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Enhanced recovery after surgery (ERAS) in patients undergoing emergency laparotomy after trauma: a prospective, randomized controlled trial

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ABSTRACT

Background The role of enhanced recovery after surgery (ERAS) has been established in elective operations. However, its role in emergency operations especially in trauma is under-recognized. The aim of this study was to explore the safety and efficacy of ERAS program in patients undergoing emergency laparotomy for trauma.

Methods In this single-center study, patients who underwent emergency laparotomy after trauma were randomized to the ERAS protocol or conventional care. The ERAS protocol included early removal of catheters, early initiation of diet, use of postoperative prophylaxis and optimal usage of analgesia. The primary endpoint was duration of hospital stay. The secondary endpoints were recovery of bowel function, pain scores, complications and readmission rate.

Results Thirty patients were enrolled in each arm. The ERAS group had significant reduction in duration of hospital stay (3.3±1.3 vs. 5.0±1.7; p<0.01). Time to remove nasogastric tube (1.1±0.1 vs. 2.2±0.9; p<0.01), urinary catheter (1.1±0.1 vs. 3.5±1.6; p<0.01), and drain (1.0±0.2 vs. 3.7±1.6; p<0.01) was shorter in the ERAS group. In ERAS group, there was earlier initiation of liquid diet (1.1±0.1 vs. 2.3±1.0; p<0.01) and solid diet (2.1±0.1 vs. 3.6±1.3; p<0.01). The usage of epidural analgesia (63% vs. 30%; p=0.01), non-steroidal anti-inflammatory drugs (93% vs. 67%; p-0.02) and deep vein thrombosis prophylaxis (100% vs. 70%; p<0.01) was higher in the ERAS group. There was no difference in the recovery of bowel function (2.4±1.0 vs. 2.1±0.9; p=0.15), pain scores (3.2±1.0 vs. 3.1±1.1; p=0.87), complications (27% vs. 23%; p=0.99) and readmission rates (07% vs. 10%; p=0.99) between the two groups.

Conclusion ERAS protocol, when implemented in patients undergoing laparotomy for trauma, has decreased duration of hospital stay with no additional complications.

Level of evidence Level 1, randomized controlled trial, care management.

Trial registration number Clinical Trials Registry of India (CTRI/2019/06/019533).

INTRODUCTION

Emergency surgery is a major component of trauma surgery, with the highest proportion of cases being laparotomies.[1 2] In view of this, various models are being tested to improve the quality of care and efficiency. Enhanced recovery after surgery (ERAS) is one such model that is not tested with full vigor in trauma laparotomies.[3]

ERAS programs are evidenced-based protocols designed to standardize and optimize perioperative care to reduce surgical trauma, perioperative physiological stress and organ dysfunction.[4] Although initially been advocated for elective colorectal surgery in 2005, it is well established for many other surgical conditions.[5] There is already substantial evidence in literature demonstrating the effectiveness of adopting ERAS protocols in elective surgery. Applying the same principle, ERAS could be beneficial in emergency trauma surgery as well.

To date, there are only few studies pertaining to ERAS in emergency surgery, evaluating its effectiveness and feasibility.[6] In the setting of trauma, there is only one case–control study.[7] The aim of this randomized controlled trial (RCT) was to test the null hypothesis in evaluating the efficacy, safety and application of ERAS in primary emergency laparotomy after trauma compared with conventional care.

MATERIALS AND METHODS

Study design and sample size

This was a single-center, prospective, RCT conducted in the Division of Trauma Surgery and Critical Care of a level I trauma center of India between June 2019 and October 2020. The study was registered at Clinical Trials Registry of India (CTRI/2019/06/019533).

Using the study by Gonenc *et al*,[8] the sample size of 30 in each arm was calculated with a difference between two means (length of stay) of 2 days and an SD of 2.2 days in a two-sided t-test with 5% α error, 80% power and 30% attrition rate. Randomization was done with computer-generated block randomization of six in each group. The patients, randomization allocation personnel and data collection personnel were blinded to the study.

Patients undergoing primary emergency laparotomy were enrolled to any of the two groups, group A (ERAS protocol) and group B (standard recovery protocol). All the patients gave informed consent before taking part in the study.

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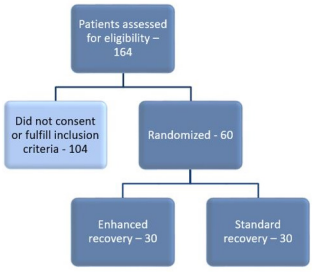

Figure 1 Consolidated Standards of Reporting Trials diagram for the study.

Patient enrollment

All acutely injured patients, age group of 16–65 years, with American Society of Anesthesiologists (ASA) class I and II requiring emergency primary laparotomy were recruited in the study. The following patients were excluded from the study: patients with ASA class of III, IV, and V; those requiring postoperative inotrope or ventilator supports; those with pre-existing liver, hematological and immunocompromised disease; and patients with solid organ. Figure 1 is the Consolidated Standards of Reporting Trials statement showing the details of enrollment. Thirty patients were enrolled in both the arms. All the patients consented for the study. None of the patients violated study protocol or dropped out of the study. All the patients (n=60) were included in the analysis.

Perioperative protocols

All patients who presented to the emergency department (ED) were treated as per advanced trauma life support protocols.[9] All underwent placement of nasogastric (NG) tube and urinary catheter. Antibiotics, tetanus toxoid and pantoprazole were given to all in ED. All the patients had laboratory evaluation and also arterial blood gas analysis.[10]

In ERAS protocol, patients underwent epidural placement if there were no contraindications and had intraoperative warming.[11 12] In the postoperative period, NG tube, urinary catheter and drains were removed at 24 hours after operation.[3] NG tube was removed if the output was less than 200 mL during 24 hours.[4] Liquid diet was started at 24 hours of operation.[4] If patients tolerated liquid diet, then solid diet was started at 48 hours after operation.[4] All patients in ERAS received paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) as analgesia along with epidural when placed. Morphine was used as rescue analgesia. Antibiotics, and ulcer and deep vein thrombosis (DVT) prophylaxis were given to all in the ERAS group.[13] The ERAS protocol is depicted in table 1.

Table 1 Comparison of enhanced recovery after surgery (ERAS) protocol vs. standard recovery protocol

	ERAS protocol in trauma	Standard recovery protocol in trauma
Preoperative care		
Counseling	Explained in brief while taking consent	Not done
Bowel preparation	Not possible	Not possible
Carbohydrate loading	Not possible	Not possible
NG tube and urinary catheter	Placed always	Placed always
Preoperative antibiotics	Inj. Augmentin 1.2 g intravenously and inj. metronidazole 500 mg three times per day	Inj. Augmentin 1.2 g intravenously and inj. metronidazole 500 mg three times per day
Intraoperative care		
Goal-based fluid therapy	Not done	Not done
Intraoperative warming	Done with warming device always	At the discretion of the team
Drain placement	At the discretion of surgeon	At the discretion of the team
Epidural analgesia	Placed if there are no contraindications	At the discretion of the team
Postoperative care		
Removal of tubes	Remove NG, urinary catheter and drain at 24 hours	Removed at the discretion of the surgeon
Initiation of liquid diet	At 24 hours after operation	At the discretion of the surgeon
Initiation of solid diet	At 24 hours after initiation of liquid diet, if tolerated the liquid	At the discretion of the surgeon
Postoperative pain relief	Paracetamol 1 g intravenously four times per day, inj. diclofenac 50 mg intravenously three times per day, epidural if inserted, morphine as rescue analgesia. Converted to oral medications once solid diet is initiated	At the discretion of the surgeon
Thromboprophylaxis	Mechanical sequential compression device, inj. Clexane 0.1 mg per kg once daily if there are no contraindications	At the discretion of the surgeon
Ulcer prophylaxis	Inj. pantoprazole 40 mg intravenously once daily converted to oral once solid diet is initiated	At the discretion of the surgeon
Postoperative antibiotics	Inj. Augmentin 1.2 g intravenously two times per day and inj. metronidazole 500 mg intravenously three times per day Antibiotics were given for 5 days and then converted to oral if discharged before 5 days	At the discretion of the surgeon
Rehabilitation	Physiotherapy-assisted walking, chest physiotherapy and incentive spirometry started at 24 hours after operation	At the discretion of the surgeon
Follow-up	In outpatient department (OPD) at 7 days after discharge and at 30 days (OPD or telephonic)	In OPD at 7 days after operation

NG, nasogastric.

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All patients were monitored and reviewed every day for reinsertion of NG, recovery of bowel function, time to discharge and intolerance due to ERAS protocol. Oral intake was stopped if there was any intolerance to diet with symptoms of vomiting, abdominal pain and abdominal distention. Feeds were restarted once the symptoms resolved and there was passage of flatus and stools.[4]

All patients in ERAS group were discharged when they were afebrile, tolerated solid diet, pain was controlled with oral analgesia, upon return of bowel function and were able to mobilize independently.[7]

In the standard care protocol, the removal of NG tubes, urinary catheter and drains was done at the discretion of the operating team. Similarly, initiation of liquid diet, solid diet, antibiotic, ulcer and DVT prophylaxis was at the discretion of the operating team. Discharge of patient was also at the discretion of the surgeons.

All patients were reviewed after 1 week and 30 days after discharge.[4]

Outcome measures

The primary endpoint was the length of hospital stay between the two groups.[3 4 14] The secondary endpoints included time to remove urinary catheter, NG tube and drains, initiation of liquid and solid diet, and time to pass flatus and stools. The other secondary outcomes included the usage of DVT, ulcer and antibiotic prophylaxis, and pain scores at 24 hours, 48 hours, 72 hours and 96 hours. Complications based on Clavien-Dindo classification, 30-day readmission rate and mortality were also studied.[4 15]

Data collection and statistical analysis

Data were collected in a pro-forma and entered in EpiData entry client software. Data were analyzed by Stata V.14 and presented in mean (SD), median (min–max) and frequency (percentage). Continuous variables were compared by independent t-test (following normal distribution) and Wilcoxon rank-sum test (non-normal test). Categorical variables were compared by X^2 test or Fisher's exact test. Statistical significance was considered at a p value of less than 0.05.

RESULTS

Demographic, injury, vital signs and laboratory parameters

Most of the patients, that is, 25 of the ERAS and 27 of the standard recovery group patients were in the age group of 16–40 years. All were men, except for one female patient who was in the ERAS group. One patient in the ERAS group and two patients in the standard recovery had comorbid illness with ASA grade II. Ten patients in ERAS group and four in the standard recovery group had a history of smoking. Sixteen of the ERAS and 13 of the standard recovery group patients had a body mass index in the overweight range.

Low velocity-penetrating injury and road traffic incident were the most common modes of injury. In the ERAS group, 14 and 9 patients belonged to this category, respectively. There were 12 and 13 patients in each of these categories in the standard therapy group. Other modes of injury included blunt injury abdomen (n=2.1), fall from height (n=3.1) and high velocity-penetrating injury (n=2.3).

Major trauma was considered when the Injury Severity Score (ISS) was more than 15.[16] Ten patients in ERAS group and five in the standard therapy group had an ISS of more than 15. Six patients in the ERAS group had associated injuries. Two had orthopedic injuries, three had chest injuries and one patient had pelvic injury. In the standard therapy group, three patients had orthopedic injuries and one had chest injury. Fourteen patients in ERAS group were positive for free fluid on Focused Assessment with Sonography for Trauma compared with 20 patients in the standard therapy group. Contrast-enhanced CT was done in 22 patients in the ERAS group and 21 patients in the standard therapy group.

Shock index, modified shock index, base deficit and serum lactate have been associated with morbidity and mortality in patients with trauma and were monitored.[17 18] Vital signs, laboratory parameters, arterial blood gas analysis, and time duration to intervene from the time of injury were noted. All these baseline parameters were comparable as summarized in table 2.

Table 2 Comparative table showing the demographic, preoperative and intraoperative variables between the two groups

	ERAS group n=30	Standard recovery group n=30
Age (years)	30±11	28±11
Male (n) (%)	29 (97)	30 (100)
ASA grade II (n) (%)	1 (3)	2 (7)
Smoking (n) (%)	10 (33)	4 (13)
BMI (kg/m^2)	25.1±2.5	24.4±2.9
Pulse rate (per min)	96±17	97±15
Systolic blood pressure (mm/Hg)	116±15	118±15
Shock index	0.7±0.2	0.8±0.9
Modified shock index	1.1±0.2	1.1±0.3
Injury Severity Score	11±5	9±4
New Injury Severity Score	11±6	09±5
Hemoglobin (g/dL)	13.2±2.3	12.5±2.3
Leukocyte count	9670±4259	10922±5350
Albumin (g/dL)	3.3±0.7	3.2±0.8
Lactate (mmol/L)	3±1.4	2±1.5
Base deficit (mEq/L)	3.8±1.7	2.8±2.1
FAST positivity (n) (%)	14 (47)	20 (67)
CECT done (n) (%)	22 (73)	21 (70)
Time to intervention (hours)	5.7±3.2	5.3±3.9
Crystalloids (mL)	1700±386.9	1740±435.9
Blood transfusion (mL)	630±156.5	600±217.9
Blood loss (mL)	250±237.7	225±182.6
Bowel repair (n) (%)	28 (93)	28 (93)

ASA, American Society of Anesthesiologists; BMI, body mass index; CECT, contrast-enhanced CT; ERAS, enhanced recovery after surgery; FAST, Focused Assessment with Sonography for Trauma.

Intraoperative management

Usage of colloids was more in the ERAS group with a mean of 863.6 mL compared with 447.1 mL in the standard therapy group. Both groups had comparable usage of crystalloids, blood transfusion and intraoperative inotropic support.

All the patients received intraoperative short-acting opioids. Nineteen patients in the ERAS group had epidural placement compared with 11 in the standard therapy group, with a statistically significant difference (p<0.01).

In the ERAS group, 26 patients had bowel injury at one site and 2 patients had bowel injuries at more than one site. Two patients had mesenteric injury with no bowel involvement. Operations done were primary close of perforation (n=15), resection and anastomosis (n=8), and resection and end stoma creation (n=5).

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In the standard recovery group, 25 patients had bowel injury at one site and 3 had bowel injuries at more than one site. Two patients had mesenteric injury with no bowel involvement. Of these, 19 patients underwent primary repair of the perforation, 7 had resection anastomosis and 2 had resection and end stoma.

Both the groups were comparable for blood loss (p=0.60), drain placement (p=0.99) and duration of operation (p=0.67).

Postoperative management

Removal of catheters

Time to remove NG tube was early in the ERAS group at 1.1±0.1 days compared with 2.2±0.9 days in the standard recovery group. The mean difference was 1.1 days (p<0.01).

Time to remove urinary catheter was earlier in the ERAS group. It was 1.1±0.9 days in the ERAS group versus 3.5±1.6 days in the standard recovery group with a difference of 2.4 days (p<0.01).

Mean duration to remove drains was early in the ERAS group at 1.0±0.2 days compared with 3.7±1.6 days in the standard recovery group with a difference of 2.7 days (p<0.01)

Initiation of diet

The mean time to initiate liquid diet in ERAS group was 1.1±0.1 days compared with 2.3±1.0 days in the standard therapy group with a difference of 1.2 days (p<0.01). The time to initiate solid diet in ERAS group was 2.1±0.1 days compared with 3.6±1.3 days in the standard therapy group with a difference of 1.5 days (p<0.01).

Bowel function recovery

The mean time to pass flatus was 2.0±0.9 days in the ERAS group and 1.6±0.6 days in the standard recovery group. The time to defecate was 2.4±1.0 days in the ERAS group and 2.1±0.9 days in the standard recovery group. For the passage of flatus (p=0.06) and for time to defecate (p=0.14), there was no statistical significant difference between the two groups.

Postoperative analgesia

Nineteen patients in ERAS group and 11 in the standard recovery group had epidural placement, which was significant (p=0.01). Ninety-three percent received NSAIDs in ERAS group versus 67% in the standard recovery group. This was significant (p=0.02). There was no difference between the two groups in paracetamol and opioid usage.

Pain score was measured at 24 hours, 48 hours, 72 hours and 96 hours with Visual Analog Scale (VAS). There was no difference in the pain scores between the two groups at 24 hours and 48 hours. There was difference in the pain scores at 72 hours (p<0.01) and 96 hours (p<0.01), however with doubtful clinical significance as patients in the ERAS group were discharged by this time.

Postoperative prophylaxis

Thirty patients received DVT prophylaxis in the ERAS group compared with 21 in the standard therapy group which was significant (p<0.01). In the ERAS group, 28 (93%) patients received both mechanical (sequential compression device) and medical (heparin) prophylaxis and 2 patients (7%) received only mechanical prophylaxis due to coagulopathy. In the standard recovery group, 5 patients (17%) received both mechanical and medical prophylaxis and 16 patients received only mechanical DVT prophylaxis (53%). There was no difference between the two groups in terms of ulcer prophylaxis and antibiotic usage.

Table 3 Comparative table showing the outcome variables between both groups

	ERAS group n=30	Standard recovery group n=30	P value
Remove NG tube (days)	1.1±0.1	2.2±0.9	<0.01
Remove catheter (days)	1.1±0.1	3.5±1.6	<0.01
Remove drains (days)	1.0±0.2	3.7±1.6	<0.01
Initiate liquids (days)	1.1±0.1	2.3±1.0	<0.01
Initiate solids (days)	2.1±0.1	3.6±1.3	<0.01
Time to flatus (days)	2.0±0.9	1.6±0.6	0.06
Time to defecation (days)	2.4±1.0	2.1±0.9	0.15
Pain at 24 hours	3.7±1.5	3.8±0.9	0.54
Pain at 48 hours	3.2±1.0	3.2±1.1	0.87
Epidural analgesia (n) (%)	19 (63)	9 (30)	0.01
NSAID (n) (%)	28 (93)	20 (67)	0.02
DVT prophylaxis (n) (%)	30 (100)	21 (70)	<0.01
Duration of hospital stay (days)	3.3±1.3	5.0±1.7	<0.01
30-day readmission (n) (%)	02 (7)	03 (10)	0.99
Complication rate (n) (%)	08 (27)	07 (23)	0.99

DVT, deep vein thrombosis; ERAS, enhanced recovery after surgery; NG, nasogastric; NSAID, non-steroidal anti-inflammatory drug.

Duration of hospital stay

The mean duration of hospital stay in the ERAS group was 3.3±1.3 days compared with 5.00±1.7 days in the standard recovery group. There was a significant difference of 1.7 days (p<0.01) between the two groups favoring the ERAS group.

Table 3 summarizes the various outcome variables.

Morbidity parameters

Readmission

One patient required readmission in the ERAS group for abdominal pain. Two patients in standard recovery group required readmission, one each for vomiting and abdominal pain. All were treated conservatively. There was no difference in the readmission rates between the two groups (p=0.99).

Complications

As depicted in table 4, eight patients in the ERAS group developed postoperative complications comprising of wound infection (n=3), paralytic ileus (n=3), vomiting (n=1) and low hemoglobin requiring blood transfusion (n=1). Seven patients

Table 4 Comparative table showing Clavien-Dindo grades of complications between both groups

	ERAS group	Standard recovery group	P value
Superficial surgical site infection	03	03	0.99
Paralytic ileus	03	03	0.99
Vomiting	01	00	0.99
Blood transfusion	01	00	0.99
Reoperation	00	01	0.99
Clavien-Dindo classification			
Grade I	07	06	0.99
Grade II	01	00	0.99
Grade IIIb	00	01	0.99

ERAS, enhanced recovery after surgery.

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in the standard therapy group had postoperative complications. Three had wound infection, three had prolonged paralytic ileus and one patient had reoperation for missed bowel perforation. All were graded based on Clavien-Dindo classification of complications. In the ERAS group, seven patients had grade I complications and one patient had grade II complication. In the standard recovery group, six patients had grade I complications and one patient had grade IIIb complication. There was no difference between the two groups with respect to postoperative complications (p=0.99).

Failure of ERAS

Four patients in the ERAS group required discontinuation of protocol due to paralytic ileus (n=3) and vomiting after initiation of solid diet (n=1). ERAS was abandoned in these patients and diet was started after resolution of symptoms and passage of flatus. All were managed conservatively and did not require further intervention. Thirteen percent of patients failed ERAS in our study.

DISCUSSION

The success of ERAS protocol depends on the recovery of the patient. The overall recovery depends on the immediate postoperative recovery and also the mental, emotional and physical recovery of the patient in the long term.[19] The duration of hospital stay and complications in the immediate postoperative period are considered as the milestone parameters to evaluate the success of ERAS protocol.

In our study, the duration of hospital stay was less in the ERAS group with a significant difference. The mean duration of stay in the ERAS group was 3.3 days (SD 1.3) versus 5.0 days (SD 1.7) in the non-ERAS group (p<0.01). Lohsiriwat[3] proved that the implementation of ERAS protocol reduced the hospital stay by 2 days in patients undergoing emergency colorectal surgery. Mohsina *et al*[4] in duodenal perforations, Gonenc *et al*[8] in emergency operations, Shida *et al*[14] and Shang *et al*[20] in obstructed colorectal emergencies had similar results with reduction of hospital stay by 3–4 days.

Time to remove NG tube was earlier by 1.1 days and time to remove urinary catheter was earlier in the ERAS group by 2.4 days in this study. Similarly, time to remove drains was also earlier in the ERAS group by 2.3 days in those who had drain placements. Catheters hinder the mobilization of patients. This directly has a bearing of postoperative recovery of bowel function, DVT and lung-related complications. Hence, early removal of catheter helps in prevention of these postoperative complications. ERAS protocol actively advocates minimal use of catheters or early removal of catheters when used. Shang *et al*[20] showed that the time to removal of NG tube was 0.7 days in the ERAS group compared with 3.1 days in the conventional arm. Chndan *et al*[21] and Wisely and Barclay[15] showed that the removal of drain was earlier in the ERAS group. Lohsiriwat[3] removed NG in the first 24–48 hours after operation and Gonenc *et al*[8] removed NG tube in the immediate postoperative period. Wisely and Barclay[15] demonstrated a 20% reduction in the number of patients requiring urinary catheter beyond 2 days which was similar to our study. Fewer postoperative complications in our study can be attributed to early walking, which is enhanced due to removal of catheters.

In our study, time to initiate liquid diet was 1.1 days and solid diet was 2.1 days. There was a reduction of 1.2 days to initiate liquid diet and 1.5 days to start solid diet, which was significant. Lohsiriwat[3] had showed a reduction of 2.1 days to initiate normal diet. Mohsina *et al*[4] reported a reduction of 2.7 days to start liquid diet and 1.6 days for solid diet. Similar results were obtained in studies done by Shang *et al*[20] in obstructed colorectal cancers and Chndan *et al*[21] in perforated peptic ulcer. Early initiation of diet helps early walking, thereby improving patient recovery.

With respect to bowel function recovery, we did not find any difference in the time to pass flatus or stools between the two groups. However, ERAS has shown to improve the recovery of bowel function. Lohsiriwat[3] showed there was early passage of flatus by 1.2 days in the ERAS group but there was no difference in the passage of stools. Mohsina *et al*[4] had a reduction of 1.5 days in the passage of flatus and 2.3 days in passage of stools. Shang *et al*[20] had a reduction of flatus by 1.4 days and stools by 1 day.

Regional anesthesia reduces postoperative pain, nausea and vomiting (PONV). PONV has shown to be detrimental in initiation of diet for patients, especially in patients who undergo operation for bowel disease.[21] The use of regional anesthesia in ERAS protocol has proven to be beneficial. We had significant difference in the ERAS group where epidural and NSAID usage was more. In our study, epidural analgesia was used in 63% in the ERAS group versus 33% in the standard therapy group. Similarly, NSAID use was in 93% patients in the ERAS group versus 67% in the standard therapy group. Mohsina *et al*[4] had observed that epidural placement reduces PONV and complications. Wisely and Barclay[15] had also noted that patient-controlled analgesia is an effective mode in ERAS protocols if epidural analgesia was not used. However, there was no difference in the requirement of rescue analgesia and postoperative pain scores measured by VAS between the two groups at 24 and 48 hours in our study.

Postoperative prophylaxis is another cornerstone of ERAS protocol, which has not been studied to date in the emergency setting. We had given DVT prophylaxis either as mechanical, medical or both to all the patients in the ERAS group, whereas only 70% of the patients in the standard therapy received DVT prophylaxis.

The immediate postoperative complications and 30-day readmission rates explain the outcome of the ERAS protocol. In our study, one patient (3%) was readmitted in the ERAS group for abdominal pain. In the standard recovery group, two patients were readmitted (7%), one each for abdominal pain and vomiting. All were managed conservatively and were subsequently discharged. Many studies have shown that there was no significant difference in the 30-day readmission rates between the ERAS group and the conventional group. Shida *et al*[14] in their study on obstructed colorectal operations showed that the 30-day readmission rate was 8.3% in the ERAS group against 6.6% in the conventional arm with no statistical significance. Shang *et al*[20] in their study on emergency colorectal operations did not have any patients who were readmitted in the first 30 days after operation.

There was no mortality in our study. Shang *et al*[20] had a mortality of three patients (0.9%) in the ERAS group compared with two patients (90.6%) in the conventional arm with no statistical significance. Shida *et al*[14] had one (0.4%) mortality in the conventional arm compared with none in the ERAS group with no statistical significance.

In our study, eight patients (27%) had complication in the ERAS group versus seven (23%) in the standard therapy group. Three patients (10%) had superficial surgical site infection (SSI) (Clavien-Dindo grade I) in both the arms. Mohsina *et al* had 10% SSI in the ERAS group compared with 29% in the standard recovery group.[4] We had three patients (10%) who had paralytic

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ileus (Clavien-Dindo grade I) in both the arms. Mohsina *et al*[4] had PONV in 18% in the ERAS group versus 63% in the standard arm. Lohsiriwat[3] in emergency colorectal operations had complications in two patients in the ERAS group versus eight in the conventional arm. Shida *et al*[14] had 10% complications in the ERAS group against 15% in the conventional arm, whereas Shang *et al*[20] approximately had 9% complication rate in both the arms.

Four patients (13%) failed ERAS protocol after initiation of solid diet in our study. In elective operations, the failure rates of ERAS protocol are as high as 30%. Though four patients failed ERAS protocol, other parameters like removal of catheters, DVT prophylaxis, and postoperative analgesia were implemented which enhance the recovery of these patients.

Limitation of our study was that we had stringent inclusion and exclusion criteria, as it was the first RCT for ERAS in trauma. As the surgeons knew the treatment allocation, it is a source of bias in the study. Goal-based intravenous fluid therapy and standard anesthesia protocol were not formulated as a part of our study which were done in other studies done in elective operations.[22] Similarly, postoperative fluid requirement was not measured in our study which was done in some studies.[15] ERAS needs multidisciplinary approach and is feasible in level I centers. However, several components can be implemented at all other levels of hospitals.

CONCLUSION

In conclusion, ERAS is feasible in trauma with decreased duration of hospital stay and similar complication rates. We recommend more such studies with wider inclusion criteria for further understanding of ERAS in trauma.

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