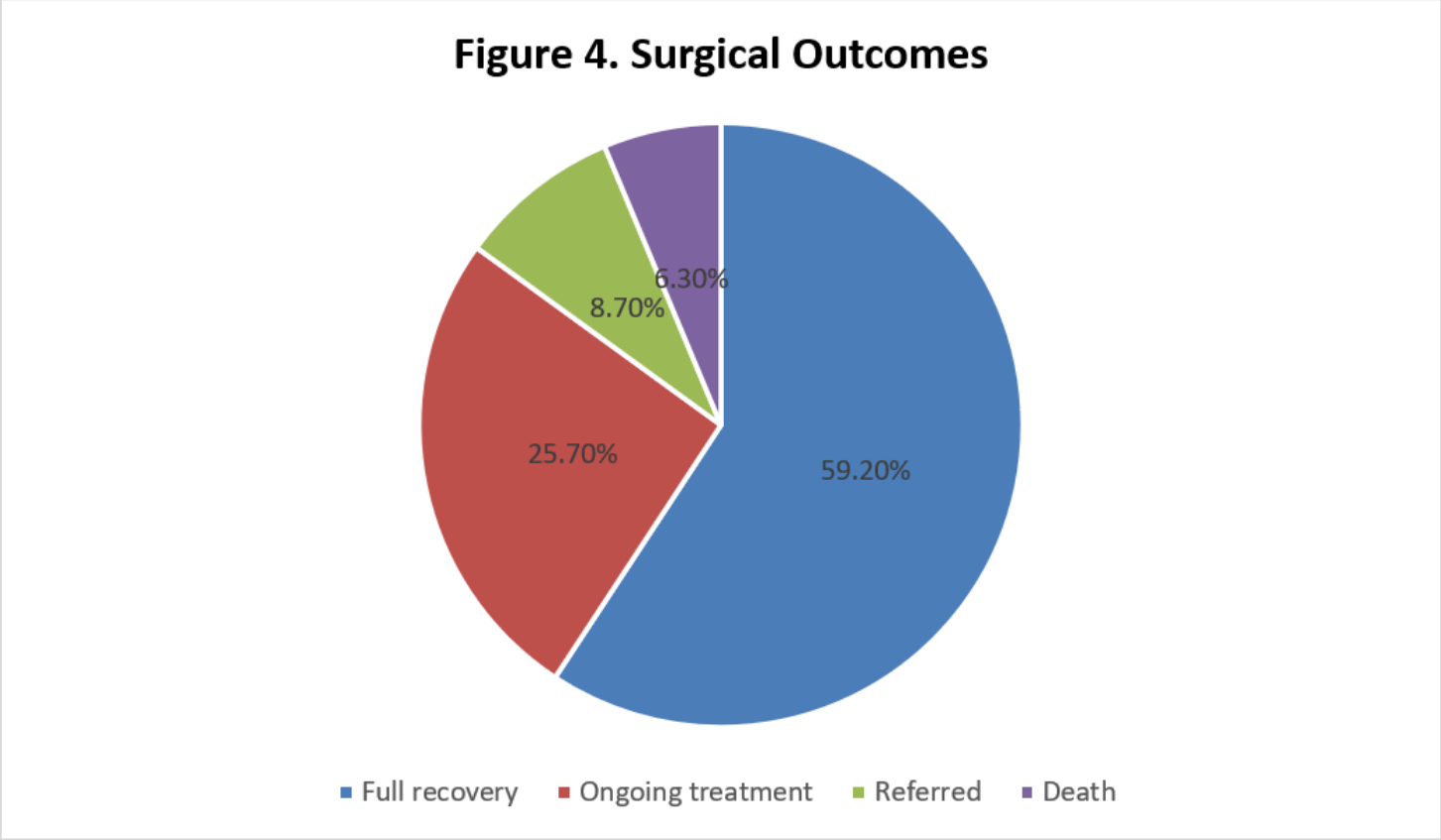


Figure 4

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