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ENHANCED RECOVERY AFTER SURGERY (ERAS) COMBINED WITH MINIMALLY INVASIVE TECHNIQUES: A PROSPECTIVE EVALUATION OF POSTOPERATIVE OUTCOMES, HOSPITAL STAY, AND PATIENT SATISFACTION IN MAJOR ABDOMINAL SURGERIES

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) protocols and minimally invasive surgery have independently improved perioperative outcomes, but evidence regarding their combined use in emergency abdominal surgery remains limited. This multicentre study evaluated the impact of ERAS combined with minimally invasive techniques on postoperative recovery, complications, hospital stay, and patient satisfaction in patients undergoing major emergency abdominal surgery.

Materials and Methods: A prospective multicentre observational study was conducted in three tertiary care teaching hospitals in South India between January 2024 and December 2025. A total of 173 adult patients undergoing emergency laparoscopic surgery for acute appendicitis, acute cholecystitis, perforated peptic ulcer, adhesive intestinal obstruction, perforated diverticulitis, and small bowel perforation were managed using a standardized ERAS protocol. Demographic characteristics, perioperative variables, ERAS compliance, postoperative recovery, complications, and patient satisfaction were analysed using validated outcome assessment tools.

Results: The Multicentre study included 104 males (60.1%) and 69 females (39.9%), with a mean age of 46.8 ± 15.2 years. Acute appendicitis (33.5%) was the commonest indication for surgery. ERAS compliance exceeded 90%, with 100% multimodal analgesia, 91.3% early oral feeding, and 89.0% early mobilization. The mean operative duration was 88.6 ± 24.3 minutes, mean blood loss was 92 ± 46 mL, and conversion to open surgery occurred in 6.4% of patients. Overall, 87.9% achieved excellent-to-good recovery, with a mean hospital stay of 4.9 ± 1.8 days, ICU admission in 10.4%, surgical site infection in 3.5%, mortality in 1.2%, and a high patient satisfaction score of 9.3 ± 0.6. High ERAS compliance was significantly associated with favourable postoperative outcomes ($p < 0.001$).

Conclusion: The combination of ERAS protocols and minimally invasive emergency abdominal surgery resulted in rapid functional recovery, reduced postoperative complications, shorter hospitalization, and excellent patient satisfaction. These findings support the routine implementation of standardized ERAS pathways with laparoscopic-first strategies to improve the quality and efficiency of emergency general surgical care.

Keywords: Enhanced Recovery After Surgery, ERAS, minimally invasive surgery, laparoscopic surgery, emergency abdominal surgery, postoperative recovery, patient satisfaction, emergency general surgery.

INTRODUCTION

Enhanced Recovery After Surgery (ERAS) and Minimally Invasive Surgery in Emergency Abdominal Surgery

The Enhanced Recovery After Surgery (ERAS) Society recommends implementing evidence-based perioperative care pathways for patients undergoing emergency laparotomy to improve postoperative recovery, reduce complications, shorten hospital stay, and decrease mortality. Emergency laparotomy requires rapid diagnosis, prompt resuscitation, correction of physiological abnormalities, and timely surgical source control because delays are associated with poorer clinical outcomes. Early risk assessment, lactate measurement, correction of fluid and electrolyte imbalance, and administration of broad-spectrum antibiotics are essential components of preoperative optimization. Patients with septic shock should ideally undergo definitive source control within 3 hours, while those with sepsis should receive surgery within 6 hours whenever feasible. Unlike elective surgery, routine preoperative carbohydrate loading is generally not recommended because of delayed gastric emptying and the increased risk of aspiration. ERAS protocols further emphasize goal-directed fluid therapy, maintenance of normothermia, multimodal opioid-sparing analgesia, prevention of postoperative nausea and vomiting, early enteral nutrition, early mobilization, venous thromboembolism prophylaxis, and continuous audit of perioperative outcomes. These measures have consistently been shown to improve functional recovery, reduce postoperative complications, decrease intensive care utilization, and shorten hospital stay in emergency abdominal surgery. [1-5,8]

The World Society of Emergency Surgery (WSES) recommends a structured perioperative pathway integrating rapid clinical assessment, early imaging, prompt resuscitation, timely antimicrobial therapy, and definitive surgical intervention for emergency general surgery. The WSES strongly supports incorporating ERAS principles into emergency surgical practice through multidisciplinary care, standardized perioperative protocols, haemodynamic optimization, early nutritional support, and protocol-based postoperative management. Whenever clinically appropriate, a laparoscopic-first approach is recommended because minimally invasive surgery is associated with less postoperative pain, fewer wound complications, faster bowel recovery, shorter hospital stay, earlier return to normal activities, and improved patient satisfaction compared with conventional open surgery. The recommendations also encourage multimodal analgesia, avoidance of unnecessary drains and nasogastric tubes, early mobilization, thromboprophylaxis, and individualized postoperative critical care for high-risk patients. The WSES concludes that combining ERAS principles with minimally invasive surgery provides better clinical outcomes while optimizing healthcare resources and should be adopted whenever institutional expertise permits.[2,6-8]

The WSES laparoscopic-first consensus guidelines recommend minimally invasive surgery for haemodynamically stable patients with emergency abdominal conditions whenever adequate expertise and facilities are available. Based on evidence from more than 323 published studies, the expert panel concluded that laparoscopy is safe and effective for acute appendicitis, acute cholecystitis, perforated peptic ulcer, adhesive small bowel obstruction, acute diverticulitis, incarcerated or strangulated hernia, selected colorectal emergencies, mesenteric ischaemia, and abdominal trauma in appropriately selected patients. Compared with emergency laparotomy, laparoscopic surgery offers reduced postoperative pain, lower wound infection rates, decreased pulmonary complications, faster bowel recovery, shorter hospitalization, improved cosmetic outcomes, and lower healthcare costs. Even when conversion to open surgery becomes necessary, the initial laparoscopic approach often improves diagnostic accuracy and operative planning. Successful implementation depends on careful patient selection, experienced surgeons, appropriate infrastructure, and institutional preparedness.[8]

To promote safe expansion of minimally invasive emergency surgery, the WSES has developed a structured competency-based training curriculum. The programme emphasizes simulation-based training, supervised operative experience, structured mentoring, gradual progression from elective to emergency laparoscopic procedures, and regular competency assessment. Essential skills include safe abdominal access, laparoscopic suturing, intracorporeal knot tying, bowel inspection, haemostasis, management of intraoperative complications, and appropriate conversion to open surgery. The curriculum also recommends credentialing, maintenance of operative volume, continuous quality assurance, and the use of simulation laboratories, cadaveric workshops, animal models, and virtual reality training. The WSES concludes that combining structured laparoscopic training with ERAS protocols can improve perioperative outcomes, reduce postoperative morbidity, shorten hospital stay, enhance patient satisfaction, and improve the quality of emergency surgical care.[9,10]

ERAS Recommendations for Emergency Laparotomy

The Enhanced Recovery After Surgery (ERAS) Society recommends that evidence-based perioperative care pathways should be routinely

implemented for patients undergoing emergency laparotomy to improve postoperative recovery, reduce complications, shorten hospital stay, and decrease mortality.[1] Emergency laparotomy requires simultaneous correction of physiological derangement, rapid diagnosis, prompt resuscitation, and timely surgical source control because delays are associated with poorer outcomes.[1,2] The ERAS guidelines recommend early risk stratification, lactate measurement, correction of fluid and electrolyte imbalance, prompt administration of broad-spectrum antibiotics in septic patients, and optimization before surgery whenever feasible.[1] Patients with septic shock should undergo definitive surgical source control as early as possible, ideally within 3 hours, while patients with sepsis should undergo surgery within 6 hours whenever clinically appropriate.[1,3] Routine preoperative carbohydrate loading is generally not recommended in emergency laparotomy because delayed gastric emptying and aspiration risk are common in emergency surgical patients.[1] The ERAS pathway also emphasizes goal-directed fluid therapy, maintenance of normothermia, multimodal opioid-sparing analgesia, prevention of postoperative nausea and vomiting, early enteral nutrition, early mobilization, thromboprophylaxis, and continuous audit of perioperative outcomes.[2,4] Implementation of standardized ERAS pathways has been shown to improve functional recovery, reduce postoperative complications, decrease intensive care utilization, and shorten hospital stay in patients undergoing emergency abdominal surgery.[2,5]

WSES Enhanced Perioperative Care in Emergency General Surgery

The World Society of Emergency Surgery (WSES) recommends a structured perioperative care pathway for emergency general surgery that integrates rapid diagnosis, prompt imaging, early resuscitation, timely antimicrobial therapy, and definitive surgical intervention.[6] The WSES position paper strongly supports adoption of Enhanced Recovery principles in emergency surgery, including multidisciplinary care, standardized perioperative protocols, optimization of haemodynamic status, early nutritional support, and protocol-driven postoperative management.[6] Whenever technically feasible and clinically appropriate, a laparoscopic-first approach is recommended because minimally invasive surgery is associated with reduced postoperative pain, fewer wound complications, faster bowel recovery, shorter hospital stay, and earlier return to normal activities compared with conventional open surgery.[6,7] The WSES recommendations further emphasize multimodal analgesia, avoidance of unnecessary drains and nasogastric tubes, early mobilization, venous thromboembolism prophylaxis, and individualized postoperative critical care for high-risk patients.[2,6] The Society concludes that combining ERAS principles with minimally invasive emergency surgery improves clinical outcomes, enhances patient satisfaction, optimizes healthcare resources, and should become the standard of care whenever institutional expertise and patient condition permit.[6,7]

WSES Laparoscopic-First Approach for Emergency Abdominal Surgery and WSES Training and **Implementation of Minimally Invasive Emergency Surgery**

The World Society of Emergency Surgery (WSES) recommends a laparoscopic-first approach for appropriately selected, haemodynamically stable patients presenting with emergency abdominal surgical conditions. Based on a comprehensive review of 323 published studies, the WSES expert panel concluded that minimally invasive surgery (MIS) is safe, feasible, and effective for many acute abdominal emergencies when performed by adequately trained surgeons.[1] The guidelines support laparoscopy as the preferred initial approach for conditions such as acute appendicitis, acute cholecystitis, perforated peptic ulcer, adhesive small bowel obstruction, acute diverticulitis, incarcerated or strangulated hernia, selected colorectal emergencies, mesenteric ischaemia, and abdominal trauma in stable patients. Compared with conventional emergency laparotomy, the laparoscopic-first strategy provides several advantages, including reduced postoperative pain, lower wound infection rates, earlier return of bowel function, decreased pulmonary complications, shorter hospital stay, faster functional recovery, improved cosmetic outcomes, and reduced healthcare costs.[2,3] The guidelines further emphasize that even when conversion to open surgery becomes necessary, patients may still benefit from the initial minimally invasive approach because of improved diagnostic accuracy and optimized surgical planning. However, successful implementation depends on careful patient selection, surgeon expertise, availability of appropriate equipment, and institutional readiness.[4] Haemodynamically unstable patients or those with uncontrolled intra-abdominal haemorrhage generally remain candidates for immediate open surgery. To facilitate wider adoption of emergency minimally invasive surgery, the WSES has also developed a structured training curriculum for emergency digestive surgery.[5] The curriculum recognizes that the traditional apprenticeship model of surgical education ("see one, do one, teach one") is insufficient for modern emergency laparoscopy. Instead, it recommends a competency-based, progressive training programme beginning with simulation-based skills training, followed by supervised clinical practice, structured mentoring (proctoring), and dedicated emergency minimally invasive surgery fellowships. The curriculum encourages gradual acquisition of advanced laparoscopic skills during elective surgery before their application to emergency procedures.[6] The WSES curriculum identifies several essential competencies for emergency laparoscopic surgeons, including safe abdominal access, laparoscopic suturing, intracorporeal knot tying, bowel inspection,

haemostasis, management of intraoperative complications, conversion techniques, and sound intraoperative decision-making. The guidelines also recommend regular skills assessment, credentialing, maintenance of adequate annual operative volumes, and continuous quality assurance to ensure patient safety. Simulation laboratories, cadaveric workshops, animal models, virtual reality platforms, and structured assessment tools are considered integral components of modern emergency surgical education. The WSES concludes that combining laparoscopic-first strategies, ERAS principles, and structured minimally invasive surgical training can improve perioperative outcomes, reduce postoperative morbidity, shorten hospital stay, optimize resource utilization, and enhance the quality of emergency surgical care.[7] The successful implementation of these recommendations requires multidisciplinary collaboration, institutional commitment, ongoing audit, and continuous surgical education to ensure safe expansion of minimally invasive techniques in emergency general surgery.

MATERIALS AND METHODS

Study Design and Setting

This prospective, Multicentre observational analytical study was conducted in the Departments of General Surgery of three tertiary care teaching hospitals in South India between January 2024 and May 2026. The study evaluated the impact of Enhanced Recovery After Surgery (ERAS) protocols combined with minimally invasive surgical techniques on postoperative recovery, hospital stay, complications, and patient satisfaction among patients undergoing major emergency abdominal surgery. The study was approved by the Institutional Ethics Committees of all participating centres, and written informed consent was obtained from all patients before enrolment.

Study Population

A total of 173 consecutive patients (N = 173) who underwent major emergency abdominal surgery using minimally invasive techniques under an ERAS protocol were included. Patients aged 18 years or older diagnosed with emergency abdominal surgical conditions requiring laparoscopic intervention were enrolled.

Sample Size: Sample size was calculated using the single population proportion formula, $n = Z^2P(1 - P)/d^2$, assuming a 95% confidence level (Z = 1.96), an anticipated prevalence of favourable postoperative recovery following ERAS of 87% based on previous published studies, and an absolute precision of 5%. The minimum required sample size was estimated to be 174 participants. The calculation was performed using Open-Epi Version 3.01 (Open-source Epidemiologic Statistics for Public Health). Considering feasibility and the multicentre design, 173 consecutive eligible patients who fulfilled the inclusion criteria during the study period were enrolled for analysis.

Inclusion Criteria

Patients undergoing emergency laparoscopic surgery for acute appendicitis, acute cholecystitis, perforated peptic ulcer, adhesive intestinal obstruction, perforated diverticulitis, and small bowel perforation who were managed according to a standardized ERAS pathway were included.

Exclusion Criteria

Patients younger than 18 years, pregnant women, trauma laparotomies, patients requiring primary open surgery because of haemodynamic instability, patients with ASA Grade V disease, terminal malignancy, chronic liver failure, chronic renal failure requiring dialysis, and patients unwilling to participate were excluded.

Study Variables

Demographic Variables

The demographic variables included age, gender, body mass index (BMI), occupation, educational status, socioeconomic status, smoking history, alcohol consumption, diabetes mellitus, hypertension, ischemic heart disease, chronic kidney disease, chronic obstructive pulmonary disease, previous abdominal surgery, American Society of Anesthesiologists (ASA) grade, nutritional status, and residence (urban/rural).

Clinical Variables

The clinical variables included duration of symptoms, abdominal pain, fever, vomiting, abdominal distension, constipation, obstipation, diarrhoea, guarding, rigidity, rebound tenderness, bowel sounds, shock, peritonitis, sepsis, laboratory investigations, inflammatory markers, and imaging findings.

Emergency Abdominal Conditions and Minimally Invasive Procedures

The study evaluated six common emergency abdominal conditions managed using six minimally invasive procedures.

Emergency Condition	Minimally Invasive Technique
Acute appendicitis	Laparoscopic appendicectomy
Acute cholecystitis	Laparoscopic cholecystectomy
Perforated peptic ulcer	Laparoscopic Graham's omental patch repair
Adhesive intestinal obstruction	Laparoscopic adhesiolysis
Perforated diverticulitis	Laparoscopic peritoneal lavage with sigmoid resection when indicated
Small bowel perforation	Laparoscopic-assisted bowel repair or resection and anastomosis

Indications for Surgery

The operative indications evaluated as variables included acute appendicitis, gangrenous appendicitis, perforated appendicitis, acute calculous cholecystitis, empyema gallbladder, perforated peptic ulcer, generalized peritonitis, adhesive intestinal obstruction, strangulated bowel, perforated diverticulitis, localized intra-abdominal abscess, bowel perforation, pneumoperitoneum, intestinal ischemia, persistent abdominal sepsis, failed conservative management, and radiological evidence of surgical abdomen.

ERAS Protocol Variables

Compliance with ERAS recommendations was evaluated using the following variables:

Preoperative variables: Patient counselling, avoidance of prolonged fasting, carbohydrate loading where appropriate, preoperative antibiotic prophylaxis, venous thromboembolism prophylaxis, nutritional assessment, optimization of diabetes, smoking cessation advice, and standardized anaesthetic preparation.

Intraoperative variables: Minimally invasive surgery, normothermia maintenance, restrictive intravenous fluid therapy, multimodal anaesthesia, prevention of hypothermia, goal-directed fluid therapy, prophylaxis against postoperative nausea and vomiting (PONV), avoidance of routine drains whenever possible, and avoidance of unnecessary nasogastric tubes.

Postoperative ERAS variables: Early oral feeding, early mobilization, multimodal analgesia, opioid-sparing analgesia, urinary catheter removal, drain removal, respiratory physiotherapy, glycaemic control, thromboprophylaxis, postoperative counselling, and discharge planning.

Postoperative Evaluation Variables

Patients were monitored using standardized postoperative assessment protocols. Variables included pain score using the Visual Analogue Scale (VAS), analgesic requirement, blood pressure, pulse rate, respiratory rate, oxygen saturation (SpO_2), temperature, urine output, drain output, postoperative bleeding, airway patency, postoperative nausea and vomiting, bowel sounds, passage of flatus, initiation of oral feeding, ambulation time, wound assessment, surgical site infection, respiratory complications, cardiovascular complications, urinary complications, thromboembolic events, intensive care unit (ICU) admission, ICU stay, duration of hospital stay, readmission, and mortality.

Outcome Measures

Primary Outcome

The primary outcome was successful postoperative recovery following ERAS combined with minimally invasive surgery, measured by time to functional recovery and readiness for discharge.

Secondary Outcomes

Secondary outcome variables included operative duration, intraoperative blood loss, postoperative pain, opioid consumption, haemodynamic stability, pulmonary complications, postoperative ileus, surgical site infection, anastomotic leak where applicable, reoperation, ICU admission, ICU stay, hospital stay, 30-day readmission, mortality, patient satisfaction, quality of recovery, and cost-effectiveness.

Final recovery was assessed using internationally validated postoperative assessment tools, including the Quality of Recovery-15 (QoR-15) Score, Postoperative Quality of Recovery Scale (PQRS), Clavien-Dindo Classification of Surgical Complications, Comprehensive Complication Index (CCI), Visual Analogue Scale (VAS) for pain, ASA Physical Status Classification, and the Patient Satisfaction Questionnaire (PSQ-18). Overall outcomes were categorized as Excellent, Good, Fair, or Poor according to postoperative functional recovery, complication profile, and patient satisfaction.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range [IQR]), depending on data distribution, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the Student's *t*-test or Mann–Whitney *U* test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables, as appropriate. Multivariable logistic regression analysis was performed to identify independent predictors of favourable postoperative outcomes, and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported. A two-sided p value <0.05 was considered statistically significant.

RESULTS

A total of **173 patients** who underwent emergency minimally invasive abdominal surgery under an **Enhanced Recovery After Surgery (ERAS)** protocol were included in this prospective multicentre study. There were **104 males (60.1%)** and **69 females (39.9%)**, with a mean age of **46.8 ± 15.2 years** (range: **18–82 years**). Acute appendicitis was the most frequent indication for surgery, followed by acute cholecystitis and perforated peptic ulcer. Compliance with individual ERAS components was high across the study population, and most procedures were completed laparoscopically without conversion to open surgery. Patients generally demonstrated early postoperative mobilization, early oral feeding, low postoperative pain scores, short hospital stay, and high levels of patient satisfaction.

Table 1. Demographic Characteristics of the Study Population (N = 173)

The study population was predominantly composed of **middle-aged adults**, with **47.4%** of patients

belonging to the **31–50-year** age group. Males constituted **60.1%** of the cohort. Most patients (**76.3%**) were classified as **ASA Grade I–II**, indicating relatively low anaesthetic risk. **Hypertension (27.7%)** and **diabetes mellitus (19.7%)** were the most frequently observed comorbidities.

Table 1: Demographic Characteristics of the Study Population (N = 173)

Variable	Number (%)	
Male	104 (60.1)	
Female	69 (39.9)	
18–30 years	36 (20.8)	
31–50 years	82 (47.4)	
51–70 years	43 (24.9)	
>70 years	12 (6.9)	
Diabetes mellitus	34 (19.7)	
Hypertension	48 (27.7)	
ASA Grade I–II	132 (76.3)	
ASA Grade III–IV	41 (23.7)	

Most patients were middle-aged adults 47.4% with relatively low anaesthetic risk. Diabetes and hypertension were the commonest associated comorbidities 19.7% and 27.7% respectively. [Table 1]

Table 2. Clinical Variables

Acute appendicitis (33.5%) was the commonest indication for emergency laparoscopic surgery, followed by acute cholecystitis (20.8%), perforated peptic ulcer (13.9%), adhesive intestinal obstruction (12.7%), perforated diverticulitis (10.4%), and small bowel perforation (8.7%). The most common presenting clinical features were vomiting (62.4%), fever (54.3%), and guarding (49.7%), whereas generalized peritonitis and sepsis at admission were observed less frequently.

Table 2: Clinical Variables

Clinical Variable	Number (%)
Acute appendicitis	58 (33.5)
Acute cholecystitis	36 (20.8)
Perforated peptic ulcer	24 (13.9)
Adhesive intestinal obstruction	22 (12.7)
Perforated diverticulitis	18 (10.4)
Small bowel perforation	15 (8.7)
Fever	94 (54.3)
Vomiting	108 (62.4)
Guarding	86 (49.7)
Generalized peritonitis	32 (18.5)
Sepsis at admission	18 (10.4)

Acute appendicitis (33.5%) remained the most frequent emergency abdominal condition followed by Acute Cholecystitis in 20.8%, perforated peptic ulcer in 13.9%, Adhesive intestinal obstruction in 12.7%, perforated diverticulitis in 1o.4% and small bowel perforation in 8.7% patients. Vomiting, fever, abdominal tenderness, and guarding were the predominant presenting features.

Table 3. Investigative Variables

Regular laboratory investigations were performed in all patients. Ultrasonography (93.1%) and contrast-enhanced computed tomography (68.2%) were the principal imaging modalities used for diagnosis. Diagnostic laparoscopy was performed in 24.3% of patients presenting with equivocal clinical findings and assisted in establishing the diagnosis while facilitating definitive surgical management.

Table 3: Investigative Variables

Investigation	Number (%)
Complete blood count	173 (100)
Serum electrolytes	173 (100)
CRP	146 (84.4)
Serum lactate	88 (50.9)
Plain abdominal X-ray	82 (47.4)
Ultrasonography	161 (93.1)
Contrast-enhanced CT	118 (68.2)
MRI abdomen	16 (9.2)
Upper GI endoscopy	18 (10.4)
Diagnostic laparoscopy	42 (24.3)

Ultrasonography and contrast-enhanced CT were the most frequently used imaging modalities. Diagnostic laparoscopy assisted diagnosis in patients with equivocal clinical findings.

Table 4. Operative Variables

Laparoscopic appendicectomy (33.5%) and **laparoscopic cholecystectomy (20.8%)** were the most frequently performed procedures. The mean operative duration was **88.6 ± 24.3 minutes**, and the mean intraoperative blood loss was **92 ± 46 mL**. Conversion to open surgery was required in **11 patients (6.4%)**, while **8 patients (4.6%)** required blood transfusion. Surgical drains were placed in **46 patients (26.6%)** based on intraoperative findings.

Table 4: Operative Variables

Variable	Mean ± SD / Number (%)
Laparoscopic appendicectomy	58 (33.5)
Laparoscopic cholecystectomy	36 (20.8)
Laparoscopic Graham patch repair	24 (13.9)
Laparoscopic adhesiolysis	22 (12.7)
Laparoscopic diverticular surgery	18 (10.4)
Laparoscopic-assisted bowel repair	15 (8.7)
Mean operative duration	88.6 ± 24.3 min
Blood loss	92 ± 46 mL
Conversion to open surgery	11 (6.4)
Blood transfusion	8 (4.6)
Drain placement	46 (26.6)

Laparoscopic surgery was successfully completed in the majority of patients. Mean intraoperative blood loss remained low, and conversion to open surgery was uncommon.

Table 5. Postoperative Results and Final Outcomes

Postoperative recovery was favourable in most patients. Excellent or good outcomes were achieved in 152 patients (87.9%), while 16 patients (9.2%) had fair outcomes and 5 patients (2.9%) had poor outcomes. The mean hospital stay was 4.9 ± 1.8 days, and the mean ICU stay among patients requiring intensive care was 1.8 ± 0.9 days. Postoperative complications included surgical site infection (3.5%), pulmonary complications (2.9%), anastomotic leak (1.2%), reoperation (1.7%), and mortality (1.2%). Overall patient satisfaction was high, with a mean score of 9.3 ± 0.6 on a 10-point scale.

Table 5: Postoperative Results and Final Outcomes

Variable	Number (%) / Mean ± SD
ICU admission	18 (10.4)
ICU stay	1.8 ± 0.9 days
Hospital stay	4.9 ± 1.8 days
Surgical site infection	6 (3.5)
Anastomotic leak	2 (1.2)
Pulmonary complications	5 (2.9)
Reoperation	3 (1.7)
Mortality	2 (1.2)
Excellent outcome	92 (53.2)
Good outcome	60 (34.7)
Fair outcome	16 (9.2)
Poor outcome	5 (2.9)
Patient satisfaction (0–10)	9.3 ± 0.6

Overall, 87.9% of patients achieved excellent or good recovery. The mean hospital stay was less than five days, postoperative complications were infrequent, and patient satisfaction was high.

Table 6. Postoperative ERAS Observation Variables

Compliance with ERAS postoperative elements was excellent, with 100% multimodal analgesia, 97.1% maintaining a secure airway, 96.0% achieving adequate urine output, 91.3% commencing oral liquids within 24 hours, and 89.0% mobilizing early. The low mean postoperative pain score (VAS 2.8 ± 1.1) and minimal postoperative bleeding (2.3%) further reflected the effectiveness of ERAS-guided perioperative care.

Table 6: Postoperative ERAS Observation Variables

ERAS Variable	Number (%) / Mean ± SD
Multimodal analgesia	173 (100)
Mean VAS score (24 h)	2.8 ± 1.1
Systolic BP (24 h)	122 ± 10 mmHg
Pulse rate	78 ± 8/min
Oxygen saturation	98 ± 1.2%
Adequate urine output (>0.5 mL/kg/h)	166 (96.0)
Significant postoperative bleeding	4 (2.3)
Airway maintained without support	168 (97.1)
Oral liquids within 24 h	158 (91.3)
Oral diet within 48 h	149 (86.1)
Ambulation within 24 h	154 (89.0)

Urinary catheter removed within 24 h	146 (84.4)
Drain removed within 48 h	38 (82.6*)
Opioid requirement after Day 2	18 (10.4)

Percentage calculated among patients requiring drains

Compliance with ERAS recommendations was excellent. Most patients achieved stable haemodynamic parameters, adequate urine output, early oral feeding, early mobilization, and minimal postoperative pain. These observations were associated with lower postoperative morbidity, reduced hospital stay, and improved patient satisfaction. Statistical analysis demonstrated significant associations between high ERAS compliance and favourable clinical outcomes ($p < 0.001$), supporting the effectiveness of combining minimally invasive surgery with ERAS protocols in emergency abdominal surgery.

DISCUSSION

The present prospective multicentre study evaluated the perioperative and postoperative outcomes of patients managed with Enhanced Recovery After Surgery (ERAS) protocols combined with minimally invasive techniques in emergency abdominal surgery. Most patients experienced favourable postoperative recovery, with a mean hospital stay of 4.9 ± 1.8 days, low postoperative pain scores, minimal blood loss, limited ICU admission, and high patient satisfaction. These findings suggest that the integration of ERAS principles with minimally invasive surgery is feasible and is associated with favourable postoperative outcomes in emergency abdominal surgery.

Most patients (47.4%) were middle-aged adults, with males constituting 60.1% of the study population. acute appendicitis (33.5%) remained the most frequent emergency abdominal condition followed by acute Cholecystitis in 20.8%, perforated peptic ulcer in 13.9%, adhesive intestinal obstruction in 12.7%, perforated diverticulitis in 10.4% and small bowel perforation in 8.7% patients. Vomiting, fever, and guarding were the predominant presenting features. These findings are consistent with the World Society of Emergency Surgery (WSES) recommendations, which recognize these conditions as the most frequent indications for minimally invasive emergency surgery and advocate a laparoscopic-first approach in haemodynamically stable patients.[5]

An important finding of the present study was the compliance with individual ERAS postoperative protocols was excellent, with 100% multimodal analgesia, 91.3% early oral feeding, 89.0% early mobilization, and stable postoperative physiological parameters. Low postoperative pain (VAS 2.8 ± 1.1) and minimal bleeding (2.3%) further is consistent with the effectiveness reported in previous ERAS studies of ERAS-guided perioperative care. Similar observations were reported by Ceresoli et al,[3] who demonstrated that ERAS protocols are feasible and safe in emergency abdominal surgery, with most postoperative recovery milestones achieved within the first three postoperative days. Their study also showed that laparoscopic surgery significantly improved adherence to ERAS pathways and accelerated postoperative recovery, closely matching the findings of the present study.

In the present study, 87.9% of patients achieved excellent-to-good recovery, with a mean hospital stay of 4.9 ± 1.8 days and a high patient satisfaction score of 9.3 ± 0.6. Postoperative complications were minimal, with low rates of surgical site infection (3.5%), reoperation (1.7%), anastomotic leak (1.2%), and mortality (1.2%). These findings agree with the Cesena Guidelines reported by Sermonesi et al,[5] who reviewed 323 studies and concluded that laparoscopic surgery is safe, feasible, and effective for selected emergency abdominal conditions. The WSES expert panel emphasized that minimally invasive surgery has been reported to provide favourable postoperative outcomes, while maintaining patient safety when appropriate patient selection and surgical expertise are available.

Postoperative pain scores were low, and all patients received multimodal opioid-sparing analgesia as part of the ERAS protocol. Early ambulation and enteral nutrition were achieved in most patients, findings that are consistent with current ERAS recommendations. These observations support the WSES enhanced perioperative care recommendations, which identify multimodal analgesia as a key ERAS component for reducing surgical stress, improving functional recovery, and minimizing postoperative morbidity.[6]

The mean hospital stay of 4.9 ± 1.8 days observed in the present study is comparable with previous reports evaluating ERAS pathways in emergency abdominal surgery reflects the combined benefits of minimally invasive surgery and standardized ERAS care. Peden et al,[4] similarly emphasized that structured perioperative pathways involving goal-directed fluid therapy, early mobilization, nutritional optimization, and standardized postoperative care significantly shorten hospital stay and reduce postoperative complications after emergency laparotomy. The WSES position paper likewise concluded that integrating ERAS principles into emergency surgery improves recovery while optimizing healthcare resource utilization.[6]

Only a small proportion of patients required ICU admission, while surgical site infection, pulmonary complications, anastomotic leak, reoperation, and mortality remained uncommon. These favourable outcomes the low frequency of ICU admission, surgical site infection, pulmonary complications, anastomotic leak, reoperation, and mortality observed in this study may be attributable to careful patient selection, standardized perioperative care,

minimally invasive techniques, and adherence to ERAS principles. Ceresoli et al,[3] similarly reported that preoperative hyperglycaemia, excessive intraoperative fluid administration, abdominal drains, prolonged operative time, and major complications delayed postoperative recovery, emphasizing meticulous perioperative management.

Patient satisfaction in the present study was excellent, with a mean score exceeding 9 out of 10. Earlier mobilization, low postoperative pain scores, shorter hospitalization, and early resumption of oral intake may have contributed to the high patient satisfaction observed in the present study. Although patient satisfaction was not the primary endpoint of the WSES consensus papers, the guidelines consistently emphasize that standardized perioperative care and enhanced recovery improve the overall quality of surgical care.[6]

Successful implementation of minimally invasive emergency surgery depends not only on technology but also on adequate surgical training. de'Angelis et al,[7] highlighted that emergency minimally invasive surgery requires structured competency-based education, simulation training, supervised operative experience, credentialing, and maintenance of surgical proficiency. These recommendations support the present study, in which favourable outcomes were achieved in centres with established laparoscopic expertise and standardized ERAS implementation. Likewise, the WSES survey by Ceresoli et al,[3] demonstrated that minimally invasive emergency surgery remains underutilized worldwide despite strong evidence supporting its safety and effectiveness, identifying surgeon experience and advanced laparoscopic training as major determinants of successful implementation.

Additional evidence from contemporary literature further supports the findings of the present study. Arnold et al,[8] analysed 190,264 emergency general surgery patients and demonstrated that increasing use of minimally invasive surgery significantly reduced hospital stay, surgical site infection, and 30-day mortality compared with open surgery. Similarly, Donohue et al,[9] reported that laparoscopic emergency general surgery was associated with significantly lower all-cause mortality than primary open surgery, while patients requiring conversion to open surgery still achieved better survival than those undergoing planned open procedures.

The benefits of ERAS have also been confirmed in perforated peptic ulcer surgery. Mohsina et al,[10] demonstrated significantly faster functional recovery, a 4.41-day shorter hospital stay, and lower postoperative complications, including surgical site infection, postoperative nausea and vomiting, and pulmonary complications, in patients managed with ERAS compared with conventional care. Similarly, Chandan et al,[12] reported that ERAS significantly reduced hospital stay, promoted earlier oral feeding, faster bowel recovery, earlier drain removal, and lower postoperative morbidity following emergency surgery for perforated peptic ulcer, confirming that ERAS is both safe and effective. In patients with obstructive colorectal cancer, Shan Guo et al,[13] further demonstrated that modified ERAS protocols accelerated bowel recovery, reduced postoperative complications, shortened hospital stay, and facilitated earlier postoperative chemotherapy compared with conventional perioperative care.

Overall, the findings of the present study support current ERAS Society and WSES recommendations advocating the integration of standardized ERAS pathways with minimally invasive surgery for emergency abdominal procedures. The favourable postoperative recovery, high compliance with ERAS components, low postoperative pain scores, limited blood loss, short hospital stay, low complication rates, and high patient satisfaction observed in this multicentre study suggest that this combined approach is feasible and is associated with favourable clinical outcomes while maintaining patient safety. Wider implementation of ERAS pathways, laparoscopic-first strategies, and competency-based surgical training may further enhance the quality and efficiency of emergency general surgical care.

CONCLUSION

The present study demonstrates that combining Enhanced Recovery After Surgery (ERAS) protocols with minimally invasive emergency abdominal surgery is associated with favourable postoperative outcomes. Overall, 87.9% of patients achieved excellent-to-good recovery, with a mean hospital stay of 4.9 ± 1.8 days and a high patient satisfaction score of 9.3 ± 0.6. Excellent compliance with ERAS principles facilitated early mobilization, effective pain control, reduced postoperative complications, faster functional recovery, and earlier discharge, supporting the routine adoption of ERAS-guided minimally invasive surgery in appropriately selected emergency abdominal surgical patients.

Limitations of the Study

This observational multicentre study included a modest sample size and lacked a control group. Variations in surgical expertise, emergency case complexity, and institutional practices may have influenced postoperative outcomes.

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