Enhanced recovery program versus traditional postoperative care for elective open colorectal cancer surgery

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Background
Traditional colorectal surgeries usually require a relatively long hospital stay of ~10 days. Inadequate pain control, intestinal dysfunction, and immobilization are the main factors associated with delay in recovery. Enhanced recovery protocols have been used to optimize the perioperative care.
Objectives
To study the outcome of the enhanced recovery program for selected patients with colorectal malignancies subjected to elective surgery compared with similar patients subjected to surgery with traditional perioperative care.
Patients and methods
This prospective study was performed at Fayoum University Hospital from April 2008 to June 2017 and involved 97 patients who had uncomplicated colorectal cancer and were planned for elective open colorectal surgeries. They were divided into two groups: group A (44 patients) was subjected to surgery based on fast-track protocol and group B (53 patients) was subjected to surgery based on traditional perioperative care. Hospital stay, perioperative morbidity, mortality data, postoperative pain, and patient satisfaction data were collected, statistically analyzed, and recorded.
Results
In groups A and B, respectively, the mean±SD age was 47.3±5.1 and 43.7±6.1 years, the number of males was 31 and 44, whereas the number of females was 13 and nine. According to American Society of Anesthesiologists (ASA) score, 43.2 and 54.7% of patients were ASA I and 56.8 and 45.3% were ASA II in groups A and B, respectively. Overall, 40.9 and 43.4% underwent low anterior resection, 36.4 and 22.6% sigmoidectomy, 22.7 and 28.3% right colectomy, and 0 and 5.7% left colectomy in groups A and B, respectively. The mean±SD length of postoperative hospital stay was 3.58±0.24 and 8.84±1.87 days in groups A and B, respectively. There was no mortality in the two groups, and overall morbidity rate was 22.7 and 22.6% in groups A and B, respectively. Overall, 4.5 and 7.5% had wound infection, 2.3 and 0% had abdominal wall dehiscence, 11.4 and 11.3% had persistent vomiting, 2.3 and 3.8% had postoperative fever in groups A and B, respectively. Moreover, one (2.3%) patient in group A required readmission and resurgery to manage anastomotic leakage and peritonitis.
Conclusions
Enhanced recovery program for elective colorectal cancer surgery has a very good effect on postoperative recovery, as it shortens the length of hospital stay, with high safety and good patient compliance; therefore, we strongly recommend the application of such protocols, provided the availability of well-trained and adequately experienced personnel in well-equipped centers.

Keywords:
colorectal, early recovery, epidural, enhanced recovery after surgery

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Introduction

Colorectal cancer is one of the most commonly diagnosed cancers in both men and women [1]. Surgery, which is still the mainline of treatment, remains a high-risk procedure, with clinically significant postoperative stress, complications (8–20%), and a lengthy postoperative hospital stay (average 8–12 days) [2]. This necessitates changes in the management policy of the colorectal cancer [3] and hence was born the idea of fast-track surgery, which is considered by some authors the most important innovation after the advent of laparoscopy (by Fowler and White [4] in 1990s for colorectal surgeries) in the field of colorectal surgery as in other fields of surgery [5]. Fast-track surgery or enhanced recovery after surgery

(ERAS) or multimodal surgery is defined as a multimodal pathway aimed at reducing surgical stress through a global package of preoperative, operative, and postoperative techniques, which in aggregate result in fewer complications, reduction in the length of hospital stay, better recovery, and quicker return to work and normal activities [6].

The principles of ERAS were first introduced by Professor Henrik Kehlet [7] in 1997, when he referred the undesirable sequelae of major surgeries to the surgical stress response, and he believed that multimodal interventions can lead to a major reduction in such sequelae, with improved recovery and reduction in postoperative morbidity and the overall costs. Four years later, Kehlet and Wilmore [8] was the first one to launch the term fast-track surgery, which was originally concerned primarily with pain and length of hospital stay and then has been evolved to mean different things to different parties. In short time, ERAS has rapidly gained popularity around the world [5]. Kehlet and Wilmore [9] concluded that the key factors that keep a patient in hospital include the need for parenteral analgesia (persistent pain), intravenous fluids (persistent gut dysfunction), and bed rest (persistent lack of mobility). So, he described a clinical pathway based on optimal pain control, stress reduction with regional anesthesia, early enteral nutrition, and early mobilization.

ERAS program components are composed of preoperative, intraoperative, and postoperative strategies combined to form a multimodal pathway.

(1) Preoperative:
    (a) Preadmission care: to optimize comorbidities (such as anemia, hypertension, and diabetes), cessation of stop smoking and alcohol intake, and adequate education to the patient and his/her family [10].
    (b) Preoperative measures: no prolonged fasting, that is, just 2 h for fluids and 6 h for solids [11]. Nondiabetic patients receive carbohydrate loading in the day before surgery and 2 h before anesthesia induction [12,13]. No mechanical bowel preparation as it may cause dehydration and fluid and electrolytes abnormalities [14]. No sedating drugs allowed from the day before surgery [15].
(2) Intraoperative:
    Normothermia maintenance is mandatory to prevent coagulopathy and adverse cardiac events and decreased resistance to wound infection [15]. Prevention of postoperative ileus by, avoidance of fluid overload and adequate pain control [14,16]. Minimally invasive surgical approach via laparoscopy or transverse incision [17]. Fluid restriction is essential with care to avoid hypovolemia [18,19]. Nasogastric tube should be inserted only if ileus develops [20,21]. Drains are avoided, as there is no evidence of beneficial effect in reducing postoperative morbidity [22,23]. Use of epidural anesthesia and analgesia with infiltration of local anesthetics around a surgical incision should be a component of all fast-track protocol [15,24].
(3) Postoperative:

Avoid overhydration with discontinuation of intravenous fluid therapy as soon as possible, with early commencement of enteral feeding [15]. Excellent epidural analgesia is very important with intravenous paracetamol and/or nonsteroidal antiinflammatory analgesics if needed but opioids should be avoided [25]. Prevention of postoperative nausea and vomiting through good perioperative oxygenation; use of prokinetics, antiemetics, beta blockers and dexamethasone; adequate pain control; and no opioids are believed to be effective by some authors to control postoperative nausea and vomiting [6,26]. Early oral nutrition should be encouraged as early as possible [25]. Early removal of urinary catheters should be done, as most patients can tolerate its removal on the first postoperative day [26–28]. Postoperative laxatives (oral or rectal) encourage earlier return of bowel function and reduce the incidence of postoperative ileus [29]. Early mobilization is the key element of ERAS in colorectal surgery where patient should be out of bed for at least 2 h on the day of surgery and 6 h thereafter [30]. Early discharge when the discharge criteria (e.g. good mobilization, adequate oral intake, no complications) have been reached followed by a daily telephone call by a well-trained nurse and then the first outpatient visit to be 10–14 days after discharge [15].

Aim

The aim was to evaluate the outcome of ERAS program compared with the traditional perioperative care in patients with colorectal cancer who were planned to undergo elective open surgery.

Patients and methods

Study design

This study was designed as a nonrandomized comparative single-center study, which was performed at the Department of General Surgery at Fayoum University Hospital during the period from April 2008 to June 2017, where 136 patients with

colorectal cancer were evaluated; 39 patients were excluded from the study (out of inclusion criteria), and 97 patients were included and planned for open surgery. We explained the protocol of ERAS program to every patient of the study population individually (n=97), and patients who agreed were selected in group A (n=44), whereas those who refused were selected in group B (n=53). Accordingly, our study populations were divided into two groups: group A, which included 44 patients subjected to open surgery based on ERAS program, and group B, which included 53 patients subjected to open surgery based on traditional perioperative care. The ERAS used in our study was designed by the authors on the basis of published protocols [2,8,9,26]. For all the patients, full history taking, detailed clinical examination, and the required investigations were done. A fully detailed written consent was taken from every patient individually. We emphasized that the surgical technique itself had never been affected by the type of perioperative care, and all surgeries were done by an experienced surgeon in the field of colorectal surgery.

Approval of ethical committee of Fayoum University Hospitals was obtained before we start the study.

Inclusion criteria

The following were the inclusion criteria: age of 18 years or older, able to understand the requirements of the study and able to provide an adequate informed consent with an adult responsible caretaker, diagnosed with uncomplicated colorectal cancer for elective surgery without need for a stoma or any further surgical procedure, no uncontrolled comorbidity with good general fitness, and with American Society of Anesthesiologists (ASA) score I or II.

Our enhanced recovery after surgery program for group A patients

Preoperative care

All patients were admitted to hospital 1 day before surgery to make sure that the preoperative measures were adhered to.

(1) Preoperative counseling and education were given to each patient and his/her caretaker to diminish fear and anxiety and included full information about ERAS, its aim, and possible complications divided into four stages: the first stage refers to the period up to the surgery, the second stage refers to the day of surgery, the third stage is the recovery period after surgery up until discharge, and the fourth stage for after discharge care and follow-up.
(2) Optimization of medical status of the patient was done by correction of any comorbidity.
(3) No mechanical bowel preparation was done apart from 120-ml single enema at the night before surgery only for patients with rectal cancer.
(4) No preoperative fasting was needed. Intake of clear fluids was allowed for 2 h and solids for 6 h before induction of anesthesia.
(5) Carbohydrate loading (except for diabetic patients) was done, where 200 ml of fresh apple juice sweetened with three teaspoons of sugar (provides 167 kcal) was given four to six times on the day before surgery and two times on the surgery morning.
(6) Prophylaxis against venous thromboembolism was done by use of elastic compression stockings and low-molecular-weight heparin (enoxaparin 1 mg/kg/day subcutaneously) starting from the night before surgery until discharge.
(7) Preanesthetic medications included ß-blocker (50 mg atenolol oral tablet/day), where the first dose was given 24 h before surgery and the second dose was at the morning of surgery and continued until discharge, and ultrashort benzodiazepines (midazolam 20 μg/kg intravenous), single dose at the night before surgery.

Intraoperative care

(1) Antibiotic prophylaxis was initiated by single dose of third-generation cephalosporins (ceftriaxone 2 g intravenous) at time of induction of anesthesia together with 1000 mg metronidazole intravenous infusion.
(2) Regarding anesthesia, combined thoracic epidural and general anesthesia was adopted. Midazolam 1–2 mg intravenous was given for anxious patients before placing the epidural catheter at T9–T10 or T10–T11, with administration of 6–12 ml of ropivacaine 0.2%. The general anesthesia was carried out with fentanyl and propofol, and atracurium was used for curarization. Sevoflurane in O_2/air was used for maintaining the anesthetic plan, and the ventilation was previously set and was adjusted during operation with capnometric monitoring ($PetCO_2$, 32–38 mmHg). Finally, neostigmine was used at the end of the operation to antagonize the curarization.
(3) Transverse abdominal incisions were done for all patients (Pfannenstiel incision was used for low anterior resection).
(4) Adequate intraoperative oxygenation was ensured.
(5) Intraoperative normothermia was maintained by electric heating blanket applied on thorax and

upper limbs and in recovery room on the whole body.
(6) Intraoperative restriction of intravenous fluids was done, usually to 1000–2000 ml of lactated Ringer guided by urine output (should be 0.5–1 ml/kg/h).
(7) Close monitoring was done of blood sugar with tight glycemic control in diabetic patients.
(8) No nasogastric tubes were inserted.
(9) No drains were placed except in patients with rectal cancer where short-term drains were placed and removed after 24 h.
(10) Urinary catheters were removed at the end of surgery before transfer to recovery room.
(11) Local anesthetic infiltration of the wound was done using 20 ml of ropivacaine 0.5% plus 1 mg adrenaline 1 : 1000.

Postoperative care

(1) Postoperative multimodal pain control: it was based on epidural analgesia that was carried out with morphine 0.5–1 mg and ropivacaine 0.2% in bolus of 5 ml followed by maintenance with morphine 0.04 mg/ml as 2 ml/2 h with ropivacaine 0.2% as 3 ml/2 h. The postoperative pain was monitored according to the Numerical Pain Rating Score. In case of insufficient analgesia, paracetamol 1 g intravenous infusion (up to three doses per day) and/or diclofenac sodium 75 mg/3 ml intramuscular or intravenous infusion (up to three doses per day) were given. This multimodal regimen was enough to achieve good pain control in most of our patients. Epidural catheter was removed on the third postoperative day for all patients.
(2) Prevention of postoperative nausea and vomiting was done by ondansetron 8 mg/12 h intravenous, metoclopramide 10 mg intravenous/12 h, dexamethasone 8 mg intramuscular/24 days, and atenolol 50 mg tablet /24 h. This regimen was given to all patients starting immediately after surgery for 2–3 days when regular adequate oral nutrition was achieved with comfort.
(3) Prevention of postoperative ileus was achieved by ensuring good analgesia, oral laxatives (30 ml bisacodyl syrup) 4 h after surgery and after 12 h, and proper postoperative fluid intake that maintains urine output 0.5–1 ml/kg/h without subsequent weight gain.
(4) Tight glycemic control was done, especially for diabetic patient, to prevent hyperglycemia through continuous monitoring blood sugar every 2 h with insulin therapy accordingly.
(5) Early oral nutrition was started, where on the day of surgery and immediately after complete restoration of conscious level, all patients were advised to start chewing gum; 2 h later, all patients started oral intake with 50 ml apple juice every 2 h, and if no vomiting after two drinks, we continued on fluids with an average 500–1000 ml per day; and on the first postoperative day, patients started semisolids (jelly, low fat yoghurt, and pudding) and small amounts of animal protein as small meal every 4 h with average fluid intake 1000–1500 ml per day. High-protein diet was started from the second postoperative day, and thereafter, as three regular meals with three snacks in-between.
(6) Early mobilization was started four to eight after surgery for at least 2 h with assistance in the day of surgery and 4–6 h/day independently from first postoperative day thereafter.

Discharge and follow-up

Patients with colonic cancer (right colectomy and sigmoidectomy) were discharged on the third postoperative day, whereas patients with low anterior resection (rectal and rectosigmoid cancer) on the fourth postoperative day, provided that the patient was not in pain, can eat and drink comfortably, walk freely, had good gastrointestinal motion, had normal urinary function, had no wound infection, and had no fever. We asked patients about how much they were satisfied with ERAS. Full information about possible complications, wound care, maintaining adequate nutrition, and adequate mobilization was also given on discharge and asked for after the patient returned home through phone calls from surgical nurse every 48 h for 10 days. The first follow-up visit on the outpatient clinic was scheduled 2 weeks after discharge. The second one was after 1 month, where we asked about pain, complications, fluid and food intake, and daily activities; moreover, careful clinical examination to detect any possible complications and measurement of body weight to assess nutritional status were done. Then the follow-up was scheduled every 3 months for 2 years and every 6 months thereafter.

Our perioperative care for group B patients

Preoperative care

(1) All patients were given clear adequate information about type and sequelae of surgery and postoperative care.
(2) Optimization of medical state of the patient was done.

(3) Bowel preparation: 1 day before surgery, nonresidue diet and clear fluids were only allowed, together with two Eucarbon tablets every 6 h, with one enema 12 h and second one 4 h before surgery.
(4) Fasting for 6–8 h before surgery was mandatory.
(5) Antianxiety medication in the form of bromazepam 1.5 mg tablet at night before surgery and at surgery day morning was given.
(6) Prophylaxis against thromboembolism was same as in group A.

Intraoperative care

(1) Anesthesia: either general or combined epidural or general anesthesia (as in group A) was given, with removal of epidural catheter at the end of surgical procedure (based on the patient's desire, as most of patients refused insertion of epidural catheter and the remaining asked to remove the catheter at the end of surgical procedure).
(2) Antibiotic prophylaxis was the same as in group A.
(3) Urinary catheter was inserted in all patients.
(4) Nasogastric tube was inserted for all patients.
(5) Regarding surgical incision, a vertical midline incision was made.
(6) Proper intraoperative hydration included maintaining urine output 0.5–1 ml/kg/h without subsequent weight gain.
(7) Adequate oxygenation and normothermia were ensured intraoperatively and maintained in the recovery room.
(8) Two suction drains were inserted: one placed under the anastomotic line and the other placed deeply in the pelvis.
(9) Local anesthetic infiltration of the surgical wound was done using 20 ml of ropivacaine 0.5% plus 1 mg adrenaline 1 : 1000.

Postoperative care

(1) Postoperative analgesia: on the day of surgery, pethidine 50–100 mg/day in divided doses (diluted intravenous injections) together with paracetamol (1000 mg intravenous) and/or diclofenac sodium (75 mg intravenous infusion). From the first day of surgery onward, 1000 mg paracetamol intravenous every 8 h, alternating with diclofenac sodium 75 mg intravenous infusion every 8 h, was initiated.
(2) Nothing per oral for 3 days for colectomy patients and 4 days for low anterior resection patients was given, and then clear fluids were started followed by semisolids, and then solids according to patient tolerance.
(3) Urinary catheters were removed 2–3 days after surgery in colectomy patients and 4–5 days after low anterior resection patients.
(4) Drains were removed when their daily output fell below 50 ml/day and after patient started oral intake.
(5) Nasogastric tubes were removed on second or third postoperative days.

Discharge and follow-up

Patients were discharged when they could eat and drink comfortably, no or acceptable pain, move independently, good motion of the gut, normal urinary function, and no wound complications or fever. Full information about possible complications, wound care, maintaining adequate nutrition, and adequate mobilization was also given on discharge. Follow-up schedule was weekly for 1 month, where we asked about pain, complications, fluid and food intake, and daily activities; moreover, careful clinical examination to detect any possible complications and measuring body weight to assess nutritional status were done. Then, the follow-up was monthly for 3 months, then every 3 months for 2 years, and every 6 months thereafter.

Data about age, sex, diagnosis, surgical procedure, perioperative morbidity and mortality, length of hospital stay, independent mobilization, postoperative pain, sleep quality, and the degree of patient satisfaction were recorded. For quantitative parametric data, we have used the independent Student t test to compare measures of two independent groups, one-way analysis of variance test in comparing more than two independent groups, and paired t test in comparing two dependent groups. For quantitative nonparametric data, we have used Mann–Whitney test for comparing two independent groups (nonpaired variables) and Wilcoxon tests for comparing two dependent groups (paired variables). For qualitative data, we have used χ^2 test to compare two of more than two qualitative groups. The level P value less than or equal to 0.05 was considered the cutoff value for significance.

Results

A total of 97 patients were adopted in this study who initially met our inclusion criteria and were divided into two groups: group A or ERAS group included 44 patients and group B or traditional care group (control group) included 53 patients. Patient characteristics, tumor locations and surgical procedures are demonstrated in Table 1. The mean ±SD age was 47.3±5.1 years in group A and 43.7±6.1 years in group B. A total of 31 (70.5%) patients were

Table 1 Patient characteristics, tumor locations, and surgical procedures

Variables	Group A (*N*=44)	Group B (*N*=53)	*P* value
Age (years) (mean±SD)	47.3±5.1	43.7±6.1	NS
Sex [*n* (%)]			
Males	31 (70.5)	44 (83)	S
Females	13 (29.5)	9 (17)	S
ASA classification [*n* (%)]			
ASA I	19 (43.2)	29 (54.7)	S
ASA II	25 (56.8)	24 (45.3)	S
Location of tumor [*n* (%)]			
Upper rectum	6 (13.6)	8 (15.1)	S
Rectosigmoid	12 (27.3)	15 (28.3)	NS
Sigmoid colon	16 (36.4)	12 (22.6)	S
Right colon	8 (18.2)	14 (26.4)	S
Hepatic flexure	2 (4.5)	1 (1.9)	S
Splenic flexure	0	3 (5.7)	S
Surgical procedure			
Low anterior resection	18 (40.9)	23 (43.4)	NS
Sigmoidectomy	16 (36.4)	12 (22.6)	S
Right colectomy	10 (22.7)	15 (28.3)	S
Left colectomy	0	3 (5.7)	S

ASA, American Society of Anesthesiologists; NS, nonsignificant; S, significant.

males and 13 (29.5%) patients were females in group A, whereas in group B, 44 (83%) patients were males and nine (17%) patients were females. According to ASA classification, in group A, 43.2% of patients were ASA I and 56.8% were ASA II, whereas in group B, 54.7% were ASA I and 45.3% were ASA II. In groups A and B respectively, 36.4 and 22.6% of patients had carcinoma of the sigmoid colon, 27.3 and 28.3% of patients had carcinoma of the rectosigmoid junction, 18.2 and 26.4% of patients had carcinoma of the right colon, 13.6 and 15.1% of patients had carcinoma of the upper one third of rectum, 4.5 and 1.9% of patients had carcinoma of hepatic flexure, and no patients in group A had carcinoma of splenic flexure but 5.7% of patients in group B had. Low anterior resection made up the majority of surgical procedures performed in the study groups (40.9 and 43.4% of patients in groups A and B, respectively), followed by sigmoidectomy in 36.4 and 22.6% of patients, respectively, then right colectomy in 22.7 and 28.3% of patients respectively, and only 5.7% of patients in group B underwent left colectomy. No stomas or additional surgical procedure done in any of the study patients.

The mean duration of surgery was 142.4±13.6 and 136.5±16.02 min in groups A and B, respectively, with no intraoperative complications. The mean time spent in the recovery room before transfer to ward was 159.4±25.4 and 166.8±23.4 min in groups A and B, respectively; all patients were transferred to ward, and none of them needed ICU admission. In groups A and B, the overall morbidity rate was 22.7 and 22.6%, respectively; two (4.5%) patients and four (7.5%) patients had mild to moderate superficial wound infection (in group A one patient was after right colectomy and the second one after low anterior resection, whereas in group B, three patients after low anterior resection and one patient after sigmoidectomy) and treated with repeated dressing and systemic antibiotic with complete cure within 1 week, one (2.3%) patient in group A developed partial abdominal wall dehiscence on the fourth postoperative day (after low anterior resection for upper rectal cancer) on the same day planned for discharge and treated with reoperation where the wound was closed with secondary tension sutures and systemic antibiotics which was summoned to stay in the hospital for extra 3 days after the second surgery. In group A, persistence of postoperative nausea and vomiting for 24 h was encountered in five (11.4%) patients, which necessitated cessation of oral intake and use of antiemetic and prokinetic drugs such as ondansetron 16 mg intravenous/12 h and metoclopramide 10 mg intravenous/8 h, dexamethasone 8 mg/12, and intravenous fluids (1500 ml lactated ringer and 500 ml dextrose 10%); this regimen was successful in treatment of PONV completely after 24 h in four (80%) patients and after 48 h in one (20%) patient, with restoration of oral intake and discharge on time in three (60%) patients and 1 day later in two (40%) patients (the last two patients underwent low anterior resection for high rectal cancer). However, in group B, six (11.3%) patients complained of postoperative nausea and vomiting after starting oral fluids (two patients after low anterior resection, one patient after right colectomy, two patients after left

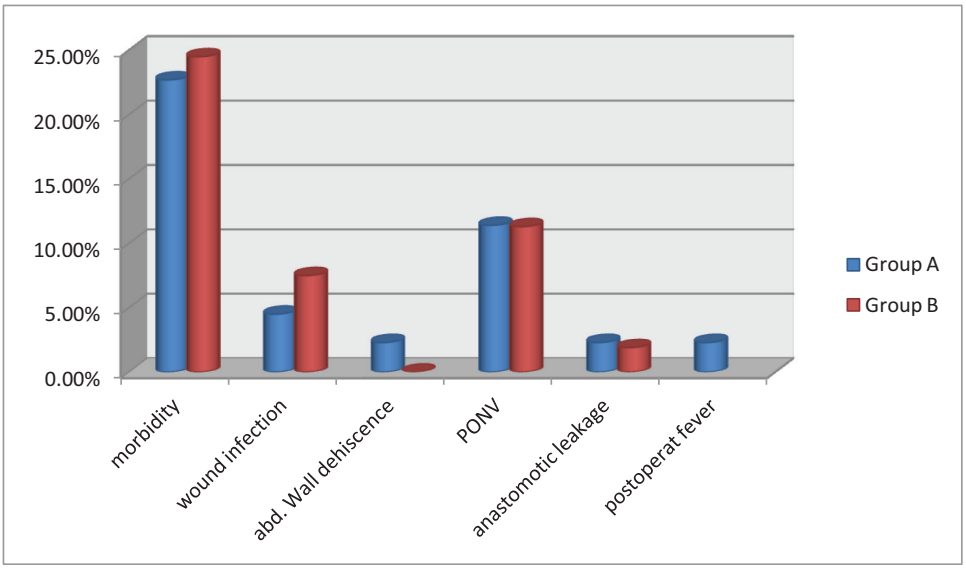
colectomy, and the last one was after sigmoid colectomy); they were treated successfully with prohibition of oral intake and antiemetic with prokinetic drugs together with intravenous fluids as in group A, with restoration of oral fluids again after 24–48 h. In group A, one (2.3%) patient required readmission and resurgery to manage anastomotic leakage and peritonitis that presented 6 days after surgery (2 days after discharge after low anterior resection for rectosigmoid carcinoma), where the patient underwent peritoneal lavage (as usual management in peritonitis) with closure of the rectal stump and brought left colon colostomy on anterior abdominal wall. Postoperative management included close monitoring with parenteral antibiotics, intravenous fluid therapy, proton pump inhibitors, and nonsteroidal antiinflammatory analgesics with nothing per oral for the 3 days, and then oral intake started gradually. Fortunately, this patient was discharged after 1 week in good general health, and restoration of gut continuity was done after 6 months. In group A, one (2.3%) patient (after low anterior resection) developed fever on the second postoperative day owing to moderate chest infection, which was treated with ciprofloxacin tablets 500 mg/12 h, bronchodilators, and mucolytic syrup. In group B, two (3.8%) patients developed postoperative fever: one patient on the third postoperative day (after low anterior resection) due to urinary tract infection before removal of the urinary catheter, treated successfully with ceftriaxone intravenous 1 g/12 h with removal of the catheter, and the second patient got feverish on the fifth postoperative day (after sigmoidectomy), with no definite cause of fever (clear chest, no urinary tract infection, negative blood culture, no wound infection, and abdomen was lax, and abdominal ultrasound examination revealed no collection); the patient treated successfully with empirical intravenous antibiotic (ceftriaxone 1 g/12 h and clindamycin 300 mg/12 h) with paracetamol intravenous 1000 mg/6 h, where fever subsided after 48 h of treatment.

In our study, no postoperative mortality was encountered in any of the two groups (Fig. 1 and Table 2).

In our study, the 30-day readmission rate in group A was 2.3% (one patient incurred anastomotic leakage after discharge), whereas no readmission in group B.

In groups A and B, the mean±SD total postoperative hospital stay for all patients including primary admission related and readmission related days was 3.58±0.24 and 8.84±1.87 days, respectively, whereas without readmission days was 3.47±0.23 and 8.84±1.87 days, respectively. The mean±SD postoperative hospital stay in patients who underwent colectomy (right, left, and sigmoid colectomy) was 3.08±0.21 and 7.31±0.084 days in groups A and B, respectively, which was significantly shorter than that in patients who underwent low anterior resection, which was 4.51±0.26 and 9.21±1.88 days, respectively (with readmission days), and 4.07±0.23 and 9.21±1.88 days, respectively (without readmission days), with *P* value less than 0.05 (statistically significant) (Table 4).

Figure 1



Postoperative morbidity.

Table 2 Postoperative morbidity and mortality

Complication	Group A (*N*=44) [*n* (%)]	Group B (*N*=53) [*n* (%)]	*P* value
Mortality	0	0	
Morbidity	10 (22.7)	12 (22.6)	NS
Wound infection	2 (4.5)	4 (7.5)	S
Abdominal wall dehiscence	1 (2.3)	0	NS
PONV	5 (11.4)	6 (11.3)	NS
Anastomotic leakage	1 (2.3)	0	NS
Postoperative fever	1 (2.3)	2 (3.8)	NS

NS, nonsignificant; S, significant.

Table 3 Postoperative pain control

Time	NPRS	Group A (*N*=44) [*n* (%)]	Group B (*N*=53) [*n* (%)]	*P* value
Day of surgery	3	35 (79.5)	0	S
	4	9 (20.5)	10 (18.9)	S
	5	0	15 (28.3)	S
	6	0	25 (47.2)	S
	7	0	3 (5.6)	S
First postoperative day	3	32 (72.7)	0	S
	4	12 (27.3)	11 (20.7)	S
	5	0	17 (32.1)	S
	6	0	24 (45.3)	S
	7	0	1 (1.9)	NS
Second postoperative day	2	24 (54.5)	0	S
	3	15 (34.1)	8 (15.1)	S
	4	5 (11.4)	16 (30.2)	S
	5	0	14 (26.4)	S
	6	0	15 (28.3)	S
Third postoperative day	2	34 (77.3)	0	S
	3	10 (22.7)	13 (24.5)	S
	4	0	15 (28.3)	S
	5	0	10 (18.9)	S
	6	0	15 (28.3)	S
On discharge	2	38 (86.4)	2 (3.8)	S
	3	6 (13.6)	17 (32.1)	S
	4	0	14 (26.4)	S
	5	0	20 (37.7)	S
On first follow up visit (1 week after discharge)	1	23 (52.3)	6 (11.3)	S
	2	21 (47.7)	17 (32.1)	S
	3	0	28 (52.8)	S
	4	0	2 (3.8)	S

NPRS, numerical pain rating scale; NS, nonsignificant; S, significant.

Table 4 Postoperative hospital stays (mean±SD)

Postoperative hospital stay	Group A	Group B	*P* value
Total postoperative stay with readmission days	3.58±0.24	8.84±1.87	S
Total postoperative stay without readmission days	3.47±0.23	8.84±1.87	S
Postoperative stay in colectomy patients	3.08±0.21	7.31±0.84	S
Postoperative stay in LAR			
Without readmission days	4.07±0.23	9.21±1.64	S
With readmission days	4.51±0.26	9.21±1.64	S

LAR, low anterior resection; NS, nonsignificant; S, significant.

The postoperative pain score according to the numerical pain rating scale (NPRS) is shown in Table 3. In group A, the score was 3 in 79.5% and 4 in 20.5% of patients on the same day of surgery; was 3 in 72.7% and 4 in 27.3% of patients on the first postoperative day; was 2 in 54.5%, 3 in 34.1% and 4 in 11.4% of patients on the second postoperative day; was 2 in 77.3% and 3 in 22.7% of patients; and on the

discharge day, NPRS was 2 in 86.4% and 3 in 13.6% of patients. During the first week after discharge, pain control was satisfactory, with NPRS being 1 in 52.3% and 2 in 47.7% of patients at the first follow-up visit. In group B, NPRS on the surgery day was 4 in 18.9%, 5 in 28.3%, 6 in 47.2%, and 7 in 5.6% of patients; on the first postoperative day, was 4 in 20.7%, 5 in 32.1%, 6 in 45.3%, and 7 in 1.9% of patients; on the second postoperative day was 3 in 15.1%, 4 in 30.2%, 5 in 26.4%, and 6 in 28.3% of patients; on the third postoperative day was 3 in 24.5%, 4 in 28.3%, 5 in 18.9%, and 6 in 28.3% of patients; on discharge was 2 in 3.8%, 3 in 32.1%, 4 in 26.4%, and 5 in 37.7% of patients; and on the first follow-up visit (1 week after discharge), NPRS was 1 in 11.3%, 2 in 32.1%, 3 in 52.8%, and 4 in 3.8% of patients.

The first bowel movement occurred after a mean±SD of 23.1±4.3 and 38.9±6.8 h after surgery in groups A and B, respectively. Patient satisfaction (Fig. 2) in groups A and B respectively was excellent in 22 (50%) patients and 13 (24.5%) patients, good in 15 (34.1%) patients and 20 (37.8%) patients, acceptable in four (9.2%) patients and 13 (24.5%) patients, poor in one (2.3%) patient and two (3.7%) patients, whereas two (4.5%) patients and five (9.4%) patients gave no answer, with overall patient satisfaction of ~93.1 and 86.8%.

Discussion

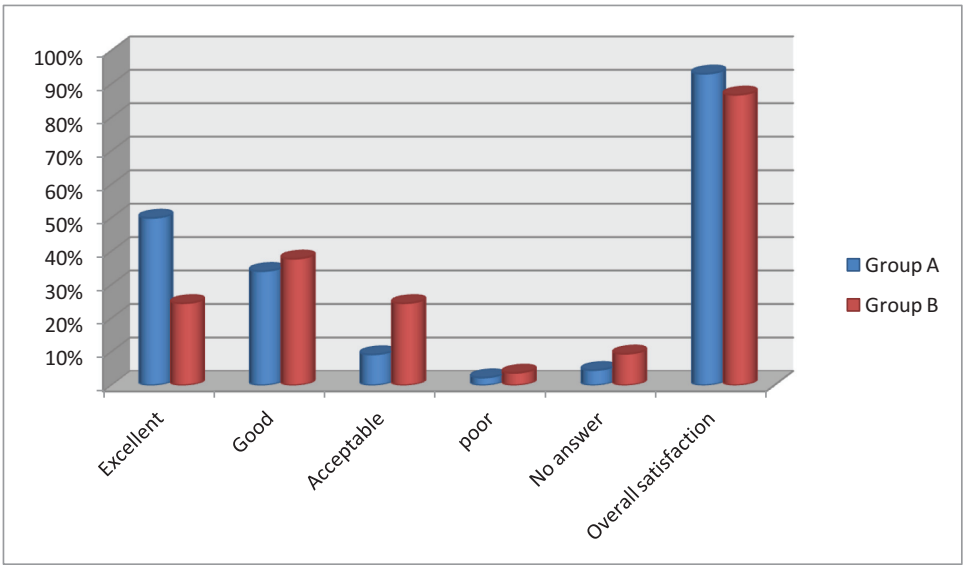
The application of ERAS protocols in patients undergoing colorectal surgery, whether open or laparoscopic, positively affects the postoperative outcome [16]. The expanding evidence-based medicine shows that ERAS program benefits not only all patients but also the health service [15].

The present study is the first application of an ERAS protocol at our hospital and aimed to assess the possibility of its introduction into our clinical practice, as the results presented in our study bring new evidence supporting feasibility and safety of ERAS program in the colorectal surgery.

The most difficult challenges we have faced in this study is the collision with some deep-seated beliefs in the minds of patients who underwent abdominal surgery, especially for cancer, and it was extremely difficult to change such beliefs completely (e.g. early mobilization and keeping the patient out of bed shortly after surgery, early oral intake, and early discharge), but fortunately, we have succeeded to complete our mission to a larger extent.

Early postoperative mobilization is important in accelerated recovery. It reduces insulin resistance and the risk of thromboembolic complications, undesired muscle loss, and fatigue and improves pulmonary function and tissue oxygenation [9]. In the present study, early mobilization started for all patients on the same day of surgery. In group A, on the surgery day, all patients got out of bed 4–8 h after surgery and started walking with assistance on an average of 2 h/day, and from the first postoperative day, they had to walk for 4–6 h/day independently; this rate is slightly lower than that recorded by some authors who recommended earlier mobilization within 2 h or less after surgery

Figure 2



Patient satisfaction of surgical procedure.

and for longer periods (4 h on the day of surgery and 6–8 h/day thereafter) [25]. In group B, mobilization was started 8–10 h after surgery for 30–60 min on the day of surgery with assistance, and from the second day, we ensured that the patient walked for at least 2 h daily with or without assistance.

In ERAS group, first oral intake was started 2 h after complete restoration of the conscious level and full orientation, which was usually achieved 2–4 h after surgery with about 1000 ml clear fluids (apple juice) divided into 50 ml/30 min on the day of surgery. Some studies recorded that patients resumed a liquid diet 2 h after surgery and began to take protein supplement orally 4 h later [21]. On the first postoperative day, we gave patients semisolids and small amounts of animal protein (50 mg) as small meal every 4 h with average fluid intake 1000–1500 ml per day, and from the second postoperative day, high-protein diets as three regular meals with three snacks in-between were given. Some authors recommended to give patients only water on the first day, liquid diet on the second day, half liquid diet on the third day, and solid diet on the fourth day, whereas some authors recommend free diet from the first postoperative day [15].

In the traditional care group (group B), first oral intake started on the third and the fourth postoperative day for colectomy and low anterior resection patients, respectively. We asked patient to start with sips of water every 30 min, and if no vomiting occurred, we gave him/her only clear fluids on that day. Next day, we started semisolids and small light diets according to patient compliance, and after that, regular food rich in proteins was allowed. The first bowel movement occurred after a mean±SD of 23.1±4.3 in group A, which is significantly shorter than group B, which was 41.9±6.8.

Because fluid restriction is thought to enhance mobilization and recovery and reduce the complication rates [15], patients in our study group A received less intravenous fluid (total fluid intake both oral and intravenous should be around 1500 ml/day), whereas in group B, patients received around 2500 ml intravenous/day (guarded by urine output and any weight gain) until adequate oral intake was ensured.

In group A, the mean total postoperative hospital stay was 3.58±0.24 days with readmission and was 3.47 ±0.23 days without readmission. Overall, 25 (56.8%) patients were discharged on the third postoperative day, 16 (36.4%) patients on the fourth day, two (4.5%) patients on the 5 day to control PONV, and one (2.3%) patient was discharged 1 week after surgery owing to reoperation to repair partial abdominal wall dehiscence. The mean postoperative hospital stay varied greatly in many studies, from 2.44 days to 6.9 days [3,6,9,15,16]. In group B, the mean total postoperative hospital stay was 8.84±1.87 days, which is significantly longer than that in group A.

In ERAS group, the 30-day readmission rate was 2.3%, which agreed with that in many of studies, which ranges from 2.7 to 8.7% [16,30], and significantly lower than that reported in the study by Mohn *et al*. [31], which was 15%. Thus, some consider that fast-track surgery will not reduce the readmission rate and consider readmission as an adverse effect, which reflects low medical quality [15]; however, others believe that it is due to a low threshold for readmission after accelerated discharge, which is a sign of quality and secures the safety of patients [21]. None of group B patients required readmission. Regarding ERAS, the overall postoperative morbidity rate in the literature showed a wide range from 12.5% up to 31% [15,21,30]. We recorded in our ERAS group 22.7% (10 patients) as the overall complication rate. The most common complication we have encountered was postoperative nausea and vomiting in five (11.4%) patients, which resulted in a delayed discharge of two (4.5%) patients for 24 h beyond the planned time. This rate is consistent with those found in many of the studies, which range from 4.3 to 13.8% [6,7,30]. However, there is currently no consensus regarding the exact regimen to prevent such complications; however, we believed that use of a multimodal approach with prokinetic and antiemetic drugs (ondansetron 8 mg/12 h and metoclopramide 10 mg/12 h), use of ß-blockers (atenolol 50 mg/day), excellent pain control, and opioid avoidance are the cornerstone to control postoperative nausea and vomiting. ß-blockers are very effective to control transient acute autonomic responses to noxious surgical stimuli [26]. We had two (4.5%) patients with wound infection: and one (2.7%) had anastomotic leak with peritonitis and one (2.7%) more had abdominal wound dehiscence, and all are in agreement with that in the literature [30].

In group B, the overall complication rate was 22.6%, which is comparable to that in group A (22.7%), with *P* value more than 0.05, and no mortality was encountered in any of the two groups. Moreover, the incidence of postoperative nausea and vomiting in both groups was similar (11.4% in group A and 11.3% in group B), and all cases were treated successfully in both groups, with restoration of oral intake after 24–48 h.

For our ERAS patients, we did not carry out the traditional intestinal preparation because it is clear now that the mechanical bowel preparation for colorectal surgeries has been lately much debated, as it was noticed that the use of polyethylene glycol or sodium phosphate may negatively affect the early postoperative healing and recovery [16].

Recently, many studies do not recommend preoperative absolute fasting to avoid postoperative nitrogen and protein losses [7,21]; moreover, by providing a clear carbohydrate-rich drink 2 h before surgery, the patients can undergo surgery in a metabolically fed state, with reduction of the prevalence of preoperative thirst, hunger, anxiety, and the endocrine catabolic response and improve insulin resistance, improving surgical results and hastening recovery [9]. So, we gave our ERAS patients carbohydrate-rich drinks (sweetened apple juice) 1 day before surgery and on the morning of surgery.

Effective analgesia is a prerequisite to decrease surgical stress response and to enhance mobilization. Continuous epidural analgesia has been considered beneficial in major open abdominal procedures not only to control pain but also to decrease catabolism, paralytic ileus, nausea, and vomiting [14,22].

Epidural analgesia therefore was used in all group A patients, in addition to paracetamol 1000 mg/8 h for 21 (47.7%) patients on the day of surgery; on the first postoperative day, paracetamol 1000 mg/8 h and NSAID (diclofenac 100 mg/12 h) were required for 23 (52.3%) patients; on the second postoperative day, paracetamol 500 mg/8 h and diclofenac 75 mg/12 h for 14 (31.8%) patients; and on the third postoperative day, paracetamol 500/8 h or diclofenac 75 mg/8 h for eight (18.1%) patients. On discharge, we gave all patients diclofenac 75 mg/12 h alternating with paracetamol 1000 mg/12 h (e.g. diclofenac at 8 a.m. and 8 p.m., whereas paracetamol at 2 p.m. and 2 a.m.) for 1 week. Still we believe that further studies are needed to define optimal procedure-specific analgesia in enhanced recovery after colorectal surgery.

In group B, we did not use epidural analgesia, because patients refused insertion of epidural catheter or asked to remove it immediately after completion of surgical procedure. The overall pain control was much better in group A than group B, as shown in Table 4. On the same day of surgery, most patients recorded NPRS score of 3 in 79.5% of patients and 5–6 in 75.5% of patients in groups A and B, respectively; on the first postoperative day, most of the patients recorded score 3 in 72.7% of patients and 5–6 in 77.4% of patients of groups A and B, respectively; on the second postoperative day, 54.5% of patients in group A recorded score 2 compared with 84.9% of patients in group B recorded score 4–6; on the third postoperative day, 77.3% of patients in group A recorded score 2 compared to 75.5% of patients in group B recorded score 4–6; and on discharge, 86.4% of group A patients recorded score 2 compared with 64.1% of patients in group B recorded score 4–5. Finally, on the first follow-up visit, in group A, the recorded NPRS score was 1 in 52.3% and 2 in 47.7% of patients, whereas in group B, it was 1 in 11.3%, 2 in 32.1%, 3 in 52.8%, and 4 in 3.8% of patients.

Overall, 93.1% of patients in group A were satisfied, which was little higher than that in group B (86.8%); the main reason of unsatisfaction in group A was postoperative nausea and vomiting, whereas in group B was annoying pain, in spite of regular parenteral analgesics.

Conclusion

There is very strong evidence that ERAS program benefits colorectal patients' recovery, clinicians, and health care systems when compared with traditional perioperative care. A well-designed ERAS program reduces the physiological response to the tissue insult from surgery, and as a result, there is less postoperative pain, fewer complications, a shorter hospital stay, faster recovery and return to work, and more patient satisfaction. The practice of ERAS should be encouraged in both laparoscopic and open surgery. So, we strongly recommend the application of such protocols, provided that in a well-equipped hospital and with very good trained and adequately experienced personnel.

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Conflicts of interest

There are no conflicts of interest.

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