Original Article

Effects of Modified Enhanced Recovery after Surgery in Patients with Colon Cancer Following Laparoscopic Surgery at a Single Medical Center

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Key Words
ERAS;
Colon cancer;
Laparoscopic surgery

Purpose. The enhanced recovery after surgery (ERAS) colorectal guidelines have been implemented in standalone institutions worldwide. We implemented the modified ERAS guidelines in a single medical center and examined the effect on patients with colon cancer.
Methods. A retrospective review of patients with colon cancer who underwent laparoscopic surgery was conducted. Patients were excluded from our selection if they required postoperative care in an intensive care unit. Additionally, patients requiring emergency surgery for tumor obstruction or colon perforation were excluded. Patients with an Eastern Cooperative Oncology Group performance status score of ≥ 3 and those scheduled for surgery involving more than one visceral organ were excluded. Length of postoperative stay, days to resume a soft diet, days to drainage tube and Foley catheter removal, first passage of flatus, and time out of bed were examined. Postoperative complications were examined on the basis of Clavien-Dindo classifications. A readmission rate of 14 days was examined.
Results. We enrolled 325 patients who underwent laparoscopic colon surgery between January 2016 and April 2022. The non-ERAS and ERAS groups consisted of 165 and 160 patients, respectively. The 2 groups had similar mean age (66.23 vs. 67.52 years), body mass index (24.51 vs. 24.39), American Society of Anesthesiologists level (2.19 vs. 2.22), and albumin level (3.903 vs. 3.917). Operation time was 224.37 and 254.34 minutes in the non-ERAS and ERAS groups, respectively, and estimated patient blood loss was 77.45 and 65 mL, respectively. Length of hospital stay was shorter in the ERAS group (9.17 ± 5.8 days vs. 7.65 ± 3.81 days, $p = .006$). The ERAS group resumed a soft diet faster (4.65 ± 1.98 days vs. 3.36 ± 1.95 days, $p < .001$) and had earlier removal of the drainage tube (7.5 ± 5.18 days vs. 6.28 ± 3.3 days, $p = .012$) and Foley catheter (2.99 ± 1.884 days vs. 1.61 ± 1.538 days, $p < .001$). Further, 117 (70.9%) and 119 (72.1%) of the patients in the non-ERAS group and 130 (81.3%) and 131 (81.9%) in the ERAS group achieved the first passage of flatus and were out of bed within 24 hours, respectively. Grade II and above Clavien-Dindo complications were observed in 12.1% and 8.13% patients in the non-ERAS and ERAS groups, respectively. In the ERAS group, one patient required readmission; none did in the non-ERAS group.
Conclusion. The implementation of the ERAS protocol is beneficial for patients undergoing colon cancer surgery because it shortens the length of hospital stay and results in the rapid resumption of a soft diet faster and earlier removal of drainage and Foley tube without increasing complications.

[*J Soc Colon Rectal Surgeon* (*Taiwan*) *2024;35:17-27*]

Received: December 31, 2022. Accepted: July 10, 2023.
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Colon cancer is among the most common cancers and is a leading cause of death globally, including in Taiwan.[1] Surgical intervention, especially colectomy, is the standard treatment for the cancer. Multiple studies have indicated that laparoscopic colectomy is a safe and feasible surgical approach, with similar or better oncological outcomes when compared with original open surgery.[2-4] Minimally invasive surgery and multiple treatment plans have become a trend worldwide to promote quicker recovery from surgery. In 2012, Gustafsson et al. introduced the enhanced recovery after surgery (ERAS) protocol for colorectal surgery, and it has been updated multiple times, with the latest version being published in 2018. This protocol has been widely employed due to its safety and efficacy in promoting early recovery.[5,6] Numerous studies have reported the benefits of using the ERAS protocol in patients with colon and rectal cancer, with the benefits including reduced length of hospital stay, decreased postoperative complications, and no difference in readmission rates when compared with original care.[7-9] Our hospital first applied the ERAS protocol to selective patients in 2016 and has fully applied it to all patients scheduled for laparoscopic colectomy since January 2019.

We modified the protocol based on the 2018 updated version, which includes preadmission, preoperative, intraoperative, and postoperative components.[5,6] The preoperative component of the original protocol recommends no mechanical bowel preparation and allows the intake of clear fluids and solid food up to 2 hours and 6 hours before the induction of anesthesia, respectively. Administration of long- or short-acting sedatives before surgery is not recommended, and mechanical thromboprophylaxis is advised until discharge. The 2018 updated version includes prehabilitation for less fit patients and focuses on correcting anemic conditions through oral iron supplementation instead of intravenous iron and blood transfusion. Our modified protocol differs from the 2018 updated version in terms of bowel preparation. According to our modified protocol, 1 day before surgery, mechanical preparation is required of patients receiving a left hemicolectomy and anterior resection. Patients are allowed to have a clear liquid diet or low-residue soft diet up to 1 day prior to surgery but are asked to fast from midnight before surgery. We perform Triflow training as respiratory prehabilitation in all patients and mechanical thromboprophylaxis with compression stockings until postoperative out-of-bed activity. In our protocol, we correct preoperative anemia through direct blood transfusion instead of iron supplementation, which differs from the 2018 ERAS protocol. Our protocol is the same as the original protocol in terms of antibiotic prophylaxis before incision and prophylactic administration for postoperative nausea and vomiting agents. A single dose of 1000 mg cephalosporin is administered 15 to 30 minutes before the incision and repeated if surgery lasts longer than 4 hours (Table 1). Intraoperatively, the 2018 ERAS protocol involves the use of a standard anesthesia protocol with short-acting anesthetics, recommends cerebral monitoring to improve recovery and reduce delirium risk postoperatively, and emphasizes examining the level and complete reversal of neuromuscular block. Our modified protocol also includes the standard anesthesia protocol, which forgoes the use of spinal and epidural anesthesia. Both the original and our modified protocols utilize an upper-body forced air heating cover. The 2018 updated version does not recommend the routine use of a drainage tube at the resection site. However, per our modified protocol, we routinely use a drainage tube in most patients. Postoperatively, a gastric drainage tube is not used in both the original and modified protocols. The 2018 updated version recommends the use of multimodal analgesia, including epidural blockade, spinal analgesia, lidocaine infusion, and ultrasound-guided abdominal wall block. The use of analgesia, including spinal analgesia, is limited in our protocol. Anesthesia is administered by anesthesiologists in our center only if patients agree to receive it during preanesthesia consultation. Oral nonsteroidal anti-inflammatory drugs and intravenous opioids are used in our protocol. Both the original and our modified protocol involve the termination of urinary drainage within 24 hours after surgery. The original protocol identifies high-risk patients, such as male patients, those receiving epidural analgesia, and those undergoing pelvic surgery. Our protocol involves removing all Foley catheters on postoperative day 1,

Table 1. Comparison of the original ERAS protocol with our modified ERAS protocol

Original ERAS protocol	Modified ERAS protocol
Preoperative	Preoperative
Preadmission patient education and counseling.	Preadmission education and preanesthesia consultation.
No mechanical bowel preparation.	Mechanical or chemical bowel preparation 1 day before surgery for left hemicolectomy and anterior resection.
Clear fluids allowed up to 2 hours and solids up to 6 hours prior to the induction of anesthesia.	Clear liquid diet or a low residual soft diet 1 day before surgery. NPO from preoperative midnight (at the anesthesiologist's request).
Not routinely receiving long- or short-acting sedatives before surgery.	Not routinely receiving long- or short-acting sedatives before surgery.
Prehabilitation only in less fit patients.	Preoperative triflow training from admission.
Correcting anemia with IV iron preferred to oral iron; avoid blood transfusion.	Blood transfusion to correct the Hb level.
Antibiotic prophylaxis before incision.	Single-dose 1000 mg cephalosporin and 500 mg metronidazole administered 15 to 30 minutes before the incision and repeatedly if surgery lasts longer than 4 hours.
Mechanical thromboprophylaxis (well-fitting compression stockings and/or intermittent pneumatic compression) until discharge.	All patients use well-fitting compression stockings and intermittent pneumatic compression from operation until out of bed after operation.
Postoperative nausea and vomiting prophylaxis administered.	Not administered routinely.
Intraoperative	Intraoperative
Use of short-acting anesthetics, cerebral monitoring to improve recovery and reduce the risk of postoperative delirium, and monitoring of the level and complete reversal of neuromuscular block is recommended.	Standard anesthesia protocol; nospinal or epidural anesthesia.
Upper-body forced-air heating cover used.	Administered routinely.
Pelvic and peritoneal drains show no effect on clinical outcomes and should not be used routinely.	Routinely use pelvic and peritoneal drains.
No gastric drainage with a nasogastric tube.	No gastric drainage with a nasogastric tube.
Multimodal analgesia (epidural blockade, spinal analgesia, lidocaine infusion, and abdominal wall block).	PCA if the patient agrees, with epidural blockade, lidocaine infusion; or abdominal wall block being optional choices; provide oral nonsteroidal anti-inflammatory drugs and intravenous opioids.
Termination of urinary drainage within 24 hours after surgery in low-risk patients andafter 3 days in relatively high-risk patients.	Termination of urinary drainage within 24 hours after surgery in all patients.
Mechanical thromboprophylaxis until discharge.	Mechanical thromboprophylaxis until patient is out of bed.
Early mobilization.	Encourage early mobilization, generally on postoperative day 1.
Most patients can and should be offered food and ONS from the day of surgery.	Water intake is allowed 2 hours after operation and clear liquid diet on postoperative day 1 despite no passage of flatus.
Maintain balanced input and output; use hypotonic crystalloids instead of isotonic crystalloids; use balanced solutions for loss replacement instead of saline-base solutions.	Terminate intravenous fluid once patient can tolerate a clear liquid diet.
Audit of compliance/outcomes.	Postoperative audit of compliance/outcomes.

NPO, Nil Per Os; PCA, patient controlled analgesia.

provided that the patient's condition allows for it. The original protocol involves applying mechanical thromboprophylaxis until discharge. In our protocol, we apply mechanical thromboprophylaxis until out-of-bed activity. Early mobilization is recommended in both protocols, and we generally allow patients to

move out of bed on postoperative day 1. The original protocol allows food intake on the operation day, whereas we allow water intake 2 hours after surgery and clear liquid diet intake on postoperative day 1. The 2018 updated version recommends balancing input and output by using hypotonic crystalloids instead of isotonic crystalloids and replacing lost volume with a balanced solution other than saline base. We balance input and output and use postoperative intravenous fluids under the same principle, terminating their use when the patient can tolerate a clear liquid diet.

Because of multiple factors and complexity as well as cooperation required across different specialists and departments to implement the original ERAS protocol, we modified it to suit our hospital and patients. Further, considering that the protocol was modified by our own department and fully focused on colorectal surgery, we are confident in our patients' compliance with the protocol. Most patients are admitted approximately 2 to 3 days prior to surgery for preoperative survey and preparation. This enables us to introduce the ERAS protocol to patients and their families. Nursing staff and other medical team members are well-informed of the modified ERAS protocol, and we have established scheduled postoperative orders to indicate the timing of intervention. All these measures enable our medical team to educate patients and their families regarding the ERAS protocol, ensuring satisfactory compliance.

Despite differences between our and the original protocol, we believe that the implementation of the modified ERAS protocol is beneficial for patients with colon cancer undergoing laparoscopic colectomy. Therefore, in this study, we examined the benefits of the modified ERAS protocol in terms of recovery and safety.

Material and Method

In this retrospective study, we analyzed 325 laparoscopic colectomies performed from January 2016 to April 2022. Our medical center introduced the modified ERAS protocol in 2019, and patients have been treated using this protocol since January 2019. Patients were not treated with the ERAS protocol during January 2016 to December 2018. Our study focused on patients with colon cancer undergoing laparoscopic colectomy. The inclusion criterion was receiving laparoscopic colectomy for colon cancer treatment (Fig. 1). Exclusion criteria were undergoing open surgery and receiving emergency surgery without proper colon preparation in conditions such as tumor-induced obstruction and perforation. In addition, patients requiring postoperative intensive unit care and those with an Eastern Cooperative Oncology Group (ECOG) performance status score of ≥ 3 were excluded. Moreover, patients scheduled for surgery involving more than one visceral organ were excluded. Data on the following patient demographic and relevant clinical characteristics were collected: age, body mass index (BMI), American Society of Anesthesiologists (ASA) level, blood albumin (Alb) level for nutritional status, operation time, estimated blood loss, and postoperative outcomes.

We examined outcomes in terms of postoperative hospital stay, time to resumption of a soft diet, and time of drainage tube and Foley catheter removal. We evaluated compliance with the ERAS protocol by examining the first passage of flatus and time spent out of bed. However, because of difficulty in determining the exact timing of the aforementioned events, we examined compliance within 24 hours postoperatively, 24 to 48 hours postoperatively, and more than 48 hours postoperatively. Complications were categorized in accordance with Clavien-Dindo classification. We focused on class II and above complications because they prolong hospital stay and affect our results. Moreover, we recorded the 14-day readmission rate. Our discharge criteria included the removal of all possible drainage tubes, restoration of normal gastrointestinal function, tolerance to soft diet intake, and smooth defecation. We removed the drainage tube when the daily output was less than 100 mL and appeared reddish. The removal of the drainage tube was typically scheduled on the discharge day or a day prior.

Statistical analysis

We compared all relevant patient characteristics

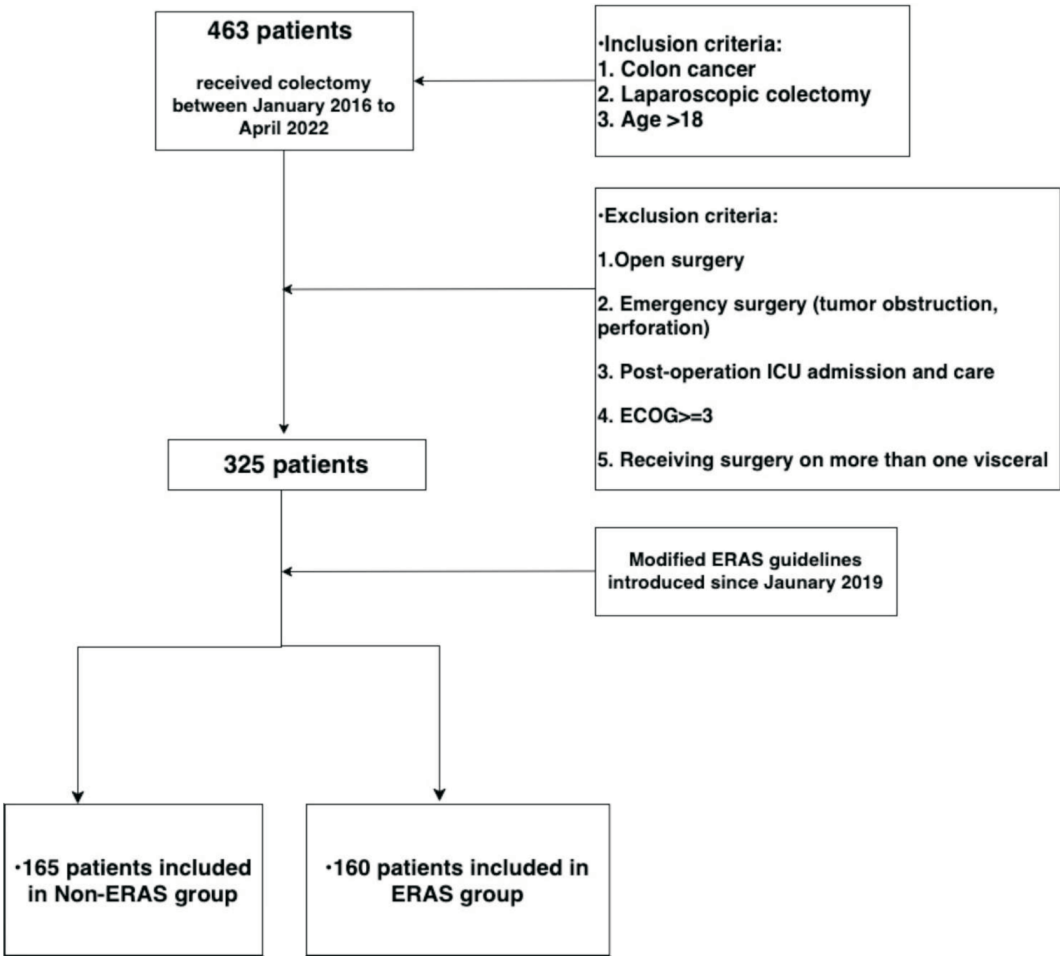

Fig. 1. Flow chart of patient selection with inclusion and exclusion criteria. ECOG, Eastern Cooperative Oncology Group.

and perioperative data between the non-ERAS and post-ERAS groups. The two groups were compared using the *t* test and chi-square test, as appropriate. All analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, released in 2019). The statistical significance level for all comparisons was set at $p < .05$.

Results

A total of 463 patients underwent colectomies in our medical center between January 2016 and April 2022; 325 were analyzed retrospectively, and 165 were treated with the non-ERAS protocol and 160 were treated with the ERAS protocol. Table 2 lists the patients' characteristics, namely sex, age, BMI, ASA classification, cancer stage, tumor location, operation method, operation time, and blood loss.

The mean age of the patients was 66.23 years in the non-ERAS group and 67.52 years in the ERAS group ($p = .326$). The BMI values, ASA levels, and blood albumin levels in the non-ERAS and ERAS groups were 24.51 and 24.39 ($p = .772$), 2.19 and 2.22 ($p = .54$), and 3.903 and 3.917 ($p = .761$), respectively. Significant differences were noted in terms of staging, with both the groups exhibiting a trend of Stage III predominance ($p = .027$). In the ERAS and non-ERAS groups, 9 (5.5%) and 21 (13.1%) patients had Stage 0, 40 (24.2%) and 38 (23.8%) patients had Stage I, 37 (22.4%) and 39 (24.4%) patients had Stage II, 57 (34.5%) and 48 (30%) patients had Stage III, and 22 (13.3%) and 14 (8.8%) patients had Stage IV, respectively. The majority of patients underwent right hemi-

Table 2. Demographic data

Group	Non-ERAS	ERAS	*p* value
Patient number	165	160	
Age (mean ± SD)	66.23 ± 12.511	67.52 ± 11.35	0.326
Sex			0.373
Male	86	92	
Female	79	68	
Body mass index (mean ± SD)	24.51 ± 3.267	24.39 ± 4.333	0.772
Blood albumin level (mean ± SD)	3.903 ± 0.447	3.917 ± 0.408	0.761
American Association of Anesthesiologist level (mean ± SD)	2.19 ± 0.424	2.22 ± 0.472	0.554
Staging			0.027
0	9 (5.5%)	21 (13.1%)	
I	40 (24.2%)	38 (23.8%)	
II	37 (22.4%)	39 (24.4%)	
III	57 (34.5%)	48 (30%)	
IV	22 (13.3%)	14 (8.8%)	
Operation method			0.782
Right hemicolectomy	59 (41.8%)	67 (41.9%)	
T-colectomy	2 (1.2%)	2 (1.3%)	
Left hemicolectomy	20 (12.1%)	12 (7.5%)	
Anterior resection	74 (44.8%)	79 (49.4%)	
Operation time (min) (mean ± SD)	224.37 ± 60.804	254.34 ± 78.553	< 0.001
Estimated blood loss (mL) (mean ± SD)	77.45 ± 130.228	65 ± 90.269	0.318

T, transverse.

colectomy and anterior resection. In the non-ERAS and ERAS groups, 59 (41.8%) and 67 (41.9%) patients underwent right hemicolectomy, 2 (1.2%) and 2 (1.3%) patients received transverse colectomy, 20 (12.1%) and 12 (7.5%) patients received left hemicolectomy, and 74 (44.8%) and 79 (49.4%) patients underwent anterior resection, respectively ($p = .782$).

The operation time significantly differed between the non-ERAS and ERAS groups (224.37 minutes vs. 254.34 minutes, $p < .001$). However, the estimated blood loss did not differ significantly between the non-ERAS and ERAS groups (77.45 mL vs. 65 mL, $p = .318$).

Between the non-ERAS and ERAS groups, we noted significant differences in the length of hospital stay (mean difference: 1.52 days; 9.17 ± 5.802 days vs. 7.65 ± 3.807 days; $p = .006$), time to resume a soft diet (4.65 ± 1.975 days vs. 3.36 ± 1.954 days, $p < .001$), and times when the drainage tube (7.5 ± 5.18 days vs. 6.28 ± 3.301 days, $p = .012$) and Foley catheter (2.99 ± 1.884 days vs. 1.61 ± 1.538 days, $p < .001$) were removed.

In the non-ERAS group, 117 (70.9%), 25 (15.1%), and 23 (13.9%) patients achieved the first passage of flatus within 24 hours of, within 24 to 48 hours of, and 48 hours after their operation, respectively. In the ERAS group, 130 (81.3%), 16 (10%), and 14 (8.75%) achieved the first passage of flatus within 24 hours of, within 24 to 48 hours of, and 48 hours after their operation, respectively ($p = .092$). Furthermore, in the non-ERAS group, 119 (72.1%), 23 (13.9%), and 23 (13.9%) patients could get out of bed within 24 hours of, within 24 to 48 hours of, and 48 hours after their operation, respectively. In the ERAS group, 131 (81.9%), 17 (10.6%), and 12 (7.5%) patients could get out of bed within 24 hours of, within 24 to 48 hours of, and 48 hours after their operation, respectively ($p = .088$).

In terms of postoperative complications (Tables 3 and 4), the total complication rates were 20.6% (34/165) and 26.3% (42/160) in the non-ERAS and ERAS groups, respectively ($p = .137$). Grade II and above Clavien-Dindo complications were noted in 12.1% and 8.13% of the patients in the non-ERAS and ERAS groups, respectively ($p = .137$). One patient in the ERAS group required readmission after 14 days due

to ileus. However, no patient required readmission in the non-ERAS group. Furthermore, 10 patients had grade III or above Clavien-Dindo complications, with 4 (2.42%) in the non-ERAS group and 6 (3.75%) in the ERAS group. Eleven cases of ileus were noted in both the non-ERAS group (11, 6.7%) and the ERAS group (11, 6.8%). Furthermore, 8 (72.3%) of the 11 patients in the non-ERAS group and 5 (45.4%) of the 11 patients in the ERAS group required nasogastric (NG) tube decompression. However, one patient in the ERAS group returned to the emergency department 9 days after discharge due to ileus. One case re-

Table 3. Postoperative outcomes

Group	Non-ERAS	ERAS	*p* value
Patient number	165	160	
Postoperative length of hospital stay (days) (mean ± SD)	9.17 ± 5.802	7.65 ± 3.807	0.006
Time to soft diet (days) (mean ± SD)	4.65 ± 1.975	3.36 ± 1.954	< 0.001
Drainage tube removal (days) (mean ± SD)	7.5 ± 5.18	6.28 ± 3.301	0.012
Foley catheter removal (days) (mean ± SD)	2.99 ± 1.884	1.61 ± 1.538	< 0.001
First passage of flatus (hours)			0.092
Within 24	117 (70.9%)	130 (81.3%)	
24 to 48	25 (15.1%)	16 (10%)	
After 48	23 (13.9%)	14 (8.75%)	
Time of out of bed (hours)			0.088
Within 24	119 (72.1%)	131 (81.9%)	
24 to 48	23 (13.9%)	17 (10.6%)	
After 48	23 (13.9%)	12 (7.5%)	
Postoperative complication rate (%)	34/165 (20.6%)	42/160 (26.3%)	0.137
Clavian-Dindo classifications Class 2 or above			0.137
II	20 (12.1%)	13 (8.125%)	
III	4 (2.4%)	5 (3.13%)	
IV	0 (0%)	1 (0.6%)	
14-day readmission rate (%)	0/165 (0%)	1/160 (0.6%)	0.309

Table 4. Postoperative complications

	Non-ERAS	ERAS	*p* value
Patient number	165	160	
Clavian-Dindo classifications Class 2 or above	20 (12.1%)	13 (8.125%)	0.137
Class 3	4 (2.4%)	5 (3.13%)	0.7
Class 4	0 (0%)	1 (0.6%)	0.309
Complications	Non-ERAS group incidence (%)	ERAS group incidence (%)	
Ileus	11 (6.7%)	11 (6.8%)	0.940
Anastomosis leakage	5 (3%)	5 (3.13%)	0.961
Chyle leakage	5 (3%)	8 (5%)	0.365
Intraabdominal infection	2 (1.2%)	2 (1.25%)	0.975
Wound infection	3 (1.8%)	4 (2.5%)	0.672
Catheter infection	1 (0.6%)	2 (1.25%)	0.544
Pneumonia	1 (0.6%)	3 (1.89%)	0.3
Urine retention	2 (1.2%)	1 (0.6%)	0.580
Urinary tract infection	2 (1.2%)	0 (0%)	0.162
Ureter injury	0 (0%)	4 (2.5%)	0.041
Wound disruption	1 (0.6%)	0 (0%)	0.324
Postoperative bleeding	1 (0.6%)	1 (0.6%)	0.983
Acute myocardial infarction	0 (0%)	1 (0.6%)	0.309

quired laparoscopic intervention on postoperative day 6 to resolve ileus. Of the 160 patients in the ERAS, none experienced urine retention or required a repeat Foley catheter. This incidence occurred in one (0.6%) patient in the non-ERAS group. Anastomosis leakage occurred in 5 (3%) patients in the non-ERAS group and 5 (3.13%) patients in the ERA group. Further, 2 patients in the non-ERAS group and 3 in the ERAS group eventually required stoma for fecal diversion. Chyle leakage occurred in 5 patients in the non-ERAS group and 8 patients in the ERAS group. All the patient resumed soft diet intake smoothly, and most of them had their drainage tube removed before discharge. Intraabdominal infection occurred in 2 (1.2%) patients in the non-ERAS group and 2 (1.25%) patients in the ERAS group. Pneumonia was noted in one (0.6%) patient in the non-ERAS group and 3 (1.89%) patients in the ERAS group. Urological complications, including ureter injury perioperatively, was observed in no patient in the non-ERAS group but 4 patients (2.5%) in the ERAS group. All cases were treated through consultation with a urologist, and the patients received ureter repair afterward. These cases required prolonged Foley catheter use compared with other patients. No patient in the ERAS group had urine retention or required repeat Foley catheter use. However, 2 (1.2%) patients in the non-ERAS group had urine retention and required repeat Foley catheter use. Similarly, no patient in the ERAS group but 2 (1.2%) patients in the non-ERAS groups developed urinary tract infections. Wound infection occurred in 3 (1.8%) patients in the non-ERAS group and 4 (2.5%) patients in the ERAS group. One case of wound infection combined with wound disruption in the non-ERAS group was managed through surgical intervention. Two wound infection cases required debridement in the operating room in the ERAS group. The other patient in the ERAS group was treated with wet dressing. One patient in the ERAS group experienced acute myocardial infarction on postoperative day 4 and required ICU care.

Discussion

Our results revealed that the implementation of our modified ERAS protocol in postoperative care resulted in a shorter postoperative length of stay and quicker resumption of soft diet intake and removal of the drainage tube and Foley catheter. Moreover, we noted no significant increase in the complication rate.

First, the length of hospital stay was shorter in the ERAS group than in the non-ERAS group. This finding can be mainly attributed to early tube removal, early mobilization, and early diet intake. Our discharge criteria include the restoration of normal gastrointestinal function with the removal of all drainage tubes. We believe that early intake of a soft diet is a key factor leading to a shorter hospital stay. A retrospective study conducted in Switzerland suggested that the delayed resumption of a normal diet led to more overall (Clavien grade I to V; 47% vs. 21%, $p < .001$) and major (Clavien grade IIIb to V; 11% vs. 4%, $p < .001$) complications and a longer length of hospital stay (9 ± 5 vs. 5 ± 4 days, $p < .001$).[10] In our study, despite the early intake of a soft diet, the rate of ileus was similar in both the ERAS and non-ERAS groups. Moreover, the percentage of patients requiring NG tube decompression to resolve ileus was higher in the non-ERAS group. Although one patient in the ERAS group required another surgery to resolve ileus, we believe our finding indicates that early diet intake is safe in patients with colon cancer undergoing laparoscopic surgery. Despite the small difference in the ileus rate in our study, it was generally lower in the ERAS group.[11] The same results were obtained for the early termination of urinary catheterization. Our results imply that the implementation of our ERAS protocol does not result in higher complications rates.

Chyle leakage was a major complication in our patients. This finding can be attributed to the fact that we perform complete mesocolic excision (CME) routinely in approximately half of our right hemicolectomy cases. Studies have suggested that CME that results in the harvesting of more lymph nodes plays a role in chyle leakage.[12,13] Since 2020, our department has been performing inferior mesenteric artery high dissection and low ligation with preservation of the left colic artery under the assistance of a 3D laparoscopy system in almost all patients receiving anterior resection. Studies have suggested that this approach

plays a role in chyle leakage.[13] Anterior resection with right hemicolectomy was performed in 85% of our cases. Although no patients required surgical intervention for chyle leakage, they had prolonged drainage tube use. In some patients, we delayed drainage tube removal after discharge until clinical follow-up. Operation time and estimated blood loss were higher in the ERAS group. Our department started performing CME in half of the patients undergoing right hemicolectomy since ERAS was adopted. A previous study reported that this approach leads to an increased operation time. We believe these approaches contributed to higher estimated blood loss and operation time. However, our department has obtained promising results in terms of short-term oncological outcomes and the number of harvested lymph nodes.

The ERAS protocol has been implemented in our department since January 2019. We examine compliance by reviewing all patients undergoing laparoscopy surgery every month. The medical quality management department holds meetings to review compliance (in terms of percentage) with the ERAS protocol routinely.

Most of the previous studies on the ERAS protocol have included patients with colon cancer and rectal cancer at the same time, which may cause a potential bias because the recovery period, complexity, and complications rates considerably differ between these 2 groups of patients. In particular, laparoscopic rectal resection is proven to result in a longer length of hospital stay.[14] Approximately 30 patients in both the groups were excluded because they received low anterior resection instead of intraoperative anterior resection. This was mainly due to the blurred margin of rectosigmoid junction lesions and upper rectal cancer. Our study focused on the colon cancer population, and we believe our results provide more specific insights into the benefits of the ERAS protocols for this population.

Our study has some limitations. First, our data were collected from a single medical center where surgeries are mainly performed by 3 to 4 surgeons. Thus, a surgeon-related factor may affect the results. Moreover, the lack of diversity raises potential questions regarding our findings. Second, the anesthesiologist in our medical center do not participant in ERAS actively, therefore the analgesia choice in the protocol are optional but not yet mainstream in our hospital. Thirdly, although the concept of ERAS is promoted across our hospital, we still cannot force all nursing staff to record the exact first passage of flatus time and the time spent out of bed. Therefore, we had to examine compliance by evaluating whether these milestones were achieved within 24 hours postoperatively, 24 to 48 hours postoperatively, or more than 48 hours postoperatively. Original and complete ERAS require cross-departmental cooperation and implementation to ensure full benefits. A prospective single-center observational study[15] focusing on ERAS outcomes in colon cancer designed their protocol with the assistance of anesthetists, nursing staff, and dieticians and included specific staff to monitor compliance with the protocol; they have reported promising results. Our protocol is relatively limited compared with their design. Despite this limitation, our outcomes differ from those reported in their study.

Conclusion

Our results indicate that the implementation of the modified ERAS protocol in colon cancer surgery reduced the length of hospital stay and led to earlier resumption of a soft diet and removal of drainage and Foley tube without increasing the complication rate. Therefore, the ERAS protocol should become standard care for patients with colon cancer undergoing laparoscopic colectomy.

Source of Financial Support

None.

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原　著

在單一醫學中心大腸癌病人接受微創手術後實施經修改的手術後早期恢復的效果

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目的　手術後早期恢復 (ERAS) 已經成為在全球醫療院所推行的治療方法。我們在單一所醫學中心接受腹腔鏡手術的大腸癌病人實行手術後早期恢復以評估效果。

方法　本研究對接受腹腔鏡大腸癌切除手術的病人進行回顧性研究。本研究排除術後需要加護病房照顧，大腸穿孔，腫瘤阻塞的急診手術病人，同時牽涉多於一個器官的手術以及 ECOG 大或等於 3 分的病人也與以排除。本研究以探討術後住院天數，第一次軟食進食，引流管及尿管移除天數評估 ERAS 成效。以第一次排氣，下床時間評估 ERAS 遵從性。併發症則以 Clavien-Dindo 分類法區別。14 日內再住院個案數也納入評估。

結果　從 2016 年 1 月至 2022 年 4 月之間，325 位病人接受了微創腹腔鏡大腸癌手術。其中 165 位病人屬 ERAS 實行前組別 (nE)，146 位屬 ERAS 實行後組別 (E)。2 組別的中位數在一眾項目中都有相似，如年齡 (nE = 66.23, E = 67.52)，BMI (nE = 24.51, E = 24.39)，ASA 等級 (nE = 2.19, E = 2.22)，白蛋白濃度 (nE = 3.903, E = 3.917)，手術時間與估計失血量 (nE = 224.37 分鐘，E = 254.34 分鐘) 與 (nE = 77.45 毫升，E = 65 毫升)。ERAS 組別的術後住院天數比無 ERAS 組別短 (E = 7.65 ± 3.81 天，nE = 9.17 ± 5.8 天) [p = 0.006]。ERAS 組別較無 ERAS 組別早進食軟食 (E = 3.36 ± 1.95 天，nE = 4.65 ± 1.98 天) [$p \leq 0.001$]，在引流管及尿管移除時間也較早 (E = 6.28 ± 3.3 天，nE = 7.5 ± 5.18 天) [p = 0.012] (E = 1.61 ± 1..538 天，nE = 2.99 ± 1.884 天) [$p \leq 0.001$]。無 ERAS 組別中 117 (70.9%) 與 119 (72.1%) 的病人達到術後 24 小時內排氣及下床。ERAS 組別中為 130 (81.3%) 與 131 (81.9%) 的病人。在 Clavien-Dindo 併發症分數中，2 級以上的併發症在無 ERAS 組別是 12.1%，ERAS 組別是 8.13%。ERAS 組別有 1 例 14 內再住院的病患，而無 ERAS 組別無個案。

結論　本研究證實，在接受微創手術的大腸癌病人中實行經修改的 ERAS 有縮短術後住院天數，更早期進食及引流管，尿管移除的好處。同時也不會引發更多併發症。

關鍵詞　ERAS、大腸癌、微創手術。