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Sustaining an essential surgical service through armed conflict: a retrospective cohort of 250 mini-laparotomy cholecystectomies at a Sudanese secondary hospital, 2021-2025

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Sustaining an essential surgical service through armed conflict: a retrospective cohort of 250 mini-laparotomy cholecystectomies at a Sudanese secondary hospital, 2021-2025

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Abstract

Background: Mini-laparotomy cholecystectomy is the operative option for gallbladder disease where laparoscopic capacity is unavailable or unreliable. Whether an established open pathway and its outcomes were sustained through the armed conflict that began in Sudan in April 2023 has not been documented. We describe the only locally available cholecystectomy pathway at a Sudanese secondary hospital between 2021 and 2025, in continuity with a published 2009-2020 series from the same institution.

Methods: Retrospective, single-centre cohort of all 250 records of mini-laparotomy cholecystectomy performed at Elduiem Teaching Hospital, White Nile State, Sudan, from January 2021 to December 2025. Index stay was categorised as<24 hours, 24-72 hours, or>72 hours to 2 weeks. Exploratory associations with index stay used Fisher-Freeman-Halton exact tests (Monte Carlo sampling, 200,000 replicates) with Holm correction; crude odds ratios are reported as exploratory contrasts.

Results: Of 250 patients (189 women, 75.6%), cholecystitis was the recorded presentation in 124 (49.6%); 189 patients (75.6%) were discharged within 24 hours of operation. Operative duration, intraoperative findings, and recorded bleeding were associated with index-stay category after Holm correction (Cramer's V 0.25-0.34); operations>90 minutes (crude OR 3.79, 95% CI 1.91-7.52) and recorded bleeding (crude OR 3.96, 95% CI 1.65-9.53) were associated with stay of 24 hours or more. In an exploratory parsimonious model, obesity was associated with a prolonged operation (>90 minutes) versus the combined underweight/normal reference (aOR 6.06, 95% CI 2.51-14.64) after adjustment for age and sex. Forty patients (16.0%) had a primary postoperative-event code, all among patients with stay of 24 hours or more. Compared with the hospital's published 2009-2020 series (512 operations), same-day discharge fell from 89.5% to 75.6% and recorded wound-infection codes rose from 1.4% to 9.6%.

Conclusions: The only locally available cholecystectomy pathway remained in continuous operation through the study period, including after the outbreak of armed conflict. The observed shifts toward longer stays and more recorded wound infection, and the associations reported here, are exploratory and do not support causal or predictive interpretation. Prospective collection should implement a defined minimum dataset for surgical surveillance in comparable settings.

Keywords

cholecystectomy; mini-laparotomy; retrospective cohort; armed conflict; surgical service continuity; hospital stay; Sudan; global surgery

Background

Laparoscopic cholecystectomy is the standard operative treatment for symptomatic gallbladder disease in most high-resource settings, and meta-analyses of randomised trials support similar perioperative safety with a shorter hospital stay than mini-laparotomy [12,14]. Its delivery, however, depends on functioning equipment, maintenance and sterilisation systems, anaesthetic capacity, trained teams, and dependable supply chains, and its adoption in resource-limited settings remains limited [2]. Where these conditions cannot be assumed, mini-laparotomy cholecystectomy may remain the operative option available to patients requiring gallbladder removal. Randomised trials found mini-laparotomy comparable to conventional open cholecystectomy on operative and postoperative outcomes [10,11], and series from low-resource settings have described it as a safe and feasible alternative [17,18,19].

Elduiem Teaching Hospital in White Nile State, Sudan, did not provide laparoscopic cholecystectomy during the study period. Mini-laparotomy was consequently not selected locally from a choice of competing approaches; it was the available approach. An earlier institutional report described 512 mini-laparotomy cholecystectomies performed at the same hospital from 2009 to 2020, in which 89.5% of patients were discharged within 24 hours and wound infection occurred in 1.4% [1]. The present report concerns a separate later period, 2021-2025, and is not intended as a historical comparison.

The earlier institutional report principally described feasibility, safety, and length of stay; it did not examine patient characteristics in relation to operative duration, and it preceded the current Sudanese conflict, which has disrupted referral systems, supply chains, and follow-up attendance nationwide [20,21]. The present analysis therefore asks three questions the earlier report could not: whether the pathway remained in continuous operation through the conflict period; and whether the outcome profile it produced changed. The contribution is deliberately hypothesis-generating and context-specific rather than a validated risk analysis.

The primary aim was descriptive: to characterise the cohort that underwent the locally available procedure. The secondary aim was exploratory: to examine whether recorded patient and perioperative

characteristics were distributed differently across categories of index hospital stay. We did not specify a causal estimand for any analysis. Published comparisons with laparoscopy provide external context only; they do not create a local comparator or substitute for one.

Methods

Design, setting, and participants

We performed a retrospective, single-centre, record-review cohort study at Elduiem Teaching Hospital, a secondary hospital in White Nile State, Sudan. The source population comprised patients with a documented mini-laparotomy cholecystectomy from January 1, 2021, through December 31, 2025. Conventional open and laparoscopic procedures were ineligible. The study period overlapped with armed conflict in Sudan; the records did not contain hospital-level measures that could quantify the effects of that disruption.

The analytic dataset included all 250 available records. No record was excluded for incomplete files (Figure 1). Because the study was a complete census rather than a sample, no formal power calculation was performed or required; the study was not designed or powered to estimate independent effects.

Care pathway and data source

The procedure was performed through a short subcostal mini-Kocher incision, generally 4-5 cm in length. Consultant surgeons led operating teams, with recently qualified surgeons and registrars participating under supervision. Principal operator, grade, and prior experience were not recorded consistently enough for operator-level analysis.

Theatre notes, ward records, and available outpatient documentation were extracted digitally: three clinicians (two registrars of general surgery and one medical doctor) transcribed the variables directly into a structured, de-identified spreadsheet over four weeks. Each record was abstracted once; the work was shared among the three clinicians, and no record was independently re-abstracted. The extracted dataset

was subsequently double-checked against the source records by the first author (S.I.B.A.). The analytic dataset contained eleven categorical variables: age group, sex, BMI category, ASA class, clinical presentation, recorded comorbidity, operative-duration category, intraoperative finding, recorded intraoperative bleeding, primary postoperative-event code, and index hospital-stay category. Categories are reported exactly as encoded in the source register; the register did not record the boundary conventions for the age and duration bands, exact ages, exact operative times, blood loss, and admission/discharge timestamps were unavailable, and the coded dataset was audited programmatically so that every reported count reproduces exactly from the de-identified data.

Postoperative events and follow-up

The postoperative-event field was an administrative coding field rather than a longitudinal complication registry. Only one primary postoperative-event code could be entered for each patient. Coexisting events were therefore not fully represented. For example, wound infection could coexist with biliary leakage, while the archive could retain biliary leakage as the primary code. Frequencies in this report are frequencies of primary recorded codes, not counts of all clinical events.

Patients were scheduled for postoperative review at approximately 2 weeks, 1 month, and 3 months, with additional assessment when clinically indicated. Serious events were generally recognised during the index admission or later hospital care. Some wound infections became apparent after discharge among patients who returned for review. The archive did not consistently record symptom onset, first diagnosis, attendance at scheduled visits, or all healthcare contacts after discharge. Because the coded dataset contains no timing field, the recognition context of each coded event (during the index admission or operation, after discharge, or not verifiable) was established afterwards by manual review of the source records by the treating team; these annotations were added outside the original coded dataset and were not independently duplicated. Conflict-related barriers to travel, communication, and access to care disrupted follow-up for some patients. Some patients required readmission after discharge, but readmission was not captured in a complete standardised format; no readmission rate was estimated.

Conceptual model and confounding

Operative difficulty has been graded and predicted systematically in laparoscopic cholecystectomy, using intraoperative difficulty grading and preoperative risk scores [3,4,8], and international guidance defines standards for safe cholecystectomy and for the management of acute cholecystitis [5,6]. None of these instruments could be applied to the present records: operative difficulty was not graded at operation, and the archive did not contain data that would support standard comorbidity classification [15] or complication-severity classification [16].

Recorded operative variables were treated as markers of operative complexity, not separable causal exposures. Disease severity, anatomy, adhesions, inflammatory burden, prior abdominal surgery, patient frailty, surgeon experience, theatre conditions, and discharge practice could simultaneously influence operative duration, bleeding, intraoperative findings, and index stay. Several of these factors were absent or inconsistently recorded. An early postoperative event could also prolong stay, whereas longer admission could increase the opportunity for an event to be recognised and documented. No causal interpretation was assigned to observed associations.

Outcomes and statistical analysis

Index stay was measured from the operation date to discharge date and classified as<24 hours, 24-72 hours, or>72 hours to 2 weeks. Index stay was cross-tabulated against age group, BMI category, ASA class, sex, clinical presentation, recorded comorbidity, operative duration, intraoperative findings, and recorded intraoperative bleeding. The primary postoperative-event code was excluded from inferential testing because event timing and ascertainment may have been related to admission duration and follow-up completion.

Exploratory comparisons used Fisher-Freeman-Halton exact tests with Monte Carlo sampling of 200,000 replicates, a replication count that bounds the Monte Carlo standard error of an estimated p-value near 0.001 to below 1.1x10^-4. Cramer's V was calculated as an unadjusted measure of association; V values

are not directly comparable across tables of different dimensions. Holm correction was applied across nine tests, with adjustedp<0.05 considered statistically significant. A post hoc sensitivity analysis collapsed stay into<24 hours versus>=24 hours and calculated crude odds ratios with Wald 95% confidence intervals for operations>90 minutes and recorded bleeding. Descriptive statistics, the exact tests, and the crude odds ratios were computed in IBM SPSS Statistics version 26; the adjusted model (below) was estimated by maximum-likelihood logistic regression in Python 3.12.10 with statsmodels 0.15.0, and every reported count and estimate was verified by recomputation against the de-identified dataset.

The analysis of index stay describes unadjusted associations; it was not designed to estimate independent predictors or causal effects. No multivariable model was fitted in this study. For index stay, only 12 patients were in the longest-stay category and the operative variables were clinically interdependent, so an adjusted model could create misleading precision. For operative duration, the 44 operations exceeding 90 minutes were analysed in a parsimonious adjusted model (Table 4), reported as exploratory. The crude odds ratios are descriptive contrasts only and remain vulnerable to unmeasured confounding.

Blank comorbidity entries (81 records) occur exclusively among ASA class 1 records; the dataset therefore cannot distinguish 'no comorbidity' from 'not recorded', and the comorbidity field is interpreted throughout as documentation status rather than confirmed disease status. The primary adjusted model excludes it; a sensitivity model adding a binary recorded-comorbidity indicator is reported in Additional file 2.

This report was prepared with reference to the STROBE statement for observational studies [9]; a completed checklist is provided as Additional file 1.

Exploratory analysis of prolonged operative duration

Operative duration was additionally analysed as a binary study-defined endpoint (more than 90 minutes versus 90 minutes or less; 44 versus 206 operations). A prespecified parsimonious multivariable logistic

regression model estimated adjusted odds ratios with 95% confidence intervals for patient characteristics recorded before operation: BMI category, age group (>=40 versus<40 years), and sex. Because only 44 operations met the endpoint, the model was limited to four coefficients (two BMI indicator terms, age, sex), approximately 11 events per parameter; the sparse underweight category (7 patients, 1 prolonged operation) was combined with normal BMI as the reference to improve stability. Penalised (Firth) logistic regression, which reduces small-sample bias, was not used for the primary estimates but is available in the verification environment and will be reported if requested; the sensitivity analyses adding a binary indicator for recorded comorbidity, excluding the underweight category, and modelling BMI ordinally are reported in Additional file 2, and the obese-category estimate remained materially unchanged across all specifications. Recorded comorbidity reflects documentation status rather than confirmed disease status and is interpreted accordingly. Intraoperative findings and bleeding were not included, as they are temporally downstream markers of operative difficulty. The model converged without separation; calibration and discrimination were not assessed because the model was not developed as an individual risk-prediction tool. All estimates are exploratory and must not be interpreted as causal effects. A two-sided $p<0.05$ was considered statistically significant.

Ethics approval and consent to participate

Ethical approval was granted by the Ethical Committee of Elduiem Teaching Hospital, White Nile State, Sudan, under approval number W.N.S SD 12/26 for the project Clinical Characteristics and Perioperative Outcomes of Mini-Laparotomy Cholecystectomy in a Resource-Limited Secondary Hospital in Sudan: A Retrospective Observational Study, on which Samir Ismail Bashir Abdelkarim was the named researcher; the approval was confirmed in writing by the hospital's General Medical Director, and a supplementary signed statement from the same authority confirms that the approval remains valid for the analyses reported in this manuscript. Because the study is a retrospective analysis of existing archived records, involves no direct patient contact or intervention, uses de-identified data with no patient names, medical record numbers, or other identifiers extracted or published, and reports findings only in aggregate form,

the requirement for individual informed consent was waived by the Ethical Committee for this retrospective record review, as documented in writing by the approving authority. Written permission to access the archive was obtained from hospital administration. No patient-identifying data are presented.

Results

The analytic dataset included all 250 available records; none was excluded (Figure 1).

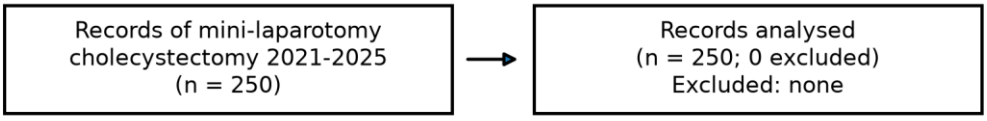


Figure 1. Record flow. All available records were included; none was excluded.

Characteristics of the cohort

Women comprised 189/250 patients (75.6%). Cholecystitis was the recorded presentation in 124 (49.6%), and 85 patients (34.0%) were ASA class III. Operations lasted 60-90 minutes in 160 (64.0%). Intraoperative findings were normal in 167 (66.8%) and adhesions were recorded in 40 (16.0%); the remaining 43 patients had other recorded findings. Recorded intraoperative bleeding was present in 23 (9.2%). 189 patients (75.6%) had a documented index discharge within 24 hours (Table 1).

Table 1. Characteristics of the record-review analytic cohort (n = 250).

Characteristic	Category	n (%)
Sex	Female	189 (75.6)
Sex	Male	61 (24.4)
Age group	<30 years	22 (8.8)
Age group	30-40 years	46 (18.4)
Age group	41-50 years	124 (49.6)
Age group	>50 years	58 (23.2)
BMI category	Underweight	7 (2.8)
BMI category	Normal	126 (50.4)
BMI category	Overweight	80 (32.0)
BMI category	Obese	37 (14.8)

Characteristic	Category	n (%)
ASA class	I	81 (32.4)
ASA class	II	84 (33.6)
ASA class	III	85 (34.0)
Clinical presentation	Cholecystitis	124 (49.6)
Clinical presentation	Biliary colic	63 (25.2)
Clinical presentation	Dyspepsia	36 (14.4)
Clinical presentation	No biliary symptoms	17 (6.8)
Clinical presentation	Obstructive jaundice	8 (3.2)
Clinical presentation	Perforation	2 (0.8)
Recorded comorbidity	Not recorded (blank)	81 (32.4)
Recorded comorbidity	Hypertension	58 (23.2)
Recorded comorbidity	Diabetes	52 (20.8)
Recorded comorbidity	Diabetes and hypertension	50 (20.0)
Recorded comorbidity	Others	9 (3.6)
Operative duration	<60 minutes	46 (18.4)
Operative duration	60-90 minutes	160 (64.0)
Operative duration	>90 minutes	44 (17.6)
Intraoperative finding	Normal	167 (66.8)
Intraoperative finding	Adhesions	40 (16.0)
Intraoperative finding	Mucocele	16 (6.4)
Intraoperative finding	Congenital anomaly	10 (4.0)
Intraoperative finding	Empyema gallbladder	9 (3.6)
Intraoperative finding	Contracted gallbladder	4 (1.6)
Intraoperative finding	Perforation	4 (1.6)
Recorded intraoperative bleeding	Yes	23 (9.2)
Recorded intraoperative bleeding	No	227 (90.8)
Primary postoperative-event code	Wound infection	24 (9.6)
Primary postoperative-event code	Biliary leak	4 (1.6)
Primary postoperative-event code	Fistula formation	4 (1.6)
Primary postoperative-event code	Missed stone	6 (2.4)
Primary postoperative-event code	Hepatic laceration	2 (0.8)
Primary postoperative-event code	No code recorded	210 (84.0)
Index hospital stay	<24 hours	189 (75.6)
Index hospital stay	24-72 hours	49 (19.6)
Index hospital stay	>72 hours to 2 weeks	12 (4.8)

All category counts are computed from the verified dataset; percentages use n = 250. Blank comorbidity entries occur exclusively among ASA class 1 records and are reported as documentation status.

Exploratory associations with index stay

The following comparisons are unadjusted exploratory associations. They describe co-occurrence of recorded variables and index-stay categories in the analytic cohort; they do not identify independent predictors of stay.

Table 2. Exploratory associations between recorded variables and index-stay category.

Variable	Monte Carlo p	Holm-adjusted p	Cramer's V
Age group	0.144	0.576	0.144
BMI category	0.014	0.084	0.176
ASA class	0.033	0.163	0.152
Sex	0.508	1.000	0.071
Clinical presentation	0.396	1.000	0.141
Recorded comorbidity	0.927	1.000	0.080
Operative duration	<0.001	<0.001	0.252

Variable	Monte Carlo p	Holm-adjusted p	Cramer's V
Intraoperative findings	<0.001	<0.001	0.340
Recorded intraoperative bleeding	<0.001	<0.001	0.329

All comparisons are unadjusted exploratory associations; Cramer's V does not control for confounding and is not directly comparable across tables of different dimensions (2x3, 3x3, and 2x2 tables yield different maxima). Fisher-Freeman-Halton exact tests with Monte Carlo sampling (200,000 replicates).

Operative duration, intraoperative findings, and recorded bleeding remained associated with index-stay category after Holm correction. BMI category and ASA class had unadjusted differences that did not remain statistically significant after correction.

Among operations lasting<60 minutes, 43/46 patients (93.5%) had an index discharge within 24 hours. The corresponding proportions were 123/160 (76.9%) for operations lasting 60-90 minutes and 23/44 (52.3%) for operations lasting>90 minutes (Figure 2). Among patients with recorded bleeding, 12/23 (52.2%) had an index stay of 24 hours or more, compared with 49/227 (21.6%) without recorded bleeding. In the post hoc binary analysis, operations>90 minutes were associated with stay of 24 hours or more (crude OR 3.79, 95% CI 1.91-7.52), as was recorded bleeding (crude OR 3.96, 95% CI 1.65-9.53). These are unadjusted descriptive contrasts.

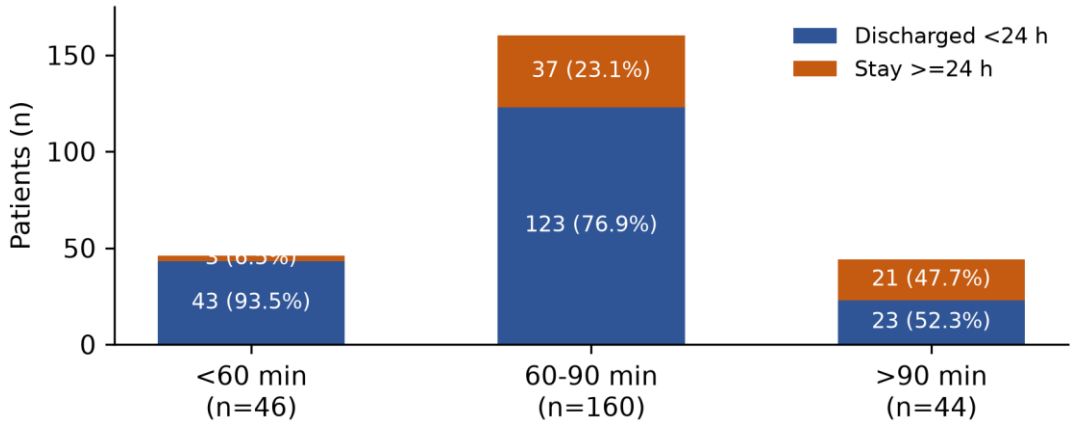


Figure 2. Index-stay category by operative-duration category. Unadjusted distribution in the analytic cohort.

Exploratory analysis of patient characteristics and prolonged operative duration

Of the 250 operations, 44 (17.6%) lasted more than 90 minutes (the study-defined prolonged-duration endpoint). Prolonged operations rose across BMI categories from 1/7 (14.3%) underweight, 12/126

(9.5%) normal, 16/80 (20.0%) overweight, to 15/37 (40.5%) obese. In the parsimonious adjusted model, obesity was associated with higher odds of a prolonged operation versus the combined underweight/normal reference (aOR 6.06, 95% CI 2.51-14.64; p<0.001); overweight showed a smaller, non-significant increase (aOR 2.21, 95% CI 0.99-4.93; p=0.053). Age (>=40 versus<40; aOR 2.04, 95% CI 0.82-5.06) and sex (male versus female; aOR 1.52, 95% CI 0.69-3.36) were not statistically significant (Table 4). Modelled ordinally, each BMI category increase was associated with roughly 2.4-fold odds (aOR 2.45, 95% CI 1.57-3.82; p<0.001), consistent with a monotonic pattern. The estimates were stable across the sensitivity specifications in Additional file 2 (adding recorded comorbidity: obese aOR 6.28, 2.58-15.29; excluding underweight: obese aOR 6.15, 2.51-15.06). These are exploratory, unvalidated estimates; they must not be interpreted as causal effects or used for individual risk prediction.

Table 4. Exploratory parsimonious multivariable logistic regression for the study-defined prolonged-duration endpoint (>90 minutes).

Variable	aOR (95% CI)	p
BMI: overweight vs underweight/normal	2.21 (0.99-4.93)	0.053
BMI: obese vs underweight/normal	6.06 (2.51-14.64)	<0.001
Age>=40 vs<40 years	2.04 (0.82-5.06)	0.125
Male vs female	1.52 (0.69-3.36)	0.299

Model N = 250; 44 events and 206 non-events; four estimated coefficients (two BMI indicators, age, sex), approximately 11 events per parameter. Reference: combined underweight/normal BMI (underweight: 7 patients, 1 prolonged operation). Estimated by maximum-likelihood logistic regression; the model converged without separation. The endpoint is study-defined and not a clinically validated threshold. Estimates are exploratory and cross-checked against the raw dataset; sensitivity analyses are reported in Additional file 2.

Primary recorded postoperative-event codes

Forty patients (16.0%) had a primary postoperative-event code in the archive. These codes appeared only among patients with an index stay of at least 24 hours, and treating-team clarification indicates that 24 of the 40 coded events were first recognised after discharge (Table 4). This pattern must not be interpreted as evidence that patients discharged within 24 hours had no postoperative morbidity. It may reflect clinical severity, opportunity for inpatient detection, later readmission, incomplete documentation, variation in follow-up, and one-code-per-patient recording.

Table 3. Primary recorded postoperative-event codes by index-stay category.

Primary recorded code	<24 h	24-72 h	>72 h to 2 wk	Total
Biliary leak	0	4	0	4
Hepatic laceration	0	0	2	2
Fistula formation	0	0	4	4

Primary recorded code	<24 h	24-72 h	>72 h to 2 wk	Total
Missed stone	0	0	6	6
Wound infection	0	24	0	24
No primary code recorded	189	21	0	210
Total	189	49	12	250

Each patient could receive one primary code only. Coexisting events, including wound infection with biliary leakage, are not fully represented. This table is not an incidence or time-to-event analysis.

The recognition context of each coded event was established by retrospective manual review of the source records by the treating team, as described in the Methods; the archive itself does not record it. Of the 40 coded events, 24 (60.0% of coded events; 24/250, 9.6% of the cohort) were first recognised after discharge: 21 wound infections after postoperative day five, two retained stones five to seven days after discharge, and one fistula after one month. Six (15.0%) were recognised during the index admission or operation: four biliary leaks and two intraoperative hepatic lacerations. Ten (25.0%) could not be timed from the available records: three wound infections, three fistulas, and four retained stones. These figures describe when each coded event was first recognised, not when it arose; the annotations were not independently duplicated; and no post-discharge complication rate in the incidence sense can be computed from this review (Table 4).

Table 4. Timing of first recognition of the 40 primary recorded postoperative-event codes (companion to Table 3).

Timing of first recognition	n	% of coded events	% of cohort
After discharge (21 wound infections, 2 retained stones, 1 fistula)	24	60.0	9.6
During index admission or operation (4 biliary leaks, 2 hepatic lacerations)	6	15.0	2.4
Not verifiable from available records (3 wound infections, 3 fistulas, 4 retained stones)	10	25.0	4.0
Total coded events	40	100.0	16.0

Based on retrospective manual review of source records by the treating team (Methods); the archive does not record event-onset dates. 'After discharge' means first recognised after discharge, not date of onset. Percentages of the cohort use N = 250. One primary code per patient; coexisting events are not represented.

Discussion

In this record-review cohort from a Sudanese secondary hospital without laparoscopic services, 75.6% of analysed patients had a documented index discharge within 24 hours. Longer operations, abnormal intraoperative findings, and recorded bleeding occurred more frequently in longer-stay categories. These are descriptive associations within the analytic cohort. They do not show that any one factor

independently prolonged admission, because each may be a consequence or marker of the same underlying operative difficulty, disease severity, patient condition, and care processes. A difficult inflammatory or adhesive dissection may lengthen the procedure, increase bleeding risk, prompt closer postoperative observation, and delay discharge; conversely, an early postoperative event may extend admission while a longer admission creates more opportunity for recognition and recording. The data therefore support local description and hypothesis generation, not risk prediction or causal inference.

Placed against the same institution's immediately preceding experience, the continuity of the pathway is more informative than either period alone. The 2009-2020 report described 512 mini-laparotomy cholecystectomies with 89.5% discharged within 24 hours and wound infection in 1.4% [1]; the present 2021-2025 cohort shows 75.6% discharged within 24 hours and a primary wound-infection code in 9.6%. Both the shift toward longer stays and the higher frequency of recorded wound infection are consistent with the operational burdens of the conflict period, including disrupted supply chains, theatre constraints, and impaired follow-up, but they are equally consistent with changes in case selection, coding practice, and documentation. Because the two reports share an administrative event field and neither captures denominator-standardised postoperative surveillance, these contrasts are hypothesis-generating descriptions, not trend estimates.

The present findings are broadly in keeping with the wider mini-laparotomy literature. In Kassala, Sudan, mini-cholecystectomy in 600 patients produced a mean hospital stay of 2.9 days with a 0.5% biliary injury rate [18]; trials and systematic reviews in other settings likewise report short stays and low complication rates for the approach [13,17], and ambulatory mini-laparotomy cholecystectomy has been described under different anaesthetic techniques [22]. Operative time has been associated with postoperative morbidity in laparoscopic cholecystectomy [7], which lends the duration findings clinical relevance, although that evidence is indirect. The 75.6% same-day discharge proportion in the present cohort sits within the range these settings describe, while the recorded biliary-leak frequency (4/250,

1.6%) and the two hepatic laceration entries warrant clinical governance review at the hospital, in line with multisociety safe-cholecystectomy guidance [6], independent of publication.

Postoperative-event findings require particular caution. Serious events were generally recognised during admission or later hospital care, whereas most wound infections and two retained stones were first recognised after discharge among returning patients, and one fistula presented after one month; a quarter of coded events could not be timed at all. The archive did not reliably record onset dates, all follow-up attendance, repeat events, event severity, all readmissions, reinterventions, or mortality. Conflict-related barriers limited follow-up for some patients. One primary code per patient prevented full representation of concurrent conditions. The recorded code distribution is therefore a floor, not a complete complication rate, and cannot establish the full timing or severity of postoperative morbidity.

This cohort cannot compare mini-laparotomy with laparoscopic cholecystectomy. Laparoscopy was unavailable at the study hospital, and no contemporaneous local laparoscopic group existed. Published comparative evidence, including meta-analyses of randomised trials [12,14], is external context rather than a benchmark. Preoperative prediction of operative difficulty is established for laparoscopic cholecystectomy [3,8] and has been examined in secondary-hospital settings [4]; no validated equivalent exists for mini-laparotomy in this environment, and the associations reported here are hypothesis-generating only. The contribution of this study is to describe outcomes and data limitations associated with the locally available surgical pathway, and to document that this pathway remained in continuous operation through the study period.

Transferability should be judged by setting rather than geography alone. The findings may be relevant to secondary hospitals that rely on mini-laparotomy because laparoscopic infrastructure, maintenance, supplies, trained teams, or referral capacity are limited. They are less directly applicable to hospitals with established laparoscopic programmes, routine advanced imaging or endoscopy, standardised 30-day surveillance, comprehensive electronic records, or different discharge pathways. Variation in case

selection, inflammatory severity, antibiotic practice, anaesthesia, operator experience, and follow-up access may materially alter outcomes.

This study has strengths and limitations. Strengths include a five-year institutional experience spanning the conflict period, inclusion of all 250 available records, exploratory testing with correction for multiple comparisons, first-author verification of the extracted dataset against source records, and verified internal consistency of the reported analyses. Limitations are substantial: all analysed measures were categorical and key continuous data were unavailable; abstraction was single-pass by three clinicians and was not independently duplicated, and the boundary conventions of the register's age and duration bands were not recorded; important clinical confounders, complete longitudinal follow-up, readmissions, reinterventions, and mortality data were not available; blank comorbidity entries were interpreted as absence of recorded comorbidity on author confirmation, an interpretation not verifiable against a standardised field; the absence of a local laparoscopic comparison cohort precludes comparative-effectiveness inference; event ascertainment was administrative, one code per patient, and sensitive to both inpatient opportunity and follow-up attendance; and the recognition-context annotations of coded events were reconstructed retrospectively by the treating team outside the original coded dataset, without independent duplication.

A minimum dataset for comparable settings

The limitations of this record review are shared by most surgical services in conflict-affected and resource-constrained settings, which typically document operations in theatre registers designed for administration rather than analysis. Table 5 sets out the minimum dataset that prospective collection in comparable settings should capture; implementing it locally would allow the questions raised here to be answered directly rather than by inference from incomplete records. An adjusted analysis of prolonged operative duration was accordingly deferred rather than fitted from these records.

Table 5. Proposed minimum dataset for surgical registries in conflict-affected and resource-constrained secondary hospitals.

Data element	Why it matters
Exact operative start and end times	Replaces study-defined duration categories with a measurable, comparable endpoint
Exact patient age	Avoids information loss from grouped categories

Data element	Why it matters
Disease severity (grading of inflammation)	Addresses the dominant confounder of duration, bleeding, and stay
ASA class with assigned criteria	Supports adjustment and case-mix description
Multiple postoperative complications with event dates	Replaces one-code-per-patient administrative coding and permits incidence and timing analysis
Readmissions and reinterventions	Captures morbidity occurring after discharge
Mortality at 30 days	Completes the outcome picture
Follow-up attendance and completeness	Makes ascertainment quantifiable rather than assumed

Derived from the data limitations documented in the present record review; each element addresses a specific limitation reported in this study.

Conclusion

Among 250 records of mini-laparotomy cholecystectomy at a Sudanese secondary hospital, the only locally available operative pathway remained in continuous operation across 2021-2025, including after the outbreak of armed conflict in April 2023. 189 patients (75.6%) had a documented index discharge within24 hours, down from 89.5% in the hospital's 2009-2020 series, while recorded wound-infection codes rose from 1.4% to 9.6%. Recorded operative duration, intraoperative findings, and bleeding were associated with index-stay category after correction for multiple exploratory comparisons, but these associations cannot be interpreted as independent predictors or causal effects. Prospective collection should implement the minimum dataset proposed in Table 5.

List of abbreviations

ASA: American Society of Anesthesiologists physical status classification; BMI: body mass index; CI: confidence interval; FFH: Fisher-Freeman-Halton; MC: Monte Carlo; OR: odds ratio; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology; V: Cramer's V.

Declarations

Ethics approval and consent to participate:

The Ethical Committee of Elduiem Teaching Hospital, White Nile State, Sudan, approved the study (approval number W.N.S SD 12/26; approved project title: Clinical Characteristics and Perioperative Outcomes of Mini-Laparotomy Cholecystectomy in a Resource-Limited Secondary Hospital in Sudan: A Retrospective Observational Study), with the approval confirmed in writing by the hospital's General Medical Director. Because the study is a retrospective analysis of existing archived records, involves no direct patient contact or intervention, uses de-identified data, and reports findings only in aggregate form, the requirement for individual informed consent was waived by the Ethical Committee for this retrospective record review. Archive access was approved by hospital administration, and no patient-identifying data are presented. The signed approval and supplementary consent-determination statement are available from the corresponding author on request.

Consent for publication:

Not applicable. No patient-identifying data are presented.

Availability of data and materials:

The de-identified dataset analysed during this study is held by the study team and is not publicly available, in order to protect patient confidentiality and honour the conditions of institutional and ethical approval. Sharing may be considered on reasonable request to the corresponding author, subject to institutional and ethical requirements and any required approval by the relevant authorities.

Competing interests:

The authors declare no competing interests.

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Authors' contributions:

Samir Ismail Bashir Abdelkarim conceived the study, supervised it surgically and provided clinical leadership, performing a substantial share of the cholecystectomies himself. Yasser Babiker Ali Al-Shambati delivered operative and perioperative surgical care. Siddig Ismail Bashir Abdelkarim assisted in theatre and carried out perioperative and postoperative follow-up. Abdel Rhman Saeed Hajnour performed preoperative medical assessment, optimisation and fitness-for-surgery decisions. Mogahid Hamdan assisted in theatre with preoperative preparation and postoperative care, and performed data extraction. Alsadig Mohamed Ali Suleiman participated in operative and perioperative surgical care and performed data extraction. Sohaila Moawia Yousif Ahmed undertook preoperative clinical assessment, preparation and follow-up. Khalid Abbas Owish Sukar supervised the work overall, appraised it critically and revised the final manuscript. Reem Abdalla Elsiddig Musa revised the final manuscript. Monira Mohammed Sarih performed data extraction and assisted in data analysis. Elddai Hammad Elnaem performed preoperative medical assessment, optimisation and fitness-for-surgery decisions, and wrote the introduction. Yasser Ibrahim Hamad Eissa performed preoperative medical assessment, optimisation and fitness-for-surgery decisions, and double-checked the extracted data. Mustafa Mahamed Ahmed Fadlalmolla performed preoperative medical assessment, optimisation and fitness-for-surgery decisions, and contributed significantly to writing the discussion. All authors read and approved the final manuscript.

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Declaration of generative AI in scientific writing:

ChatGPT (OpenAI) was used during manuscript preparation for language editing and document organisation. The authors reviewed and edited the revised text, verified all data and interpretations, and take full responsibility for the submitted content.

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