Comparative study between enhanced recovery after surgery and conventional perioperative care in elective colorectal surgery

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Objective
This joint research between the Departments of General Surgery and Anesthesiology aimed to examine the feasibility and safety of enhanced recovery after surgery (ERAS) in elective colorectal surgery.
Patients and methods
The study included 80 patients who were candidates for abdominal colorectal surgery, and were randomly divided into two groups: group C contained 40 patients managed perioperatively through conventional management procedures and group E contained 40 patients managed according to ERAS protocols. Patients in both groups were monitored throughout the perioperative period. Collected data included compliance data, operative data, postoperative complications, bowel recovery as well as the length of ICU and hospital stay.
Results
The overall compliance rates with the ERAS protocols was 80%. No significant difference was found between the two groups concerning operative time. Pain scores were significantly low ($P<0.001$) between patients of the ERAS group compared with the other group. First flatus occurred at the first postoperative day in both groups with a significant difference in a number of cases ($P<0001$) among both groups. Median postoperative length of stay was significantly different ($P<0.001$) between the two groups.
Conclusion
ERAS pathway is feasible for application in colorectal surgery, as it shortened the postoperative hospital stay and showed no risk to patients in terms of morbidity or mortality.

Keywords:
colorectal surgery, enhanced recovery after surgery pathway, perioperative

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Introduction

Significant improvements in outcomes subsequent to abdominal major operations can be accomplished by implementing a consistent protocol on evidence-based medicine in all perioperative steps [1]. This method has merged into enhanced recovery after surgery (ERAS) pathway or 'fast-track surgery', which have progressed into a wider model named the perioperative surgical home [2]. Over the last decade, ERAS programs have produced a real revolution in the management of colorectal surgery, vascular surgery, and thoracic surgery patients. Initially introduced by Henrik Kehlet from Denmark, in the early1990s [3], ERAS is a multidisciplinary set of a pathway that targets to diminish the stress response to surgery and improves postoperative outcome by controlling perioperative management process. The main aim of all perioperative programs is to decrease hospital stay and to speedily regain the complete well-being of the patient without increasing the rate of complications [4].

Concentrating on colorectal surgery, now a strong evidence indicating that, there is a well-documented association between ERAS and improved postoperative short-term outcomes, comprising decline in length of hospital stay, decrease in morbidity, quicker resume of bowel function, faster ambulation, and lower pain scores [5,6]. Despite all great benefits of ERAS, there are major limitations in employing such protocols; this may be attributed to the difficulties in patients' acceptance of all interventions within the program [7]. There is a wide acceptance to ERAS in western countries and the USA, whereas in the developing countries, ERAS programs are still facing considerable challenges for application [8]. There are restricted number of studies recording successful application of ERAS in Egypt. ERAS

protocol is a promising approach and we attempt to achieve it among patients submitted to abdominal colorectal surgery at our university hospital.

Patients and methods

The present prospective study was conducted at the General Surgery Department, Benha University Hospital, King Sauid Hospital, Onizah, Kingdom of Saudi Arabia, and Al-Adwani General Hospital, Taif, Kingdom of Saudi Arabia, from October 2013 to October 2016. After approval of the study protocol by the Local Ethical Committee and obtaining an written consent from patients or nearest relatives, the study included 80 patients presenting with a colorectal problem who were candidate for abdominal colorectal surgery. Before inclusion in the present study, each participant had a comprehensive discussion about the nature of the ERAS and details of the preoperative, intraoperative, and postoperative items of the care plan. When the patients were randomized, an extra consent was taken for the surgical procedure. The patients were assessed by a multidisciplinary team including participants from colorectal surgery, gastrointestinal surgery, anesthesiology, autritional services and the nursing staff.

The inclusion criteria included (a) patients presenting with a colorectal problem candidate for abdominal colorectal surgery for the malignant or benign disease; (b) age between 18 and 70 years; (c) the American Society of Anesthesiologists grade I, II, or III; (d) patients who are able to understand and follow the necessities of the program and to offer a consent; and (e) having some social criteria for early discharge, for example, a home sited within 1 h from the hospital.

And the exclusion criteria were (a) emergency colorectal surgery; (b) abdominal surgery requiring resection of more than one organ; (c) American Society of Anesthesiologists grade IV; (d) the need for inpatient postoperative rehabilitation; (e) age less than 18 or more than 70 years; and (f) low socioeconomic status.

Patients were randomly distributed into two equal groups according to the assigned management technique using sealed envelopes: group C included patients assigned for conventional recovery pathway and group E included patients assigned for ERAS protocols.

Preoperative preparation for the enhanced recovery after surgery pathway group

(1) All staff and nurses dealing with patients were educated about the ERAS care strategy.
(2) In the preoperative anesthesia visit, patients were informed broadly about our ERAS protocols and the objective of early postoperative discharge.
(3) The preoperative preparation procedure did not comprise mechanical bowel preparation. However, in patients undergoing left colonic and rectal resection, an evacuating fleet enema (120 ml) was carried out the night before and the morning of the surgery for the safety of colorectal anastomosis.
(4) Patients received 200 ml of carbohydrate-rich drinks four times a day earlier to the surgery and two doses on the morning of the operation.
(5) Patients kept fasting before the operation: 2 h for liquids and 6 h for solids.
(6) Prophylactic IV antibiotic (metronidazole 500 mg and ceftriaxone 1 g) was given 1 h before surgery and sustained for 24 h subsequently (two extra doses).
(7) Prophylactic therapy against thromboembolism: subcutaneous enoxaparin 40 mg given 12 h before insertion of epidural catheter and sustained as 40 mg once daily until discharge.
(8) The continuation of medicines the patient is already taking.
(9) Starting at midnight before the surgery, patients did not take any medications recognized to cause long-term sedation. Short-acting drugs only allowed to aid in insertion of epidural catheter.

Intraoperative adherence to enhanced recovery after surgery pathway

Standard anesthesia protocol

(1) Propofol (Diprivan, Fresenius Kabi, USA) was used for intravenous induction because of its short time of action with a minimal side effect. Highly volatile agents like sevoflurane or isoflurane were used for maintenance.
(2) After induction of anesthesia, a urinary catheter and an nasogastric tube (NGT) were inserted in all patients.
(3) Ketorolac IV (1 mg/kg) and dipyrone sodium (20 mg/kg) were given in a loading dose if not contraindicated to offer a multimodal analgesic regimen.
(4) A local anesthetic (lidocaine 2% without epinephrine) was given (unless contraindicated) in the epidural catheter, which was inserted preoperatively.
(5) Low-dose fentanyl (0.5–1 μg/kg) was given intraoperatively through the epidural catheter to offer suitable postoperative analgesia.
(6) Intraoperative maintenance of normothermia was done.
(7) Antiemetic prophylaxis: after induction of anesthesia, a single dose of intravenous dexamethasone 8 mg and ondansetron (Zofran, GlaxoSmithKline) 8 mg was given.

(8) Perioperative fluid administration: 500 ml of colloid was given regularly before epidural running of local anesthetics. Intraoperatively, intravenously lactated Ringer's was given 4 ml/kg/h. Lost blood was replaced 1 : 1 with colloids.
(9) Packed red blood cells was given depending on the target hematocrit, that was determined along with age and absence or presence of cardiomyopathy. Target hematocrit was 26 if neither of these was present (cardiomyopathy or patient's age >65), 28 if there was cardiomyopathy or patient's age more than 65, and 30 if there was cardiomyopathy and patient's age more than 65.

Standard surgical technique

(1) All patients underwent abdominal colorectal surgery. The laparoscopic approach was considered as the first-choice surgical technique, and if not possible, conventional laparotomy was carried out with smallest incision, and transverse incisions was preferred.
(2) To minimize postoperative pain, wounds were infiltrated with a local anesthetic agent before closure.
(3) No regular placement of intra-abdominal drainage.
(4) The NGT was removed inside the operating theater at the time of extubation.

Postoperative items for enhanced recovery after surgery pathway

(1) Immediate postoperative monitoring was completed in the postanesthesia care unit. Subsequent to full recovery, patients were shifted to ordinary ward.
(2) Postoperative analgesia: in postanesthesia care unit, patients received a continuous epidural low-dose local anesthetic (0.125% bupivacaine) as well as a low-dose opioid (2 mg/ml of the analgesic solution). Ketorolac 1 mg/kg was given means three times a day (TID) till patients were able to tolerate enteral feeding, and then oral analgesia was provided.
(3) Throughout the postoperative period, patient-controlled analgesia pumps were not used.
(4) Metoclopramide hydrochloride was received if nausea or vomiting really occurred.
(5) Early ambulation: patients were managed in a situation that encouraged independence and quick mobilization. Patients were strongly enforced to be out of bed on the day of the surgery, and then mobilized not less than 2 h throughout the first postoperative day.
(6) Immediate postoperative cessation of intravenous fluids; 6 h postoperatively, patients restarted a liquid diet. Twelve hours postoperative patients were allowed to eat the semisolid meal sitting at the table.
(7) On the first postoperative day, patients were reassessed and the care plan was discussed again. Urinary catheter was removed (except in patients who underwent low anterior rectal resection or abdominoperineal resection, in whom it was removed on the second postoperative day).
(8) On the second postoperative day, ordinary hospital meals were allowed. The epidural catheter was removed.
(9) On the third postoperative day, assessment of patient status and discharge was approved according to discharge criteria, which were as follows: patient should be alert and oriented, no fever, no tachycardia, tolerance of oral feeding, pain control with oral analgesia, mobilized independently, and suitable care at home. (Passage of flatus or stool was not considered at the time of discharge.)
(10) Postdischarge care: at the time of discharge, patients of the ERAS group were instructed how to contact the hospital when needed; moreover, they received a phone call by the anesthetist 1 day after discharge.

Perioperative management of group **C** patients was done according to conventional hospital management protocols.

Patients of both groups attended a follow-up outpatient visit on the seventh postoperative day and then 1 month later.

Statistical analysis

Obtained data were presented as mean±SD, ranges, numbers, and ratios. Results were analyzed using Wilcoxon's ranked test for unrelated data (*Z*-test), and the χ^2-test. Statistical analysis was conducted using the Statistical Package for the Social Sciences, version 15, 2006 for Windows statistical package (SPSS; SPSS Inc., Chicago, Illinois, USA). The *P* value less than 0.05 was considered statistically significant.

Results

The present study included 80 patients who were candidates for elective abdominal colorectal surgery. They were divided randomly into two groups according to the perioperative protocols offered to them. Group **C** (control group) included 40 (50%) patients assigned for conventional recovery pathway and group E included 40

(50%) patients assigned for ERAS pathway. There was a nonsignificant ($P>0.05$) difference between the two study groups regarding demographic and general clinical data, as shown in Table 1.

Patients of both groups passed the procedure efficiently without any intraoperative complications. All operative and postoperative data mentioned in details in Table 2. The mean operative time was 160±5.4 min in ERAS

Table 1 Patients' demographic data

Data	Group C	Group E	*P* value
N (%)	40 (50)	40 (50)	–
Age (years)	58.2±11.13 (41–69)	60.5±10.67 (39–65)	>0.05
Sex			
Males	27 (67.5)	24 (60)	0.464
Females	13 (32.5)	16 (40)	–
BMI (kg/m^2)	25.5 (14.9–36.7)	24.1 (15.8–38.3)	>0.05
Associated comorbidities			
Frequency			
No	15 (37.5)	20 (50)	–
One	14 (35)	13 (32.5)	–
Two	11 (27.5)	5 (12.5)	–
Three	0.0	2 (5)	–
Mean number	1.1±0.6 (1–2)	1.6±0.7 (1–3)	0.102
Types			
Diabetes mellitus	6 (15)	8 (20)	>0.05
Hypertension	5 (12.5)	6 (15)	–
Hepatic disease	2 (5)	3 (7.52)	–
Renal troubles	1 (2.5)	2 (5)	–
CVA	1 (2.5)	0.0	–
Total	15	19	–
ASA grades			
I	29 (72.5)	26 (65)	0.603
II	9 (22.5)	13 (32.5)	–
III	2 (5)	1 (2.5)	–
Indication for surgery			
Colorectal carcinoma	23	25	NS
Malignant polyp	6	8	–
Diverticular disease	9	7	–
Inflammatory bowel disease	2	0.0	–

Data are presented as numbers and mean±SD; percentages and ranges are present in parenthesis. ASA, American Society of Anesthesiologists; CVA, Cerebrovascular accident.

Table 2 Operative and postoperative data

Data	Strata	Group C	Group E	*P* value
Operative time (min)	–	155±9.6 (110–215)	160±5.4 (100–230)	NS
Intraoperative bleeding (ml)	–	150±8.5 (100–550)	175±8.8 (200–450)	NS
Operative procedure	Laparoscopic	13 (32.5)	15 (37.5)	NS
	Laparoscopic converted to open	5 (12.5)	6 (15)	–
	Open	22 (55)	19 (47.5)	–
Operation	Right/extended right hemicolectomy	6 (15)	8 (20)	NS
	Sigmoidectomy	9 (22.5)	7 (17.5)	–
	Hartmann reversal	8 (20)	6 (15)	–
	Subtotal colectomy	5 (12.5)	4 (10)	–
	Total colectomy and proctectomy	2 (5)	0.0	–
	Anterior resection	7 (17.5)	10 (25)	–
	Abdominoperineal excision	3 (7.5)	5 (12.5)	–
PO complication	Total events	5	4	NS
PO ICU admission (days)	1	3 (7.5)	1 (2.5)	NS
	2	1 (2.5)	1 (2.5)	–
Total (days)		21±6.58 (0–36)	13±4.39 (0–20)	

Data are presented as numbers and mean±SD; percentages and ranges are present in parenthesis. PO, postoperative.

group and 155±9.6 min in control group, this did not reach statistical significance ($P<0.05$).

Guidelines of the ERAS pathway were followed closely in our study with an overall compliance (adherence) rate 80%. The details of perioperative adherence to protocols are showed in Table 3.

Postoperative outcomes among patients who were managed through the ERAS pathway showed a significant difference ($P<0.001$) in the total and postoperative hospital stay in comparison with patients who were managed through conventional perioperative technique (Fig. 1). Postoperative patient self-stated pain scores revealed a significant ($P<0001$) lower median pain scores among patients managed through ERAS compared with controlled group (Fig. 2).

Patients in the ERAS group had a shorter time to first flatus (55 vs. 20% in the first postoperative day) and a shorter time to resumption of normal diet, ($P<0.001$) which is statistically significant. The incidence of postoperative complications was lower in the ERAS group (10 vs. 12.5%). As regard readmission and reoperation there was no any significant difference between both groups ($P<0.05$). There was no mortality during the follow-up period in both groups.

Details of postoperative outcomes of ERAS group versus controlled group mentioned clearly in Table 4 and Fig. 3.

Table 3 Adherence to the rules in the enhanced recovery after surgery group versus the control group

Parameters	Group C	Group E
Preoperative patient education and psychotherapy	90	100
Preoperative no bowel preparation	30	65
Day before surgery: oral drinks rich in carbohydrate	0.0	70
Preoperative practice nonopioid medications	10	90
Preoperative medication for DVT prophylaxis	40	90
Preoperative prophylactic antibiotic	75	95
Intraoperative practice of epidural analgesia	25	60
Intraoperative practice of adjunctive medications		
Ketamine	30	40
Dexamethasone	30	55
Avoidance of NGT or intra-abdominal drains	15	80
Smallest length of abdominal incision	25	75
PO practice of epidural analgesia	25	70
PO practice nonopioid medications	60	90
PO early suspension of intravenous fluids	0.0	80
PO early oral intake	0.0	90
PO discontinue of intravenous fluids	0.0	85
PO need for NGT	90	15
PO catheter removal by second day	30	100
PO patient mobilization		
Mobilized on POD 0	15	80
Mobilized on POD 1	40	95
Mobilized on POD 2	50	100
Discharge before resume of normal bowel habit	0.0	60

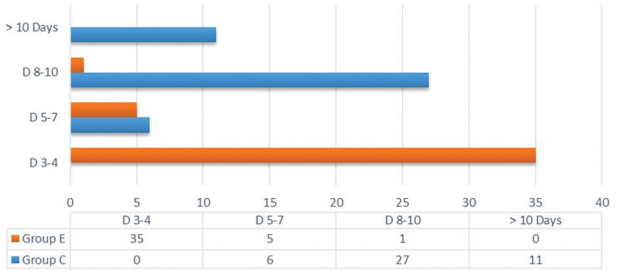
Data are presented as percentages. DVT, deep vein thrombosis; NGT, nasogastric tube; PO, postoperative; POD, postoperative day.

Discussion

ERAS pathway (fast-track surgery) was described over the last 20 years [9]. The intentions of procedure are faster patient ambulation, raped and proper discharge postoperatively and quick return to work [10]. This program deals with the patients before, during, and after surgery [11]. The concurrent use of such guidelines has a synergistic outcome which achieved the desired goals of the program [12]. Our ERAS management plan included patient counseling, avoidance of mechanical bowel preparation, no preanesthetic medications, suitable anesthesia and pain control, NGT removal with extubation and controlled the volumes of intravenous fluids to diminish effect of fluid overload. Furthermore, quick ambulation, early enteral feeding and rapid discharge.

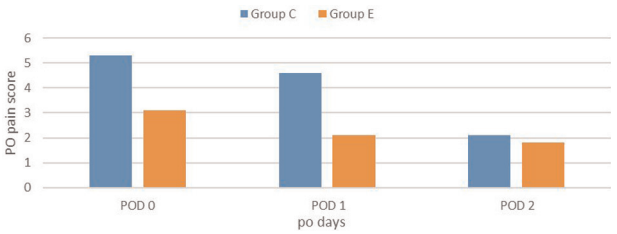
All steps in our ERAS program based on scientific evidence. Some deficits in compliance considered as

Figure 1



The frequency of postoperative stay in studied groups

Figure 2



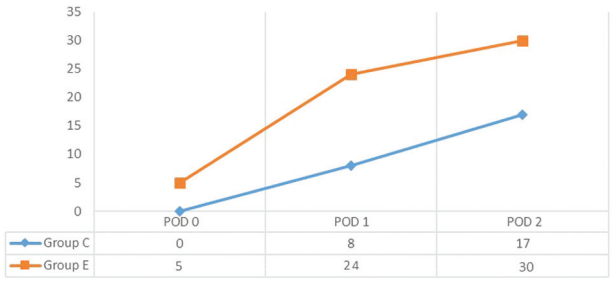
The frequency of postoperative patients' self-reported pain scores. PO, postoperative; POD, postoperative day

Table 4 Postoperative outcomes of enhanced recovery after surgery group versus controlled group

Parameters	Strata	Group C	Group E	*P* value
PO hospital stay (days)	3–4	0.0	35 (87.5)	–
	5–7	6 (15)	5 (12.5)	–
	8–10	27 (67.5)	1 (2.5)	–
	>10	11 (27.5)	0.0	–
Total (days)		8.5±1.52 (5–17)	3.8±1.95 (3–8)	<0.001
PO nausea and vomiting	–	13 (32.5)	4 (10)	<0001
pain scores: from 0 (no pain) to 10 (most horrible pain)	On POD 0	5.3 (3–8)	3.1 (2–6)	–
	On POD 1	4.6 (2–7)	2.1 (1–4)	<0001
	On POD 2	2.1 (1–4)	1.8 (0.0–3)	–
Passage of flatus/faces	On POD 0	0.0	0.0	–
	On POD 1	8 (20)	21 (55)	<0001
	On POD 2	17 (37.5)	30 (75)	–
Readmission (within 30 days PO)	–	2 (5)	3 (7.5)	NS
Reoperation (within 30 days PO)	Due to bleeding	1 (2.5)	1 (2.5)	NS
	Due to leakage	2 (5)	1 (2.5)	–
Mortality	–	0.0	0.0	–

Data are presented as mean±SD and numbers; ranges and percentages are in parenthesis. PO, postoperative; POD, postoperative day.

Figure 3



The frequency of timing of postoperative passage of flatus/faces in the studied groups. POD, postoperative day

acceptable. Anne *et al.* [13], mentioned that, when we want to fix such protocols, the objective is to achieve total compliance with all procedures outlined, but it is usually impossible target. In our study the overall rate of compliance is 80%, however, the rates are widely variable between different parameters and the reasons should be investigated. Zhao *et al.* [14] and Charles *et al.* [15], confirmed that, patient counseling as an important subject in the patients' response to surgery and declines patients' worry before surgery and leads to less analgesia required in the postoperative period as patients significantly suffering less pain than uninformed patients. This correlate with our findings as patients of ERAS pathway group significantly ($P<0.001$) experienced less pain than controlled group with a median postoperative pain score 3.1 versus 5.3, respectively.

Santiago *et al.* [16], found that, bowel preparation raises the risk for postoperative leakage with a subsequent increase in rates of postoperative infectious complications. Despite our adherence rates to avoidance of preoperative mechanical bowel preparation in ERAS group was 75% compared with 35% in controlled group, however the postoperative leakage occurs less among patients of ERAS 2.5% compared with 5% in controlled group. This results parallel to Timothy and Joanne [17], who reported that, mechanical preoperative bowel preparation had raised the rates of spillage in colorectal surgery patients when compared with those who did receive bowel preparation: 15 versus 9%, respectively.

Wisam and colleagues showed that most of European and US surgeons do not remove NGT after surgery; however, there is no proof supporting their opinion as this may be linked with patient discomfort as well as more complications [18,19]. We reinforced the opinion of elimination of the NGT at time of extubation with a compliance rate of 80%. This goes with Gustafsson *et al.* [20], who proved that, diminished use of NGT may decrease the incidence of postoperative chest morbidities.

Early removal of NGT, prompts early enteral feeding within 6 h postoperatively in ERAS pathway group with a compliance rate of 90% compared with delayed first oral feeding up to 72 h among patients of controlled group. Roulin *et al.* [8], reported that, early oral feeding keeps the absorptive function of the bowel that leads to more collagen at the anastomotic line, positive nitrogen balance, accelerate wound healing as well as lessen postoperative sepsis. This goes with Massimiliano *et al.* [21], who said that, postoperative enteral feeding is harmless even with colorectal anastomosis. We followed ERAS protocols in avoiding insertion of intra-abdominal drain in 80% of patients. This goes to high extent with Liang *et al.* [22], who reported that, drainage can be

avoided or restricted to a small period in utmost patients, helping quick mobilization. To avoid hazards of fluid overload, we significantly restricted intraoperative intravenous fluids administration to no more than 1 l of crystalloids, additional amounts were given as needed, along with patients' hemodynamic status. Our plane is supported by Robert *et al.* [23], who found that, fluid overload has been linked with cardiac and pulmonary morbidities, diminished oxygen concentration in muscles and postpone regaining of GIT function.

According to Mingjuan *et al.* [24], anesthesia and pain control have a significant impact on postoperative morbidities and patient global recovery. Our ERAS protocol involved the use of epidural anesthesia and nonopioid medications for pain control, with compliance rates of 60 and 90%, respectively. This is in contrast to Smith *et al.* [25], who omitted the use of epidural catheters as it elevates the risk for urinary retention, delayed ambulation, and eventual delay in postoperative hospital discharge. However, our plan was encouraged by Timothy *et al.* [17], who proved that nonopioid or opioid-reduced analgesia may accelerate recovery. Our ERAS included early postoperative ambulation with a compliance rate of 100% compared with 50% of the control group in the second postoperative day. Quick mobilization is a key for hastening the postoperative recovery period as it stimulates the return of normal gastrointestinal tract function and guards against thromboembolic complications. Gregg *et al.* [26] also mentioned that, early ambulation is directly linked to a reduction in hazard of chest complications, DVT as well as protection of motor power.

Discharge criteria within the ERAS group proved that, discharge of patients before the resume of bowel function (passage of flatus or stool) does not carry any significant postoperative hazards. Around 60% of our patients were discharged home before flatus or feces passage and yet there were no increased morbidities. This is in line with Ahmed *et al.* [27], who proved that patients do not suffer more morbidity when discharged home before the resume of normal bowel function. Recorded rates of postoperative complications, readmission, and reoperation among patients of the ERAS group were approximately similar to those reported for our control group as well as by other authors in similar randomized controlled trials. Finally, ERAS was associated with a significant decline in mean postoperative hospital stay, which was 3.8±1.95 days in comparison with 8.5±1.52 days for our control group. Cun *et al.* [28], mentioned that, in a newly published multicenter study from Spain, comprising data from 50 hospitals, the mean postoperative stay was 9.36±3.22 days subsequent to colorectal surgery in patients who were managed through conventional perioperative planes.

Conclusion

ERAS pathway was shown to be feasible for application in colorectal surgery as it shortened their postoperative hospital stay and showed no risk to patients in terms of morbidity or mortality. The question now is no longer to be whether the use of ERAS protocols in colorectal surgery or perioperative conventional care is better, but somewhat how to improve the procedure and facilitate its distribution.

Conflicts of interest

There are no conflicts of interest.

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