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Laparoscopic colorectal surgery and Enhanced Recovery After Surgery (ERAS) program

Experience with 200 cases from a single Italian center

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Abstract

There is increasing evidence that minimally invasive techniques associated with Enhanced Recovery After Surgery (ERAS) protocols reduce surgery-related stress and promote faster recovery after major colorectal surgery. As a single tertiary referral center for colorectal surgery, our aim was to analyze the effects of our ERAS protocol on a heterogeneous population undergoing laparoscopic colorectal surgery.

Prospectively collected data from 283 patients undergoing laparoscopic colorectal resection at the Division of General and Hepatobiliary Surgery, University of Verona Hospital Trust, between March 2014 and March 2018 were retrospectively analyzed. Patients' adherence to pre-, intra-, and postoperative ERAS protocol items together with surgical short-term outcomes such as morbidity, mortality, length of hospital stay, and readmission rate was considered.

The study protocol was approved by the Ethics Committee of Azienda Ospedaliera Universitaria Integrata di Verona (CRINF-1034 CESC).

During the study period, 200 patients met the inclusion criteria and were enrolled in the ERAS protocol. In this series, 34% of patients were aged 70 years or older. Rectal resections represented 26% of all cases, with stoma formation performed in 14.5% of patients. Despite such procedural heterogeneity, good short-term results were obtained: by postoperative day (POD) 2, 58.5% of patients had full return of bowel function, while 63.5% and 88% achieved regular soft diet intake and autonomous walking, respectively. Median (range) length of hospital stay was 5.5 days (2–40) with 71% of patients being discharged by POD 6. No postoperative mortality was recorded, and the rate of major complications was 3.5%. During the study period, 6 patients required redo surgery (3%) and 5 patients required rehospitalization within 30 days (2.5%).

This study analyzing the results of the fast-track program in our first 200 cases confirms the feasibility and safety of ERAS protocol application within a heterogeneous population undergoing laparoscopic colonic and rectal resection for benign and malignant diseases.

Abbreviations: ASA = American Society of Anesthesiologists, BMI = body mass index, COPD = chronic obstructive pulmonary disease, ERAS = Enhanced Recovery After Surgery, FAP = familial adenomatous polyposis, IBD = inflammatory bowel disease, LAR = low anterior resection, LOS = length of hospital stay, POD = postoperative day, POIS = PeriOperative Italian Society, PONV = postoperative nausea and vomiting, TME = total mesorectal excision, VAS = visual analog score.

Keywords: colorectal surgery, ERAS protocol, laparoscopic surgery, minimally invasive surgery, rectal cancer

1. Introduction

Laparoscopy and Enhanced Recovery After Surgery (ERAS) programs represent 2 major recent innovations in colorectal surgery. The ERAS protocol is a model of perioperative care for patients undergoing different types of major surgeries.[1] Such protocols consist of pre-, intra-, and postoperative interventions, with the aim of minimizing surgery-related stress and promoting faster restoration of homeostasis. Several perioperative measures have proven to reduce morbidity and hospital stay in patients undergoing colorectal surgery.[2] ERAS programs streamline such interventions as a perioperative pathway leading to lower complication rates and healthcare cost reduction.[3–6] Recent evidence also shows an association between ERAS item adherence and 5-year survival after colorectal surgery.[7]

In colorectal surgery, the application of minimally invasive techniques together with ERAS programs has also produced an improvement in short-term outcomes.[8–12]

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This retrospective observational study analyzed data from the first 200 patients undergoing the ERAS protocol at our center after elective colorectal laparoscopic surgery with the aim of assessing the compliance with the protocol's items and its impact on short-term postoperative outcomes.

2. Methods

2.1. Inclusion criteria and population under study

The ERAS protocol was introduced at the Division of General and Hepatobiliary Surgery, University of Verona Hospital Trust, in March 2014. From that date to March 2018, the ERAS protocol was completed by 200 patients undergoing elective laparoscopic colorectal resections for neoplastic or diverticular diseases aged 18 years or older without age limitations. The exclusion criteria were inflammatory bowel disease (IBD), familial adenomatous polyposis (FAP), palliative surgery, body mass index (BMI) above 35 kg/m^2, American Society of Anesthesiologists (ASA) physical status above 3, coagulopathy, impaired kidney function, uncontrolled diabetes, severe cardiovascular impairment or chronic obstructive pulmonary disease (COPD), psychiatric disorders, drug and alcohol addiction, surgery duration of more than 6 hours, and denied consent. The effective reasons of exclusion from the ERAS protocol are shown in Figure 1.

Informed consent was obtained from all the patients, and the study was approved by the local ethics committee (CRINF-1034 CESC).

2.2. Surgical technique

Surgical technique and anesthesia protocol have already been described in previous publications by our group.[13,14]

Colectomy for lesions located between the cecum and splenic flexure was performed using a 5-port technique, and the specimen was usually extracted through a periumbilical incision obtained by extending the camera port. Anterior resection and sigmoid and left hemicolectomy were performed using a 4-port technique, and the specimen was removed through a suprapubic incision. An additional 11-mm suprapubic trocar was used in low and ultralow anterior resection (LAR) to optimize surgical field exposure. Loop ileostomy was performed after total mesorectal excision (TME). In these cases, the specimen was removed through an incision in the right lower quadrant obtained by extending the 12-mm working port.

2.3. ERAS protocol and postoperative measurements

The protocol was devised in accordance with the recommendations of the ERAS Society[1] and has been previously described.[13,14] The objective of the ERAS program was to provide all the items to all patients as far as possible. ERAS items are shown in Table 1.

Patients were clinically reviewed at least twice a day by a trained member of the surgical team. The presence of nausea and vomiting, passage of flatus and stools, tolerance to liquid and solid diet, and visual analog score (VAS) score was recorded. Diet was considered tolerated when patient oral intake would be deemed sufficient to avoid starvation and independent of intravenous fluids.

Any deviation from the expected postoperative course, even asymptomatic, was considered a complication and recorded together with its management. All adverse events developing within hospitalization or 30 days after surgery were recorded as postoperative morbidity and mortality. Readmission rate was calculated as percentage of patients re-admitted to the hospital within 30 days from discharge, and complications were graded according to the Clavien–Dindo classification. Complications graded as 3 or more were considered as major complications.[15]

The discharge criteria included the following: absence of major complications, resumption of general diet, passage of stool and urine, adequately controlled pain (VAS < 4 with oral analgesics), independent mobilization, and C-reactive protein (CRP) concentration measured on postoperative day (POD) 3 lower than 120 mg/dL.[14] Since the aim of our ERAS protocol was not to pursue very early discharges, these were based on a combination of clinical evaluation and patients' views on how comfortable they felt with returning home.

2.4. Data collection and analysis

All demographic and clinical data were prospectively collected in a PC data set. Statistical analysis was performed using SPSS

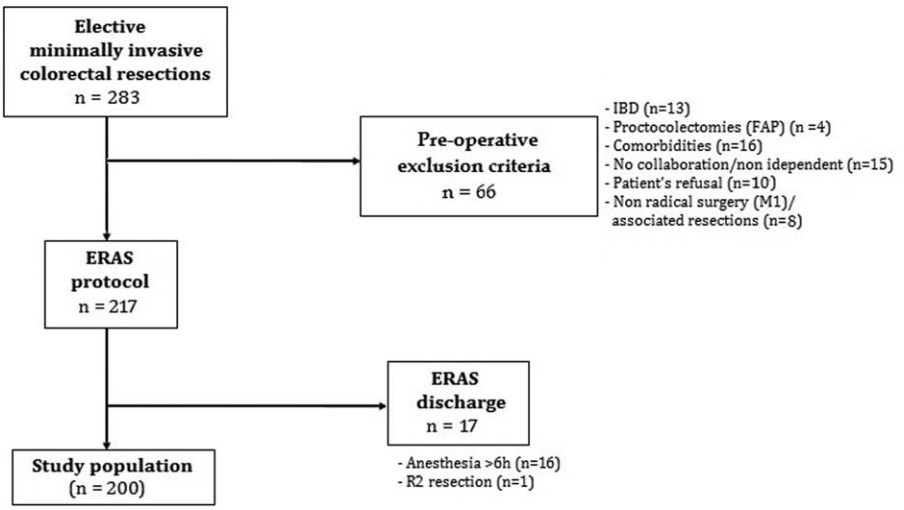

Figure 1. STROBE-compliant flowchart reporting exclusion process from the ERAS protocol for the 283 patients submitted to minimally invasive colorectal resection between March 2014 and March 2018. ERAS = Enhanced Recovery After Surgery.

Table 1

ERAS protocol at the Division of General and Hepatobiliary Surgery, University of Verona Hospital Trust.

Preoperative phase	
Preoperative counseling	Adequate and tailored information to the patient and caregivers to optimize adherence to the protocol
Bowel preparation	Limited to low anterior resection with diverting stoma
Antibiotic prophylaxis	Ampicillin + sulbactam 3 g 30′ before skin incision
Thromboprophylaxis	Graduated compression stockings Enoxaparin 4000 UI starting from the night before surgery
Premedication	No premedication
Intraoperative phase	
Minimally invasive surgery	Laparoscopic surgery with intracorporeal or extracorporeal anastomosis with the smallest incision
Locoregional analgesia	Bilateral TAP block (ropivacaine 20 ml 0.35%)
Normothermia	Intraoperative warmed blanket
Intraoperative fluid management	Intravenous hydration based on hemodynamic criteria
PONV prophylaxis	Dedicated anesthesiologic protocol
Postoperative phase	
No nasogastric tube	Nasogastric tube removed before extubation
Optimal pain control	According to Acute Pain Service (APS) indications
Nonopioid analgesia	Contraction of iv and oral opioid drugs for pain control
Prokinetics and antiemetics	Bisacodil 12 mg x 2 and ondansetron 4 mg x 2 (POD 0–3)
Pulmonary physical therapy	Bedside pulmonary physiotherapy on POD 1–3.
Early mobilization	1 h out of bed 6 hours after surgery and 6 h the days after. Walking encouraged from POD 1
Early oral fluids and nutrition	Oral fluid intake the day of surgery (Alitraq x 2 in 250 ml of water) and oral feeding on POD 1 (soft diet)
Intravenous fluid restriction	Intravenous fluids stopped as soon as possible
Urinary catheter removal	Low rectal resections: POD 2 females and POD3–4 males. Colonic and other rectal resections: POD1 females and males

APR = abdominoperineal resection, POD = postoperative day, PONV = postoperative nausea and vomiting, TAP block = ultrasound guided transversus abdominis plane block.

software version 21.0. Continuous data were reported as means (standard deviation) or medians (range), while descriptive variables were reported as frequencies. Adherence to the ERAS protocol and clinical outcomes were analyzed as a binary outcome (yes/no), and they were expressed as frequencies.

3. Results

Patients' demographics and clinical characteristics are presented in Table 2. The most frequent indication to surgery was the presence of a colonic neoplasia (55.5%), although rectal cancer was observed in 19.5% of the patients. Median age was 65.4 (18–92) years with 34% aged ≥70 years (n = 68), 25.5% aged ≥75 years (n = 51), and 15% aged ≥80 years (n = 30). Median BMI was 24.6 (16.9–36.3) kg/m^2, and 26.5% of patients (n = 53) were overweight with a BMI ≥28 kg/m^2. The percentage of patients classified as ASA 3 was 18%, while 38.5% were affected by 2 or more comorbidities. Most frequent comorbidities were cardiovascular diseases (15.5%), diabetes (9.5%), and pulmonary diseases (6.1%).

Surgical procedure data are presented in Table 3. The most frequently performed surgical procedures were right hemicolectomy (30.5%) and sigmoid resection/left hemicolectomy (33.5%), followed by rectal resection (26%). Twenty-nine patients (14.5%) required stoma formation, this being either a terminal colostomy (3.5%) after abdominoperineal resection or a diverting ileostomy (11%) following TME with low colorectal (n = 16) or coloanal anastomosis (n = 6). No diverting ileostomy was performed after anterior resection or other colonic resections.

Postoperative outcomes are shown in Table 4. No mortality was observed during the study period. Median length of hospital stay (LOS) was 5.5 days (2–40) with no significant difference between colonic (5.5, 2–20 days) and rectal resections (6, 4–40 days) ($P = 0.073$). Among the 200 patients, 71% were discharged by POD 6 (n = 142), 50% by POD 5 (n = 100), and 27.5% by POD 4 (n = 55). Re-admission within 30 days after discharge was required for 5 patients (2.5%).

Overall complication rate was 29.5%. Most complications were classified as Clavien–Dindo grades 1 and 2 (26%), while major complications developed in 3.5% of the patients. Redo

Table 2

Demographic and clinical characteristics for the 200 patients under study.

	No. of cases (median)	Percentage (range)
Median age, years	65.4	18–92
Gender		
Male	104	52%
Female	96	48%
Indication to surgery		
Colon tumor	111	55.5%
Adenocarcinoma	99	49.5%
Adenoma low-moderate dysplasia	6	3%
Other (lymphoma, NET)	6	3%
Rectal adenocarcinoma	39	19.5%
Diverticular disease	50	25%
Tumor location		
Right colon and flexure	61	40.7%
Transverse colon and left flexure	11	7.3%
Left colon	39	26%
Rectum	39	26%
Median BMI (range)	24.6	16.9–36.3
ASA class		
ASA 1	24	12%
ASA 2	140	70%
ASA 3	36	18%
Presence of comorbidities		
None	56	28%
One	67	33.5%
Two or more	77	38.5%
Previous abdominal surgery		
None	94	47%
One	80	40%
Two or more	26	13%

Table 3

Data of surgical procedure for the 200 patients under study.

	No. of cases (median)	Percentage (range)
Extent of resection		
Right hemicolectomy	61	30.5%
Left colectomy	10	5%
Left hemicolectomy/sigmoid resection	67	33.5%
Anterior/Low anterior resection	46	23%
Abdominoperineal resection	6	3%
Hartmann reversal	5	2.5%
Segmental resection	5	2.5%
Associated surgical procedure*		
No	147	73.5%
Yes	53	26.5%
Stoma formation		
No	171	85.5%
Yes	29	14.5%
Diverting ileostomy	22	11%
Terminal colostomy	7	3.5%
Median time of anesthesia, min	277	150–360
Median time of surgery, min	229	125–345
Median length of incision, cm	5	3–25
Median blood loss, ml	40	10–400
Conversion to open surgery		
No	193	96.5%
Yes	7	3.5%

Left colectomy was reserved for left flexure tumors and it was defined as the resection of mid-distal transverse colon and descending colon.

* Lymphadenectomy along superior mesenteric vessels in CME right hemicolectomy was considered as associated procedure (n = 40).

Table 4

Postoperative outcome data for the 200 patients under study.

	No. of cases (median)	Percentage (range)
Post-operative complications*		
None	141	70.5%
Minor complications	52	26%
Grade 1	30	15%
Grade 2	22	11%
Major complications	7	3.5%
Grade 3a	1	.5%
Grade 3b	6	3%
Red blood cells transfusion		
No	188	94%
Yes	10	6%
Postoperative ileus		
No	185	92.5%
Yes	15	7.5%
Median hospital stay, days	5.5	2–40
Redo surgery		
No	194	97%
Yes	6	3%
Re-admission		
No	195	97.5%
Yes	5	2.5%

* According to the Clavien–Dindo classification[15].

surgery was required in 3% of the patients. The causes were anastomotic leak and mechanical bowel obstruction with 3 cases each. Primary postoperative ileus was observed in 7.5% of the patients (n = 15). Red blood cell transfusion was required in 10 patients (6%).

Adherence to ERAS items and postoperative outcomes is shown in Table 5.

All patients received multidisciplinary counseling, antibiotics, antithrombotic prophylaxis, and intraoperative active warming. A nasogastric tube was placed upon induction of general anesthesia and generally removed at the end of the procedure (88.5%) or on POD 1 for procedures completed late in the evening (10.5%). Nasogastric tube re-insertion rate was 6.5%.

Most patients (96.5%) adhered to respiratory physiokinetic therapy in the perioperative period; 90% mobilized from bed to chair on POD 1 for at least 4 hours, and 88% walked independently by POD 2. Opioid drugs were prescribed quite frequently in the early postoperative phase (42%), and good pain control (VAS<4) was achieved in the majority of patients (86.5%) by POD 3. Routine prokinetics and antiemetic drugs were administered in 94.5%. Nevertheless, postoperative nausea and vomiting (PONV) rate during the first 3 PODs was recorded at 36.5%. As a result, intravenous fluid therapy was discontinued only in 29% of patients on POD 1 and 52.5% of patients on POD 2. Around 129 patients (64.5%) passed flatus on POD 1, while stool passage was recorded in 58.5% and 79% of patients on PODs 2 and 3, respectively.

Full oral fluid intake on POD 0 was rarely achieved (22.5%). However, this goal was more consistently achieved by POD 1 (85%). Soft diet was tolerated by PODs 1 and 2 in 35.5% and 63.5% of the patients, respectively.

4. Discussion

This study reports the initial results of our experience with an enhanced recovery pathway in a cohort of 200 patients without age limitations undergoing elective colonic and rectal surgery.

Table 5

Adherence to ERAS protocol items for the 200 patients under study.

	Median, days (Range)	POD0 (%)	POD 1 (%)	POD 2 (%)	POD 3 (%)
Bowel open to gas	1 (0–6)	24 (12)	129 (64.5)	183 (91.5)	195 (97.5)
Bowel open to stool	2 (0–9)	3 (1.5)	49 (24.5)	117 (58.5)	158 (79)
Sitting on chair	1 (0–7)	21 (10.5)	180 (90)	196 (98)	198 (99)
Walking	2 (0–8)	NA	89 (44.5)	176 (88)	193 (96.5)
Tolerated fluid intake	1 (0–7)	45 (22.5)	170 (85)	189 (94.5)	192 (96)
Tolerated soft diet	2 (1–13)	NA	71 (35.5)	127 (63.5)	171 (85.5)
UC removal	2 (1–10)	NA	95 (47.5)	145 (72.5)	171 (85.5)
Nasogastric tube removal	0 (0–2)	177 (88.5)	198 (99)	200 (100)	200 (100)
IV fluid discontinuation	2 (1–17)	NA	58 (29)	105 (52.5)	141 (70.5)
Drain removal	5 (2–25)	NA	–	–	9 (6.1)

NA = not applicable, POD = postoperative day, UC = urinary catheter, IV = intravenous.

In the last decades, ERAS pathways have been associated with a significant reduction in both morbidity and LOS following open and laparoscopic colorectal surgery.[8–10,16] ERAS interventions aim to reduce surgical stress which alters patients' homeostasis, causing prolonged recovery and postoperative complications. The faster restoration of patients' homeostasis derives from the synergistic effect of ERAS intervention and minimally invasive approaches. Such a combination has been shown to promote better outcomes and shorter hospital stay with no increase in morbidity, mortality, and 30-day readmission rates.[17,18]

ERAS protocols were initially considered adequate for younger and fit patients. However, a growing amount of evidences show that benefits of ERAS extend to less selected populations. There is also consensus that age selection or tailored ERAS protocols in elderly people are unnecessary.[9,18,19] We did not consider more advanced ages in the exclusion criteria and have involved 68 patients older than 70 years of age (34%) and 30 patients older than 80 years (15%). The advanced age of our patient population was related to high comorbidity rates with 13% of the total population presenting 2 or more comorbidities and 18% being classified as ASA 3. Among the 283 patients who underwent minimally invasive colorectal surgery within the study period, we excluded patients with severe or uncontrolled comorbidities (5.5%) and those who were unable to reliably comply with the ERAS interventions. We therefore excluded patients who were greatly dependent on caregivers for daily activities and those with psychoneurological impairment or substance (mostly alcohol) addiction (5.3%). Among the excluded patients, 10 refused to adhere to the ERAS protocol (3.5%). Among these, 6 patients were observed in the first year of protocol application. Better patients' information and team familiarity with the protocol may have acted as motivators toward patients' agreement in participating in the study in the following years.

We offered the ERAS protocol to patients undergoing rectal cancer surgery who represent a consistent part of our population (19.5%). Similarly, the ERAS protocol was applied to patients who underwent new stoma formation (14.5%), both definitive colostomy for abdominoperineal resection and protective ileostomy for high-risk rectal resections and TME. ERAS items were tailored upon specific needs of different patients or procedures: for example, urinary catheter removal after LAR was considered from POD 2 in women and PODs 3–4 in men to avoid urinary retention. Despite some item variations, patients undergoing surgery for rectal cancer showed similar results in terms of both protocol adherence and outcomes when compared to other colonic resections. Unlike those described in other studies,[20] our results show that median LOS was 6 days for both laparoscopic rectal and colonic resections.

During the first 4 years of protocol application, we have obtained good surgical outcomes such as low major morbidity (3.5%), redo surgery (3%), and re-admission rates (2.5%). Re-admission rate in our cohort was notably lower compared to recent reports where LOS was even shorter than ours[21] and in line with the results of the PeriOperative Italian Society (POIS) Registry.[18]

Adherence to items such as respiratory physiokinetic therapy (96.5%) and routine prokinetics/antiemetic drug administration (94.5%) was notably high. Other ERAS goals, such as out-of-bed mobilization, walking, early fluid and diet intake, and intravenous fluid administration interruption, were generally achieved with a delay of about one day, highlighting room for further improvement. Passage of flatus occurred on POD 1 in 64.5% of patients, whereas complete return to bowel function occurred in 58.5% of patients by POD 2. The aim of our ERAS protocol was to not achieve exceedingly early discharges but promote early restoration of patient's homeostasis. We consider our median LOS of 5.5 days a good result for such a heterogeneous cohort of patients. Excluding 29 patients with stoma formation whose LOS was influenced by the time necessary for stoma education (PODs 3–6), among the remaining 171 patients, we registered a "possible POD 3 discharge ratio" of 82% (140 patients). This would be the total number of patients that could be potentially discharged on POD 3 based on the following criteria: bowel open to gas, well tolerated semiliquid diet, independent ambulation, urinary catheter removal, and adequate pain control (VAS$\leq$4). Within the population of "POD 3 potentially dischargeable patients," only 1 would have been subject to early readmission (<1%).

Within certain health systems, the actual time of discharge often does not reflect the clinical readiness to discharge. This is due to the fact that certain patients, especially the elderly, may have home support requirements, the logistics of which often delays discharge. In certain circumstances, validated indicators of short-term recovery such as "time to readiness for discharge" should be used against ERAS efficacy.[22]

Our results can be compared to those in the recent literature where a good ERAS adherence is associated with both a reduction of LOS and overall morbidity and improvements in surgical outcomes.[23] We included in this study only patients treated with a minimally invasive approach, since its effect on recovery after major surgery is well reported and it increases adherence to postoperative ERAS protocol items as recently reported by the PeriOperative Italian Society.[20] Since the best postoperative outcomes are achieved combining ERAS protocol and laparoscopy, we considered the laparoscopic approach as a standard item of the ERAS protocol when indicated.

5. Conclusions

Our experience with 200 patients confirms the feasibility and safety of ERAS protocol application within a heterogeneous population undergoing laparoscopic colorectal resection. Moreover, the laparoscopic approach should be considered part of the enhanced recovery pathway also in elderly people and rectal resections.

Author contributions

Conceptualization: Corrado Pedrazzani, Nicola Menestrina, Alfredo Guglielmi.
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Writing – original draft: Corrado Pedrazzani, Cristian Conti, Guido Mantovani, Eduardo Fernandes.
Writing – review & editing: Nicola Menestrina, Alfredo Guglielmi.

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