Comparative study between enhanced recovery after surgery and traditional care pathways in elective laparoscopic colonic surgery at two teaching hospitals in Cairo

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Received: 22 September 2021
Revised: 08 October 2021
Accepted: 27 October 2021
Published: 10 October 2022

The Egyptian Journal of Surgery 2022, 41:120–129

Background
The delay until full recovery after colorectal surgery has been greatly improved by the introduction of an evidence-based postoperative management program. Enhanced recovery after colorectal surgery (ERAS) program has been covering the entire perioperative period and formulated into a standardized protocol.
Objective
The study assessed the feasibility of application of the ERAS system in Maadi Armed Forces and Ain Shams University hospitals, trying to establish a core unit, team, and a protocol for evidence-based perioperative care of our patients.
Patients and methods
This was a prospective comparative study conducted on 53 colorectal surgery patients to compare patients within ERAS program with patients with conventional perioperative care. The two groups were similar regarding age, comorbidities, operative time and technique, and intraoperative blood loss.
Results
There was a highly significant decrease in ICU and hospital stays in the ERAS group compared with the traditional care group. There was a highly significant decrease in visual analog scale score in the ERAS group compared with the traditional care group. There was a highly significant decrease in the early readmission rate in the ERAS group compared with the traditional care group. There was a highly significant increase in immediate postoperative albumin in the ERAS group compared with the traditional care group. There was a highly significant increase in follow-up postoperative albumin in the ERAS group compared with the traditional care group.
Conclusion
On the basis of the current data, it appears that ERAS program is feasible and can be implemented in our hospitals. Moreover, it resulted in an overall improvement in postoperative outcomes. ERAS patients were found to have shorter length of hospital stay, less overall postoperative complication rate, and better postoperative nutrition status. However, further studies are needed to be conducted on a bigger sample of patients to prove reproducibility and reliability.

Keywords:
colon cancer, colonic surgery, enhanced recovery, enhanced recovery after surgery, perioperative care

Egyptian J Surgery 2022, 41:120–129

1110-1121

Introduction

Major colonic surgery that involves wide resection of the colon and anastomosis generally involves a prolonged hospital stay, on an average of 12–14 days. A stay of 1 week is usually the minimum that can be expected, which reduces the productivity of the health care system [1].

This prolonged occupation of a hospital bed is not usually owed to problems of morbidity but to the conventional care protocol followed. For decades, this protocol has hardly been modified; it therefore does not take into account the advances that have been made in the perioperative management of such patients [2].

The enhanced recovery after surgery (ERAS) protocol questioned this traditional perioperative care doctrine, including prolonged fasting, mobility restrictions, mechanical bowel preparation, routine use of drains, and delayed enteral feeding postoperatively. Kehlet It

is theorized that the avoidance of such perioperative doctrine shortens the length of hospital stay by reducing the metabolic stress, fluid overload, and insulin resistance placed on the body [2].

The delay until full recovery after colorectal surgery has been greatly improved by the introduction of this evidence-based treatment. This treatment has been covering the entire perioperative period and formulated into a standardized protocol [3].

Compared with traditional management, ERAS represents a fundamental shift in perioperative care. The ERAS care pathways aim to reduce surgical stress, maintain postoperative physiological function, and enhance mobilization after surgery. This has the expected results of reduced rates of morbidity, faster recovery, and shorter length of stay in hospital [4].

The results that can be achieved with ERAS – reduction in postoperative morbidity, average length of hospital stay, and the consumption of resources – are, however, significant, and the general implantation of ERAS for the colorectal surgery patients is recommended [2].

Aim

The study compared the results of the newly implemented ERAS pathway for laparoscopic colonic surgery with the traditional pathway of postoperative care in Maadi Armed Forces and Ain Shams University hospitals. The feasibility of application of the ERAS system was also assessed. We presented the results to support establishing a core unit, team, and a protocol for evidence-based perioperative care of our patients.

Patients and methods

The study compared laparoscopic colonic surgery patients within the ERAS program with patients with conventional perioperative care regarding length of hospital stay; postoperative complications including leak, wound infection, and urinary retention, deep venous thrombosis (DVT), etc.; duration of postoperative ileus; pain control; and rate of early readmission. Patient data were collected in accordance with the code of conduct of research with human material in Egypt. This study was approved by the ethical medical committee of Ain Shams University and ethical medical committee of Armed Forces Medical Services/Maadi AF hospital. All subjects gave written informed consent.

Design: a prospective, comparative study was conducted between July 2017 and December 2019.

Setting: the study was conducted at Ain Shams University hospitals and Maadi Armed Forces Hospital.

Patients: a total of 53 colorectal surgery patients were enrolled in the study.

Eligible patients were selected according to the following inclusion and exclusion criteria:

Inclusion criteria: age 18 years or older, scheduled for elective laparoscopic colonic surgery, primary anastomosis, no need for a temporary or permanent stoma or any further surgical procedure, no distant metastasis or local recurrence, and no previous abdominal surgery.

Exclusion criteria: the need for emergency surgery; open or rectal surgery; incapacitating advanced systemic disease, an American Society of Anesthesiologists class IV; the need for a colostomy or ileostomy, as this would add morbidity and possible complications related to the procedure, which would affect the results especially length of hospital stay and postoperative ileus; inability to provide informed consent; diabetic patients with possible gastric neuropathy, as these patients may have delayed gastric emptying for solid food and postoperative insulin resistance; and patients previously documented to have slow evacuation, as they may have delayed restoration of bowel movement postoperatively.

Patient randomization: the 53 colorectal surgery patients were classified using a closed envelope method into two independent groups:

ERAS group: it included 26 patients.

Traditional care group: it included 27 patients.

Methods

ERAS group patients were subjected to the following:

Preoperative care: it included optimization of patient's comorbidities; selective mechanical and chemical bowel preparation (mechanical bowel preparation should not be used routinely in colonic surgery, whereas there is growing evidence that chemical bowel preparation is effective in terms of anastomotic leakage and wound infection); preoperative carbohydrate loading in the evening before surgery and 2h before surgery, which has been shown to reduce preoperative thirst, hunger, and anxiety, as well as postoperative insulin resistance. Carbohydrate treatment results in less postoperative losses of nitrogen and protein, as well as better maintained lean body mass and muscle strength; avoid long-term sedation from night before surgery, as it

delays immediate postoperative recovery and disturbs the normal sleep pattern postoperatively; prophylaxis against thromboembolism; and antibiotic prophylaxis.

Intraoperative care: it included normothermia (intraoperative maintenance of normothermia with a suitable warming device or warmed intravenous fluids to keep body temperature >36°C); temperature monitoring, which is essential to titrate warming devices and to avoid hyperpyrexia; prevention of postoperative ileus by mid-thoracic epidural analgesia and avoidance of fluid overload; selective use of nasogastric tube; postoperative nasogastric tubes should not be used routinely; nasogastric tubes inserted during surgery should be removed before reversal of anesthesia; selective use of surgical drains as it probably impairs mobilization; and epidural analgesia.

Postoperative care: it included hydration and early oral intake; adequate analgesia (epidural, local, and opioids); prevention of postoperative nausea and vomiting (PONV), where a multimodal approach to PONV prophylaxis should be adopted in all patients undergoing major colorectal surgery, and if PONV is present, treatment should be given using a multimodal approach; nutrition support; early mobilization; and early removal of urinary catheter and peritoneal drains.

Conventional care group patients were subjected to the following.

Preoperative care: it included optimization of patient's comorbidities; selective mechanical and chemical bowel preparation; preoperative carbohydrate loading was not used in this group; prophylaxis against thromboembolism; and antibiotic prophylaxis.

Intraoperative care: it included selective use of nasogastric tube and selective use of surgical drains as it probably impairs mobilization.

Postoperative care: it included hydration and oral intake when bowel sounds are auscultated; adequate analgesia; prevention of PONV, only when found; and nutrition support.

Discharge criteria were as follows: good mobilization, adequate oral intake for liquids and solids, gastrointestinal transit of gas, normal urinary function, no wound problems, pain control, no fever, and patient knows about possible complications and their detection.

Outcomes

The following variables were evaluated as the outcome of both groups: length of hospital stay, postoperative complications, postoperative ileus, pain control, and rate of early readmission.

Statistical methodology

Data entry, processing, and statistical analysis were carried out using MedCalc ver. 18.11.3 (MedCalc, Ostend, Belgium). Tests of significance [Mann–Whitney's, Friedman's, χ^2 tests, logistic regression analysis, Spearman's correlation, and receiver operating characteristic (ROC) curve analysis] were used. Data were presented, and suitable analysis was done according to the type of data (parametric and nonparametric) obtained for each variable. *P* values less than 0.05 (5%) were considered to be statistically significant.

The level of significance was set as follows:

P value more than 0.05: nonsignificant.
P value less than 0.05: significant.
P value less than 0.01: highly significant.

Results

In the studied population, the mean age of all patients was 58.3 ± 12.8 years. Regarding sex of the patients, the majority (62.3%) of patients were males, whereas 37.7% were females (Table 1).

Regarding postoperative outcome data, the average ICU and hospital stays were 2.03 ± 1.3 and 6.2 ± 2.4, days, with an average visual analog scale (VAS) score of 2.18 ± 1.6 (Tables 2 and 3).

Regarding postoperative outcome data, all patients had good recovery outcome. Overall, 9.4% had early readmission rate, and 17% experienced complications, with 5.7% having wound infection, whereas 3.8% had hypertension, leak, and tachycardia, and 17% had paralytic ileus (Tables 2 and 3).

Comparative studies

The 53 colonic surgery patients (Table 4) were classified randomly according to outcomes into two independent groups:

(1) ERAS group (26 patients).
(2) Traditional care group (27 patients).

Comparative studies between the two groups revealed the following:

Table 1 Sociodemographic data among 53 colorectal surgery patients

Variables	*n* (%)
Age (years) (mean±SD)	58.3 ± 12.8
Sex	
Female	20 (37.7)
Male	33 (62.3)

Table 2 Comparison between the two groups regarding postoperative outcome data using Mann–Whitney's *U* and χ^2 tests

	ERAS group (26)	Traditional care group (27)	Mann–Whitney's *U* test
Variables	Median (IQR)	Median (IQR)	*P* value
ICU stay (days)	1 (1–2)	2 (2–3.7)	<0.0001**
Hospital stay (days)	4 (3–5)	8 (7.2–9.7)	<0.0001**
VAS score	1.5 (0–2)	3 (1.2–4.7)	0.0003**
Analgesia consumption (ampoules)	0 (0–1)	2 (1–3)	<0.0001**
			χ^2 test
Variables	ERAS group (26) [*n* (%)]	Traditional care group (27) [*n* (%)]	*P* value
Good recovery outcome			
Positive	26 (100)	27 (100)	1.000
Complications rate			
Positive	2 (7.7)	7 (25.9)	0.08
Paralytic ileus			
Positive	1 (3.8)	8 (29.6)	0.013*
Early readmission rate			
Positive	0	5 (18.5)	0.022*

ERAS, enhanced recovery after surgery; IQR, interquartile range. *Statistically significant, **statistically insignificant.

Table 3 Postoperative outcome data among 53 colorectal surgery patients

Variables	*n* (%)
ICU stay (days)	2.03 ± 1.3
Hospital stay (days)	6.2 ± 2.4
VAS score	2.18 ± 1.6
Analgesia consumption (ampoules)	1.3 ± 1
Good recovery outcome	
Positive	53 (100)
Early readmission rate	
Positive	5 (9.4)
Complications rate	
Positive	9 (17)
Paralytic ileus	
Positive	9 (17)
Type of complications	
HTN	2 (3.8)
Leak	2 (3.8)
Tachycardia	2 (3.8)
Wound infection	3 (5.7)

HTN, hypertension; VAS, visual analog scale.

Table 4 Basic surgical data among 53 colorectal surgery patients

Variables	*n* (%)
Diagnosis	
Ascending colon cancer	7 (13.2)
Cecal cancer	1 (1.9)
Cecal large polyp	1 (1.9)
Cecal mass	1 (1.9)
Diverticulosis	1 (1.9)
Familial adenomatous polyposis	1 (1.9)
Hepatic flexure cancer	3 (5.7)
Left colon cancer	2 (3.8)
Rectosigmoid cancer	3 (5.7)
Reverse of colostomy	11 (20.8)
Sigmoid cancer	17 (32.1)
Splenic flexure cancer	4 (7.5)
Transverse colon cancer	1 (1.9)
Surgical history	
No surgical history	27 (50.9)
Appendectomy	3 (5.7)
Cholecystectomy	1 (1.9)
Hartmann's procedure	9 (17)
Inguinal hernia	2 (3.8)
Intestinal obstruction	2 (3.8)
Oophorectomy	1 (1.9)
Open heart surgery	2 (3.8)
Piles	3 (5.7)
Tonsillectomy	1 (1.9)
Varicocele	1 (1.9)
Varicose veins	1 (1.9)

(1) There was a nonsignificant difference regarding age and sex of the patients (P>0.05) (Table 5).
(2) There was a nonsignificant difference regarding all comorbidities (P>0.05) (Tables 6 and 7).
(3) There was a nonsignificant difference regarding blood loss, operative time, and blood and plasma transfusion (P>0.05) (Table 8).
(4) There was a highly significant increase in immediate postoperative albumin in the ERAS group (P=0.01) (Table 9).
(5) There was a nonsignificant difference regarding immediate postoperative and all the remaining immediate postoperative laboratory data (P>0.05) (Table 9).

Regarding outcome data, comparative studies between the two groups revealed the following

(1) There was a highly significant decrease in ICU and hospital stay in the ERAS group (P<0.01 each) (Table 10).
(2) There was a highly significant decrease in VAS score and analgesia consumption in the ERAS group (P<0.01, respectively) (Table 10).
(3) There was a highly significant decrease in the early readmission rate in the ERAS group (P<0.05) (Table 10).

Table 5 Comparison between the two groups regarding sociodemographic data using Mann–Whitney's *U* and χ^2 tests

	ERAS group (26)	Traditional care group (27)	Mann–Whitney's *U* test
Variables	Median (IQR)	Median (IQR)	*P* value
Age (years)	61.5 (51–64)	62 (56.2–68)	0.5038
			χ^2 test
Variables	ERAS group (26)	Traditional care group (27)	*P* value
Sex [*n* (%)]			
Female	9 (34.6)	11 (40.7)	0.6487
Male	17 (65.4)	16 (59.3)	

ERAS, enhanced recovery after surgery; IQR, interquartile range.

Table 6 Comorbidities among 53 colorectal surgery patients

Variables	*n* (%)
HTN	25 (47.2)
IHD	5 (9.4)
AF	1 (1.9)
HCV	5 (9.4)

AF, atrial fibrillation; HCV, hepatitis C; HTN, hypertension; IHD, ischemic heart disease.

(4) There was a nonsignificant difference regarding good recovery outcome and complication rate (P>0.05) (Table 2).

Correlation studies

Correlation studies between postoperative outcomes and its relative independent predictors (basic clinical, surgical, laboratory, and operative variables) revealed the following:

(1) Spearman's correlation analysis shows that operative time had a highly significant positive correlation with ICU stay (P<0.01) (Fig. 1) (Table 11).
(2) Spearman's correlation analysis shows that operative time had a highly significant positive correlation with hospital stay (P<0.01) (Fig. 2) (Table 12).
(3) Logistic regression analysis shows that after applying the forward method and entering some predictor variables, the increase in operative time had an independent effect on increasing the probability of complications occurrence; with significant statistical difference (P=0.045) (Table 13)

ROC curve analysis to predict ERAS efficacy and safety (Fig. 3):

(1) By using ROC curve analysis, the ERAS program usage predicted ICU stay decrease, with fair (76%) accuracy, sensitivity (57%), and specificity (85%) (P<0.01).
(2) By using ROC curve analysis, the ERAS program usage predicted hospital stay decrease, with perfect (100%) accuracy, sensitivity (100%), and specificity (100%) (P<0.001).
(3) By using ROC curve analysis, the ERAS program usage predicted VAS score decrease, with fair (78%) accuracy, sensitivity (100%), and specificity (44%) (P<0.01) (Table 14).
(4) By using ROC curve analysis, the ERAS program usage showed nonsignificant predictive values in complications and early readmission occurrences (failed accuracy – area under the curve > 0.7) (Table 15).

Discussion

This was a prospective comparative study conducted on 53 colorectal surgery patients to compare patients within ERAS program with patients with conventional perioperative care.

This study has demonstrated the feasibility and effectiveness of ERAS program in Egyptian hospitals in the setting of elective laparoscopic colonic surgery. Compared with those having a conventional care pathway, patients within an ERAS program had a shorter length of hospital stay and faster recovery of bowel movement. The reduction in hospital stay did not lead to an increase in 30-day readmission or a higher rate of postoperative complication. In fact, the incidence of postoperative complication tended to be reduced in the ERAS group.

We found that the mean age of all patients was 58.3 ± 12.8 years. Regarding sex of the patients, the majority (62.3%) of patients were males, whereas (37.7%) were females, which was in agreement with Yilmaz *et al.* [5].

Yilmaz *et al.* [5] reported that ERAS group included 30 patients, with a mean age of 47.9 ± 7.36 years, and the conventional group included 32 patients with a mean age of 48.3 ± 5.84 years.

In this study, the ERAS program shortened the median length of hospital stay by 2 days. The magnitude of reduction in hospital stay is fairly comparable to those reported from the ERAS pathway for elective

Table 7 Comparison between the two groups regarding comorbidities using χ^2 test

Variable	ERAS group (26) [*n* (%)]	Traditional care group (27) [*n* (%)]	χ^2 test *P* value
HTN			
Positive	14 (53.8)	11 (40.7)	0.3439
IHD			
Positive	1 (3.8)	4 (14.8)	0.1761
AF			
Positive	1 (3.8)	0	0.3082
HCV			
Positive	4 (15.4)	1 (3.7)	0.1497

AF, atrial fibrillation; ERAS, enhanced recovery after surgery; HCV, hepatitis C; HTN, hypertension; IHD, ischemic heart disease.

Table 8 Comparison between the two groups regarding intraoperative data using Mann–Whitney's *U* and χ^2 tests

Variables	ERAS group (26) Median (IQR)	Traditional care group (27) Median (IQR)	Mann–Whitney's *U* test *P* value
Operative time (h)	2 (2–2.5)	3 (2–3)	0.0967
Blood loss (ml)	300 (150–400)	200 (100–275)	0.1085
Variables	ERAS group (26)	Traditional care group (27)	χ^2 test *P* value
Blood and plasma transfusion [*n* (%)]			
Positive	16 (38.5)	12 (44.4)	= 0.6616

ERAS, enhanced recovery after surgery; IQR, interquartile range.

Table 9 Comparison between the two groups regarding immediate postoperative laboratory data using Mann–Whitney's *U* test

Variables	ERAS group (26) Median (IQR)	Traditional care group (27) Median (IQR)	Mann–Whitney's *U* test *P* value
Hb (g/dl)	10 (9.8–11)	11 (9.6–11)	0.5749
PLT (10^3/μl)	218.5 (166–272)	218 (155–296.5)	0.7964
TLC (10^3/μl)	11 (9.1–13)	11 (7.2–11)	0.1089
INR	1.2 (1.1–1.3)	1.2 (1.1–1.2)	0.6381
Sodium (mEq/l)	136.5 (133–140)	135 (133–137.7)	0.3659
Potassium (mEq/l)	4 (3.7–4.3)	4 (3.7–4.2)	0.7012
Creatinine (mg/dl)	0.9 (0.8–1.1)	0.9 (0.8–1.1)	0.5618
Albumin (g/dl)	3.2 (3–3.5)	2.9 (2.7–3.2)	0.01**

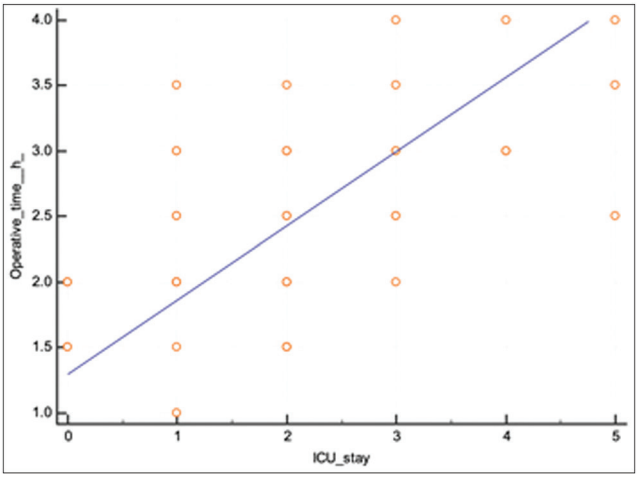
ERAS, enhanced recovery after surgery; Hb, hemoglobin; INR, international normalized ratio; IQR, interquartile range; PLT, platelet; TLC, total leukocyte count. **Statistically insignificant.

Table 10 Comparison between the two groups regarding postoperative outcome data using Mann–Whitney's *U* and χ^2 tests

Variables	ERAS group (26) Median (IQR)	Traditional care group (27) Median (IQR)	Mann–Whitney's *U* test *P* value
ICU stay (days)	1 (1–2)	2 (2–3.7)	0.00052**
Hospital stay (days)	4 (3–5)	8 (7.2–9.7)	<0.0001**
VAS score	1.5 (0–2)	3 (1.2–4.7)	0.0003**
Analgesia consumption (ampoules)	0 (0–1)	2 (1–3)	<0.0001**
Variables [*n* (%)]	ERAS group (26)	Traditional care group (27)	χ^2 test *P* value
Good recovery outcome			
Positive	26 (100)	27 (100)	1.000
Complications rate			
Positive	2 (7.7)	7 (25.9)	0.08
Paralytic ileus			
Positive	1 (3.8)	8 (29.6)	0.013*
Early readmission rate			
Positive	0	5 (18.5)	0.022*

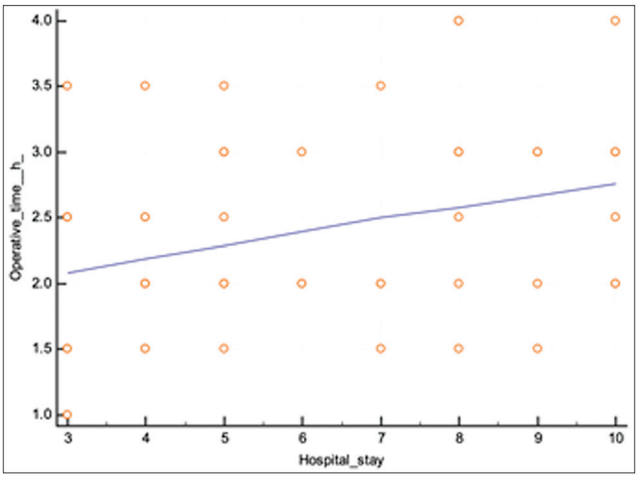
ERAS, enhanced recovery after surgery; IQR, interquartile range; VAS, visual analog scale. *Statistically significant, **statistically insignificant.

Figure 1



Correlation between ICU stay and operative time.

Figure 2



Correlation between hospital stay and operative time.

Table 11 Spearman's correlation analysis for preoperative factors associated with ICU stay

Associated factor	ICU stay	
	Rho	*P*
Clinical		
Age (years)	–0.0542	0.6998
Intraoperative		
Operative time (h)	0.544	<0.0001**
Blood loss (ml)	0.236	0.0886
Laboratory		
Hemoglobin (g/dl)	–0.162	0.2452
Sodium (mEq/l)	–0.115	0.4140
Potassium (mEq/l)	0.0669	0.6343
Albumin (g/dl)	–0.188	0.1767

Rho, Spearman's rho (correlation coefficient). **Statistically insignificant.

Table 12 Spearman's correlation analysis for preoperative factors associated with hospital stay

Associated factor	Hospital stay	
	Rho	*P*
Clinical		
Age (years)	0.138	0.3227
Intraoperative		
Operative time (h)	0.297	0.03*
Blood loss (ml)	–0.0933	0.5062
Laboratory		
Hemoglobin (g/dl)	0.125	0.3737
Sodium (mEq/l)	–0.0415	0.7679
Potassium (mEq/l)	–0.146	0.2977
Albumin (g/dl)	–0.0489	0.7281

Rho: Spearman's rho (correlation coefficient). *Statistically significant.

Table 13 Logistic regression model for the factors affecting complications occurrence using the forward method

Predictor factor	Coefficient	OR	*P* value
Constant	–5.15920		
Operative time	1.22119	3.391	0.045*

OR, odds ratio. Other factors excluded from the model as *P* value more than 0.1. *Statistically significant.

colorectal surgery [6,7]. A recent meta-analysis of 13 randomized trials including 1910 patients has shown that ERAS programs in an elective setting were associated with a significant reduction in total hospital stay with a weighted mean difference of 2.44 and 2.39 days, respectively [7].

The average ICU and hospital stays were 2.03 ± 1.3 and 6.2 ± 2.4) days, with an average VAS score of 2.18 ± 1.6, which came in agreement with other studies [8–11].

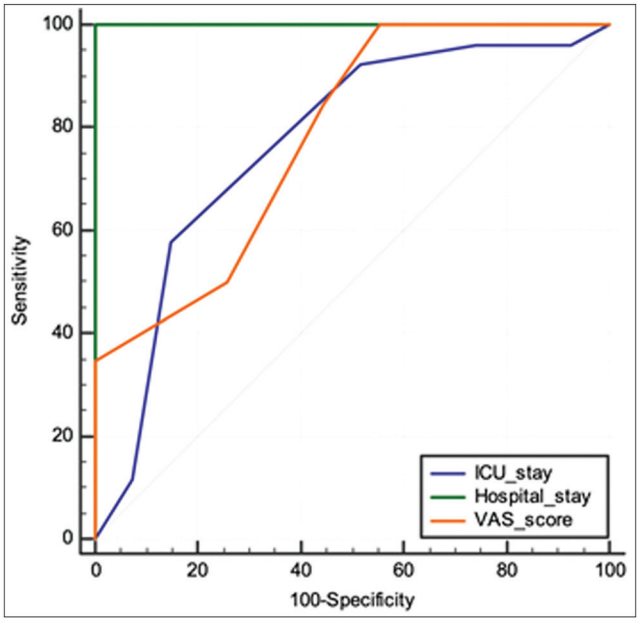
Miralpeix *et al.* [10] reported that most of the ERAS data in the literature is relate to colorectal surgery. One of the first studies to evaluate ERAS was a study reported in 2000 that studied 60 patients undergoing elective colonic resection with an enhanced recovery program including continuous thoracic epidural analgesia, enforced early mobilization, and enteral nutrition. The median length of hospital stay was 2 days [10].

Kang *et al.* [8] reported that, the possible postoperative hospital stay (range) was 5.0 (4–11) days in the ERAS group compared with 5.7 (4–11, *P*=0.038) days in the conventional group [8].

Dogan *et al.* [9] reported that the overall hospital stay was reduced by almost 1 day from 65 to 43 h (*P*<0.001). The amount of medium care admissions was significantly reduced from 19 to 5% (*P*<0.05) [9].

The present study revealed a tendency toward a lower incidence of postoperative complications in the ERAS group. The reduction of postoperative complication in the ERAS program for patient undergoing elective colonic resection is likely to result from a combination of multimodal perioperative interventions, rather than a

Figure 3



ROC curves (ERAS program usage). ERAS, enhanced recovery after surgery; ROC, receiver operating characteristic.

Table 14 Receiver operating characteristic curve of enhanced recovery after surgery program usage to predict safety

Variables	AUC	SE	Sensitivity (%)	Specificity (%)	*P* value
Complications	0.591	0.0506	92.31	25.93	0.0714
Early readmission	0.593	0.0381	100	18.52	0.015*

AUC, area under the curve. *Statistically significant.

Table 15 Receiver operating characteristic curve of enhanced recovery after surgery program usage to predict efficacy

Variables	AUC	SE	Sensitivity (%)	Specificity (%)	*P* value
ICU stay	0.768	0.0652	57.69	85.19	<0.0001**
Hospital stay	1.000	0	100	100	<0.0001**
VAS score	0.781	0.0609	100	44.44	<0.0001**

AUC, area the under curve; VAS, visual analog scale. **Statistically insignificant.

single factor alone, aiming to attenuate metabolic response to surgery, to support the recovery of organ function, and to preserve postoperative immune system [3,12,13].

Regarding postoperative outcome data, all patients had good recovery outcome, 9.4% had early readmission rate, and 17% experienced complications, with 5.7% having wound infection, whereas 3.8% had hypertension, leak, and tachycardia, and 17% had paralytic ileus, which came in agreement with Yilmaz *et al.* [5] and Miralpeix *et al.* [10].

Yilmaz *et al.* [5] reported that nine (30%) patients in the ERAS group and 12 (37.5%) patients in the conventional group experienced a complication (P=0.112) such as vaginitis, wound infection, chest pain, abdominal pain, perioperative bleeding, and ileus. One (3.3%) patient in the ERAS group and 11 (34.4%) in the traditional pathway [5].

Postoperative gastrointestinal recovery seems to be quicker in patients with ERAS program, as they had a shorter period to pass the first flatus and they were able to resume normal diet in less than 4 days postoperatively. These results might be partly owing to the combination of the administration of postoperative nausea/vomiting prophylaxis, judicious fluid therapy, and the preferential use of nonopioid analgesia in the ERAS pathway.

Miralpeix *et al.* [10] reported that most patients (57 of 60) tolerated early enteral nutrition and experienced return of bowel function within 48 h. Nine (15%) patients required readmission, two (3.3%) patients died, and five (8.3%) patients had complications [10].

A comparative study between the two groups revealed highly significant increase in follow-up postoperative albumin in the ERAS group compared with the traditional care group (P=0.01), which came in agreement with Swaminathan *et al.* [11].

Swaminathan *et al.* [11] reported that many of the patients taken up for surgery were found to have a suboptimal nutritional status (serum albumin<3.5 g/dl) [11].

A comparative study between the two groups revealed a highly significant decrease in ICU and hospital stay in the ERAS group compared with the traditional care group (P<0.01 each), which came in agreement with Miralpeix *et al.*, [10], Wang *et al.* [12], Ripollés-Melchor *et al.* [14], Yeung *et al.* [15], Yilmaz *et al.* [5], and Swaminathan *et al.* [11].

Miralpeix *et al.* [10] reported that during the 30 days of follow-up, 73% of the patients (44 of 60) were satisfied with their postoperative care. The authors concluded that compared with traditional care, enhanced recovery program may reduce postoperative length of stay [10].

Ripollés-Melchor *et al.* [14] reported that the median postoperative hospital stay was 13 ± 17 days for patients receiving conventional care and 11 ± 10 days for patients who had followed the ERAS protocol (P=0.034) [14].

Yeung *et al.* [15] reported that the length of stay (LOS) for the ERAS group was significantly shorter than that of the conventional group (6.5 compared with 9.7 days; P=0.049) [15].

Yilmaz *et al.* [5] reported that postoperative early mobilization on the first postoperative day was achieved in eight (26.7%) patients in the ERAS group. On the contrary, none of the control group patients mobilized on day 1. ERAS protocol led to a significantly shorter length of hospital stay (P=0.010) [5].

Teeuwen *et al.* [16] reported that the total LOS (including days after readmission) was significantly shorter in the ERAS program (P<0.05) [16].

Vigerland *et al.* [17] reported that a longer operative time was found in the ERAS group compared with the conventional care group (P=0.09), whereas intraoperative blood loss and the homologous blood transfusion rate were similar in the two groups.

A comparative study between the two groups revealed a highly significant decrease in the VAS score in the ERAS group compared with the traditional care group (P=0.0003), which came in agreement with Kang *et al.* [8].

Kang *et al.* [8] reported that the day of first flatus was faster in the ERAS group compared with the conventional group: 2.9 (1–5) and 3.4 (1–5, P=0.008) days, respectively. The dates of first fluid, semifluid diet, and soft-blended diet were all significantly faster in ERAS in accordance with the given protocol. The maximum pain score derived using the VAS scale was significantly higher in the conventional group [8].

A comparative study between the two groups revealed a highly significant decrease in early readmission rate in the ERAS group compared with the traditional care group (P<0.05 each), which came in agreement with Miralpeix *et al.* [10], Yeung *et al.* [15], Ripollés-Melchor *et al.* [14], Teeuwen *et al.* [18], and Zhang *et al.* [19].

Miralpeix *et al.* [10] reported that during the 30 days of follow-up, 73% of the patients (44 of 60) were satisfied with their postoperative care. The authors concluded that compared with traditional care, enhanced recovery program may reduce postoperative length of stay and the rate of complications in high-risk patients undergoing colonic resection [10].

Yeung *et al.* [15] reported that major postoperative complication rates were similar between the groups (4% compared with 7%; P=0.70). The ERAS group had significantly fewer total complications (39% compared with 61%; P=0.04) and significantly fewer minor complications (32% compared with 57%; P=0.01) [15].

Ripollés-Melchor *et al.* [14] reported that patients treated according to the ERAS program developed significantly fewer complications and had shorter hospital stay [14].

Teeuwen *et al.* [18] reported that the results of this study suggest that the ERAS program is superior to conventional postoperative care for patients undergoing elective colonic or rectal resection. Patients treated according to an ERAS program develop significantly less complications and have shorter hospital stay [18].

Zhang *et al.* [19] reported that six RCTs including 712 patients (365 in the ERAS group and 347 in the CRAS group) recorded postoperative complications. The fixed-effects model showed that the ERAS and the CRAS groups were similar in terms of the postoperative complications (odds ratio=0.63, 95% confidence interval: 0.63–1.34, P=0.64) [19].

A comparative study between preoperative and postoperative measurements revealed a highly significant increase in hemoglobin in follow-up postoperative measurements in ERAS and traditional care groups (P<0.05 each), which came in agreement with Tejedor *et al.* [20].

Tejedor *et al.* [20] reported that patients in whom malnutrition or anemia less than 10 g/dl was confirmed were sent to an intensive preoperative treatment program. As a result, preoperative albumin and hemoglobin values were higher in the ERAS group, and this may explain the lower rate of anastomotic leakage [20].

By using ROC curve analysis, the ERAS program usage predicted hospital stay decrease, with perfect (100%) accuracy, sensitivity (100%), and specificity (100%) (P<0.001), which came in agreement with Miralpeix *et al.*[10], Teeuwen *et al.* [16], and Varadhan *et al.* [21].

Miralpeix *et al.* [10] reported that compared with conventional perioperative care, the ERAS program was associated with significantly reduced median number of days in hospital from surgery until discharge (weighted mean difference, −2.44 days; 95%, P<0.0001), and total hospital stay, including additional hospital days for readmissions (weighted mean difference, −2.39 days; P=0.0003) [10].

Teeuwen *et al.* [16] reported that the median LOS was significantly shorter in the ERAS group than in the conventional care group: 8 days (interquartile range, 6–18.5 days) versus 12 days (interquartile range, 9–17.5 days; P=0.005) [16].

Varadhan *et al*. [21] reported that patients undergoing major open colonic/colorectal surgery and managed with a perioperative ERAS pathway had a primary hospital stay of 2.5 days less than those managed with a traditional care pathway (P<0.00001) [21].

Conclusion

On the basis of current data, it appears that ERAS program is feasible and can be implemented in our hospitals. Moreover, it results in an overall improvement in postoperative outcomes. ERAS patients were found to have a lesser length of hospital stay, less overall postoperative complication rate, and better postoperative nutrition status. However, further studies are needed to be conducted on a bigger sample of patients to prove reproducibility and reliability.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that they have no conflict of interest.

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