Original Article

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Surgery Section

Comparison of Enhanced Recovery after Surgery Protocols with Conventional Treatment Protocols in Patients undergoing Emergency Laparotomy: A Randomised Controlled Study

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ABSTRACT

Introduction: Enhanced Recovery After Surgery (ERAS) is a multimodal and multidisciplinary approach intended to reduce the length of stay, postoperative complications, and readmission rates. The benefits of ERAS protocols in elective surgery are well established; however, the evidence to support their safety and efficacy in emergency surgery is rare.

Aim: To compare the modified ERAS protocol with conventional management protocol following emergency laparotomy regarding the time taken to recover bowel function and the incidence of postoperative complications, duration of postoperative hospital stay, need for readmission, and 30 day mortality.

Materials and Methods: The present study was a randomised controlled study conducted in the Department of General Surgery, Pt. B.D. Sharma Institute of Medical Sciences, Rohtak, Haryana, India over a period of two years from June 2017 to May 2019. It included a total of 70 patients who presented in an emergency with perforation peritonitis. A total of 10 patients were excluded based on the exclusion criteria, and the remaining 60 patients were randomised into the Group-A (case group/ERAS group) and the control Group-B (control group/conventional group), with 30 patients in each group. Postoperative outcomes like postoperative complications, time of appearance of bowel sounds, time to first flatus, time to first defaecation, time to resumption of normal diet, and length of hospital stay were noted in both groups.

Results: The length of hospital stay was shorter in the case group (8.83±4.69 days) compared to the control group (12.23±8.65 days); however, the difference was not statistically significant (p=0.064). Similarly, the difference in the time taken for the recovery of bowel sounds, postoperative complications, and 30 day mortality was also statistically insignificant between the two groups. No patient required readmission in either group.

Conclusion: The use of ERAS protocols in emergency surgery is feasible, but all the elements of ERAS are difficult to apply in an emergency setting. Hence, a tailored approach to the ERAS protocols has to be used in emergency surgery. However, no significant benefit was noted in the group following modified ERAS protocols compared to the group following conventional protocols.

Keywords: Clavien-Dindo, Emergency surgery, Length of hospital stay, Perforation peritonitis

INTRODUCTION

The ERAS protocol is a multimodal and multidisciplinary approach intended to reduce the length of stay, postoperative complications, and readmission rates, thus reducing the healthcare burden. Various components of ERAS protocols include avoidance of prolonged fasting, preoperative carbohydrate loading, nutritional optimisation, restriction of perioperative fluids, avoiding bowel preparation, avoidance of opioid analgesics, early removal of tubes, and early mobilisation of the patient [1].

The benefits of ERAS protocols in elective surgery are well established; however, the evidence to support their safety and efficacy in emergency surgery is rare [2]. It is not feasible to apply all the ERAS protocols suggested for elective surgery in the emergency setting, like preoperative carbohydrate loading, nutritional optimisation, and goal-directed fluid therapy. Therefore, a tailored approach for the use of ERAS protocols in emergency settings is required, which is also known as modified ERAS protocols [2,3].

The 30 day mortality rate of emergency laparotomy done for various diagnosis ranges between 14% to 34%. Such a high rate of mortality and morbidity can be attributed to physiological derangement at the time of presentation, extremes of age, associated co-morbid factors, or haemodynamic instability. These patients may benefit from a structured approach to perioperative management like ERAS protocols, which can decrease the surgery-related stress of the patients as well as help them to recover quickly [4]. Since the evidence supporting the use of these protocols in emergency surgery is less, the present study was conducted with the aim to compare the modified ERAS protocol with conventional management following emergency laparotomy with regards to:

- Time taken for the recovery of bowel functions and the incidence of postoperative complications.
- Duration of postoperative hospital stay, need for readmission, and 30 day mortality.

MATERIALS AND METHODS

The present study was a randomised controlled study conducted in the Department of General Surgery at Pt. B.D. Sharma Institute of Medical Sciences, Rohtak, Haryana, India, from June 2017 to May 2019, after getting approval from the Institutional Ethics Committee (approval letter no. IEC/Th/17/Surgery/01). Informed consent regarding participation in the study was taken. It was a parallel trial (each group receiving only one treatment), with patients in the case group managed with ERAS protocols and the control group managed with conventional treatment protocols. The allocation ratio for the case and control groups was 1:1.

Sample size calculation: Based on a study by Gonenc M et al., the length of stay was used to calculate the sample size, with a mean difference of 2 and a standard deviation of 2.2. Taking the

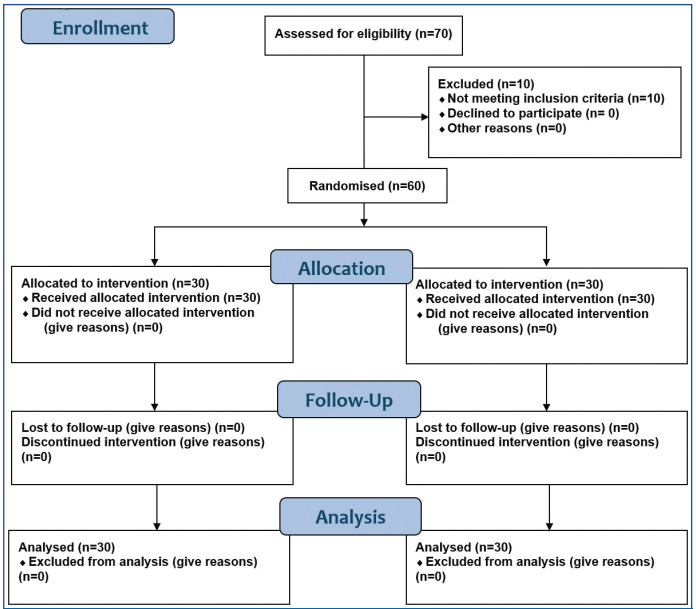
significance level as 5% and the power of the test as 80%, a sample size of 50 patients was calculated, with 25 patients in each the study and control groups [5].

$n=(Z_{\alpha/2}+Z_{\beta})^2 *2*\sigma^2/(\mu_t-\mu_c)^2$

$n=(1.96+1.28)^2 *2* 2.22/(2)^2$

n=25.4 (in each group)

A total of 70 patients with perforation peritonitis presenting in an emergency were initially included in the study, out of which 10 patients were excluded based on the exclusion criteria. The remaining 60 patients were randomised into two groups of 30 patients each (case and control) [Table/Fig-1].



[Table/Fig-1]: Consolidated Standards of Reporting Trials (CONSORT) 2010 flow diagram.

Inclusion and Exclusion criteria: A total of 70 patients who presented in an emergency with perforation peritonitis were included. Patients who refused to participate in the study, patients with a history of previous laparotomy, American Society of Anaesthesiologists (ASA) grade 3 and 4 (ERAS protocols are not feasible for grade 3 and 4 patients due to sick condition, with some requiring ventilatory support in the immediate postoperative period), patients in septic shock, pregnant patients, and those with underlying debilitating illnesses such as Chronic Obstructive Pulmonary Disease (COPD), chronic use of steroids, uncontrolled diabetes, chronic renal failure, and Acquired Immunodeficiency Syndrome (AIDS) were excluded from the study.

Study Procedure

During the preoperative period, components of ERAS like maintaining euvolemia and normothermia were included, whereas during the intraoperative period, the use of goal-directed fluid therapy, avoidance of opioid analgesics, and the use of short-acting anaesthesia were implemented. In the postoperative period, opioid analgesics were avoided, and analgesia was managed with paracetamol and non steroidal anti-inflammatory drugs. Early mobilisation of the patient on the first postoperative day, early removal of a nasogastric tube when output was less than 200 mL, was implemented, drain removal, removal of urinary catheters on the first postoperative day, initiation of oral feeds as soon as the patient was able to accept them orally, and discontinuation of intravenous fluids once the patient started accepting oral intake were implemented. However, components of ERAS like preoperative patient counselling, stoma education and stoma site marking, preoperative carbohydrate loading, and nutritional optimisation could not be included in the present study.

In patients assigned to the control group, protocols of conventional care were followed, and the use of intraoperative fluids and type of anaesthesia were at the discretion of the anaesthesia team. Postoperatively, use of type of analgesia, and removal of nasogastric tube, catheters, and drain, patient mobilisation, and initiation of oral feeds were at the discretion of the treating surgeon.

The patients were randomly allocated to the study group (Group-A) and control group (Group-B) using computer-generated randomisation. The sequence was enclosed in 60 envelopes, which were opened after the patient was admitted and met the inclusion criteria. Thereafter he/she was assigned to the group as per randomised sequence. Participants were blinded. In the study group, patients were managed using a modified ERAS protocol, while in the control group, patients were managed conventionally. After initial resuscitation, the patients underwent emergency laparotomy. All patients received antibiotics empirically, including ceftriaxone, amikacin, and metronidazole in standard doses during the perioperative period, which were changed according to the culture reports during treatment. Postoperative monitoring was done regarding the return of bowel activity and the occurrence of wound sepsis and systemic complications.

The postoperative outcomes in both groups included postoperative complications (graded I-V according to the Clavien-Dindo classification system) [6], time of appearance of bowel sounds, time to first flatus, time to first defaecation and length of hospital stay. Postoperative complications were managed according to standard guidelines. The need for hospital readmission and death within 30 days were recorded.

STATISTICAL ANALYSIS

At the end of the study, the categorical data were analysed using the Chi-square test, and continuous data were analysed using the Student's t-test. The significant variables were combined in a logistic regression model to predict the outcome. A p-value less than 0.05 was considered significant. Statistical Package for the Social Sciences (SPSS) trial version 24.0 was used for statistical analysis.

RESULTS

The age of the patients ranged from 15 to 65 years, with the mean age for the case group being 39.07±16.98 and for the control group being 35.33±15.59 years. The difference in length of stay between both groups was statistically insignificant, with a p-value of 0.064 [Table/Fig-2].

Parameters	Group-A (n=30)	Group-B (n=30)	p-value
Age (years)	39.07±16.98	35.33±15.59	0.379
Male/Female	26/4	28/2	0.671#
BMI (kg/m^2)	23.23±1.57	22.96±1.51	0.489
Duration of hospital stay (days)	8.83±4.69	12.23±8.65	0.064
Preoperative resuscitation <12 h/>12 h	22/8	22/8	1.000#
Duration of surgery (min)	125.50±32.14	135.50±39.81	0.289
Intraoperative fluids (mL)	1666.66±273.33	1950.00±303.71	<0.001
Postoperative monitoring			
Nasogastric tube removal (days)	2.59±1.54	3.03±1.35	0.242
Appearance of bowel sounds (days)	1.83±0.53	1.97±0.61	0.360
Passage of flatus (days)	2.38±1.77	2.57±0.85	0.383
Orally allowed (days)	2.10±1.31	3.50±1.40	0.269
Passage of stool (days)	3.59±1.26	4.00±1.59	0.276
Postoperative fluid (mL)	1568.96±220.55	1983±206.92	<0.001

[Table/Fig-2]: Profile of patients in Group-A (case group) and Group-B (control group). Student's t-test was used.
#Chi-square test was used

Small gut perforation was the most common cause of peritonitis in Group-A (n=18). In Group-B, small gut perforation was also the most common cause of peritonitis (n=17). Burst appendix was the indication for exploratory laparotomy in one patient in Group-A and four patients in Group-B. Four patients in Group-A required surgery for large bowel perforation, of which two patients had rectosigmoid growth, one patient had caecal volvulus, and one patient had sigmoid colon perforation. In Group-B, two patients had large bowel perforation, with one patient having an ascending colon growth and the other having sigmoid colon perforation [Table/Fig-3].

The distribution of surgical procedures among the two groups was comparable, with a p-value of 0.616 [Table/Fig-4].

Final diagnosis	Group-A	Group-B	p-value
Stomach and duodenal perforation	7 (23.3%)	7 (23.3%)	0.647
Small gut perforation	18 (60%)	17 (53.40%)	
Burst appendix	1 (3.3%)	4 (6.7%)	
Large gut perforation	4 (13.3%)	2 (3.3%)	

[Table/Fig-3]: Indications of emergency laparotomy in Group-A (case group) and Group-B (control group) (Chi-square test, df=3).

Procedure	Group-A (n=30)		Group-B (n=30)		Total
	Frequency	%	Frequency	%	
Primary repair of perforation	11	36.7%	8	26.7%	19
Diversion ileostomy/ colostomy	9	30.0%	10	33.3%	19
Resection and anastomosis	2	6.7%	1	3.3%	3
Modified Graham patch repair	7	23.3%	7	23.3%	14
Appendicectomy	1	3.3%	4	13.3%	5
p-value	0.616				

[Table/Fig-4]: Surgical procedures performed in Group-A (case group) and Group-B (control group).
Chi-square test was used

Postoperative monitoring was done for the resolution of ileus. The nasogastric tube was removed in 2.59±1.54 days in Group-A and in 3.03±1.35 days in Group-B, with a p-value of 0.242. The time for the appearance of bowel sounds, passage of the first flatus, and passage of stool after surgery in the study group (ERAS group) was 1.83±0.53 days, 2.38±1.77 days, and 3.59±1.26 days, respectively, whereas in the control group managed with conventional methods, it was 1.97±0.61 days, 2.57±0.85 days, and 4.00±1.59 days, respectively [Table/Fig-2].

Wound infection was the most common postoperative complication in both groups, followed by burst abdomen and prolonged ileus (absent bowel sounds >72 hours) [Table/Fig-5].

Postoperative complications	Group-A	Group-B	p-value
Prolonged ileus	2	4	0.431
Anastomotic leak	0	2	0.221
Wound infection	16	12	0.304
Burst abdomen	4	7	0.538
Incisional hernia (on follow-up)	2	3	0.766
Mortality in 30 days	2	1	1.000

[Table/Fig-5]: Postoperative surgical complications in Group-A (case group) and Group-B (control group).
Chi-square test was used

Postoperative complications were graded according to the Clavien Dindo classification. A total of 14 patients in Group-A and 16 patients in Group-B had deviations from the normal postoperative course, like bedside drainage of wound collection or correction of electrolytes, use of antipyretics or antiemetics, or the need for physiotherapy, and were categorised as Grade-I complications. Escalation of antibiotics was required in 14 patients in Group-A and 11 patients in Group-B due to conditions like wound infection, and they were categorised as Grade-II. Two patients in Group-B had anastomotic leakage and required repeat intervention, thereby assigned as Grade-III complications. Mortality (Grade-V complication) within 30 days was seen in two patients in Group-A and one patient in Group-B [Table/Fig-6]. In Group-A, one patient died on the 2nd postoperative day due to fulminant sepsis and irreversible shock, and the second patient died on the 7th postoperative day due to septicaemia and Acute Respiratory Distress Syndrome (ARDS). In Group-B, one mortality occurred on the 14th postoperative day due to septicaemia and ARDS. However, the difference was not found to be statistically significant. No patient in either group required readmission.

Grade	Intervention	Group-A (ERAS)	Group-B (Conventional)
Grade-I	Any deviation from normal postoperative course like Bedside drainage of seroma or collection Correction of electrolytes Use of antipyretic Use of antiemetics Chest physiotherapy	14	16
Grade-II	Requiring escalation of antibiotics in conditions like wound infection	14	11
Grade-III	Requiring intervention under local/ regional or general anaesthesia (For anastomotic leakage)	00	02
Grade-IV	Complication requiring Intensive Care Unit (ICU) admission/single or multiple organ failure	00	00
Grade-V	Mortality	02	01
Total		30	30

[Table/Fig-6]: Clavien-Dindo grading of postoperative complications in Group-A (case group) and Group-B (control group).

DISCUSSION

Early recovery of bowel function in the ERAS group might be a result of alteration of systemic immune response and reduced postoperative bowel oedema due to judicious use of perioperative fluids [3]. In the present study, the time for the appearance of bowel sounds, passage of the first flatus, and passage of stool after surgery was less in the case group (ERAS group), but the difference was not found to be statistically significant. Similarly, a randomised controlled study in patients requiring emergency laparotomy after trauma showed no significant difference in the recovery of bowel function, such as the passage of flatus and stool, in the ERAS group compared to the conventional group [6]. On the contrary, a case-control study in patients undergoing emergency surgery for obstructing colorectal cancer reported a significantly earlier passage of flatus in the ERAS group compared to the conventional group (1.6±0.7 vs 2.8±1.3). However, no significant difference was noted in the time to the first defaecation after surgery. They acknowledged the use of prophylaxis for nausea and vomiting, avoiding opioids as analgesics, and judicious use of fluids as the cause of earlier recovery of bowel function in the ERAS group [7]. Similarly, a randomised controlled study showed early recovery of bowel function (time to pass flatus) in the ERAS group compared to the conventional group, and the results were statistically significant [8].

Early initiation of diet, protein drinks, and early mobilisation helps the patient preserve lean body mass and maintain work performance [9]. Purushothaman V et al., were able to initiate a liquid diet in the ERAS group significantly earlier (1.1±0.1 days) compared to the conventional group (2.3±1.0 days) [6]. Similarly, studies in patients undergoing emergency abdominal surgery for trauma and a case-control study in obstructing colourectal cancer patients showed a significantly early initiation of oral feed in the ERAS group compared to the conventional group [7,9]. Poor general condition of the patient, haemodynamic instability, and the presence of bowel oedema may

be attributed to decreased early tolerance of diet and delay in the return of bowel function, as seen in the present study.

In the present study, postoperative complications were graded according to the Clavien-Dindo classification. The majority of patients in both groups had Grade-I and Grade-II complications, and the difference between the two groups was not statistically significant. These findings are supported by a randomised controlled trial conducted by Purushothaman V et al., in patients undergoing emergency laparotomy after trauma, which showed that 8 out of 30 patients in the ERAS group had complications, of which 7 were reported as Grade-I as per Clavien-Dindo grading. Also, 7 out of 30 patients in the standard recovery group had complications, of which 6 were categorised as Grade-I complications [6]. Similarly, Moydien MR et al., classified complications as per Clavien-Dindo grading and reported that out of 40 patients in the non ERAS group, 5 patients had Grade-I complications, 1 patient had Grade-II, and 5 patients had Grade-III complications. They also reported that 12 out of 38 patients in the ERAS group had complications, with 7 being Grade-I, 2 Grade-II, and 3 reported as Grade-III [10]. Lohsiriwat V showed a lesser incidence of postoperative complications in the ERAS group (25%) compared to the conventional care group (48%), but the difference was not statistically significant [7]. A systematic review comparing ERAS with conventional care in emergency surgery reported a reduction in major postoperative complication rates in only one out of five studies [11]. In contrast to the findings of the present study, Sharma J et al., reported a significant reduction in major postoperative complications like chest infection and surgical site infection in the ERAS group compared to the conventional group [8]. Emergency laparotomies are associated with paralytic ileus, decreased pulmonary function, decreased mobility, and an increased catabolic process causing increased postoperative morbidity as well as a prolonged hospital stay. The early use of non opioid analgesia, early mobilisation, and chest physiotherapy help the patient maintain pulmonary function, thereby making an early recovery and decreasing the chances of pulmonary complications [9].

Apart from improving patient outcomes and reducing postoperative complications, ERAS is also credited with reducing hospital stays through early mobilisation, early initiation of feed, and judicious use of analgesia and fluids. This helps decrease the workload of the overburdened healthcare system and facilitates early recovery from surgical stress for the patient. In the present study, postoperative hospital stay in the ERAS group was shorter than in the conventional care group. However, this difference between the groups was not found to be statistically significant. A randomised controlled clinical trial studying the feasibility of ERAS protocols in patients undergoing emergency surgery for peptic ulcer disease found a significant reduction in the length of stay in the ERAS group compared to the conventional care group [5]. Similarly, studies comparing ERAS and conventional care in patients undergoing emergency colonic surgery also showed that the ERAS group had a significantly shorter hospital stay [2,3,12]. Shang Y et al., acknowledged the multimodal approach of ERAS as a reason for the reduced length of stay, which causes early recovery of organ function due to reduced local inflammation and tissue oedema [3]. Several randomised controlled trials in patients required emergency abdominal surgery for trauma also demonstrated a significant reduction in hospital stay in the ERAS group. ERAS protocols help the patient return to normal physiology and achieve early recovery [6,9].

In the present study, no difference was found between the two groups in terms of 30-day mortality. No readmission was required in either group. Similarly, 30-day mortality was studied as one of the primary objectives by Sharma J et al., and they also noted no significant difference between both groups in terms of mortality as well as readmission rate [8]. Another randomised controlled study by Gonenc M et al., in patients requiring emergency surgery for perforated peptic ulcer disease, also showed no significant difference in mortality or readmission rate between the ERAS and conventional groups [5]. In patients operated on for obstructive colorectal cancer, Shang Y et al., showed no significant difference in mortality between those managed following ERAS protocols and those without ERAS protocols (0.9% vs 0.6%) with a p-value of 0.5 [3]. Vinas X et al., reported no mortality in both ERAS group as well as conventional care group in patients undergoing emergency surgery for left colon perforation [12].

The biggest strength of the present study is that it included a wide spectrum of indications requiring emergency laparotomy and a variety of surgical procedures being performed in general surgery.

Limitation(s)

There were few limitations in the present study. Patients with debilitating illnesses or those presenting with septic shock could not be included in any of the previous studies, including the present study, as the ERAS protocol cannot be applied to them. Therefore, these results cannot be generalised to all patients requiring emergency laparotomy. However, the inclusion of such patients in the study would neither be feasible nor ethically correct.

Hence, a larger sample size is required to understand the challenges and feasibility of the ERAS protocol in patients undergoing laparotomy for emergencies in general surgery.

CONCLUSION(S)

The use of ERAS protocols in emergency surgery is feasible, but applying all the elements of ERAS in an emergency setting is challenging. Therefore, a tailored approach is needed in such cases. In the present study, the ERAS group showed fewer postoperative complications and a shorter length of hospital stay; however, the results were found to be statistically insignificant. Hence, further randomised controlled trials with larger sample sizes are necessary to assess the feasibility and effectiveness of ERAS in emergency general surgery cases.

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