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Implementation of an Enhanced Recovery After Surgery program in elective colorectal surgery: a prospective cohort study

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ABSTRACT

Objective: To evaluate the results of an Enhanced Recovery After Surgery (ERAS) protocol in elective colorectal surgery compared to the historical cohort of this hospital with standard care, in terms of hospital Length Of Stay (LOS), 30 days readmissions rate and 3–5 Clavien–Dindo Complications (CDC).

Methodology: Data were collected from consecutive patients during 2 time periods, before (135 patients from hospital database) and after implementation of an ERAS protocol (121 with prospective follow up). Multivariate lineal or logistic regressions were used to assess the impact of ERAS program, adjusting by gender, age, laparoscopy and 3–5 CDC.

Results: The two groups were homogeneous in terms of demographic and surgery details, with the exception of the operative approach, with increased use of laparoscopy in the ERAS group. The ERAS protocol decreased LOS (9.8 ± 3.7 vs. 11 ± 3.8, $p = 0.018$) without increasing 30 days readmission rate or the number of severe CDC. In a multivariate analysis, age and 3–5 CDC were independently associated with a longer LOS while male gender, ERAS protocol and laparoscopic surgery with a decreased LOS. 3–5 CDC increased readmissions (OR = 3.5, 95% CI 1.2–10.2) while laparoscopic surgery decreased them (OR = 0.2, 95% CI 0.1–0.8). ERAS improved compliance with secondary variables in a statistically significant way: more laparoscopic surgery; more regional analgesia in the intraoperative period; earlier adherence to ambulation; faster onset of oral liquid diet and analgesia by mouth; and lower requirements of opioids.

Conclusions: ERAS protocol and laparoscopic surgery decreased LOS without increasing 30 days readmission rate. Severe CDC increased LOS and readmissions.

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Implantação de um programa de recuperação aprimorada após cirurgia colorretal eletiva: um estudo prospectivo de coorte

Palavras-chave:
Cirurgia colorretal
Recuperação aprimorada após a cirurgia
Laparoscopia

RESUMO

Objetivo: Avaliar os resultados de um protocolo de recuperação aprimorada após a cirurgia (*enhanced recovery after surgery* [ERAS]) em cirurgia colorretal eletiva em comparação com a coorte histórica deste hospital, que recebeu o tratamento padrão, em termos de hospitalização, taxa de readmissão de 30 dias e graus 3 a 5 na escala de complicações cirúrgicas de Clavien-Dindo (CCD).

Metodologia: Os dados foram coletados de pacientes consecutivos em dois períodos de tempo: antes (135 pacientes do banco de dados do hospital) e depois da implementação de um protocolo ERAS (121 pacientes com acompanhamento prospectivo). Regressões lineares ou logísticas multivariadas foram usadas para avaliar o impacto do protocolo ERAS, ajustando por sexo, idade, uso de laparoscopia e graus 3 a 5 na escala CCD.

Resultados: Os dois grupos foram homogêneos em termos de características demográficas e cirúrgicas, com exceção da abordagem operatória, com o aumento do uso de laparoscopia no grupo ERAS. O protocolo ERAS diminuiu o tempo de internação (9,8 ± 3,7 *vs.* 11 ± 3,8; p = 0,018) sem aumentar a taxa de readmissão de 30 dias ou a severidade na escala CCD. Na análise multivariada, a idade e os graus 3 a 5 na escala CCD foram independentemente associados a uma hospitalização mais longa, enquanto o sexo masculino, o protocolo ERAS e a cirurgia laparoscópica foram independentemente associados a uma hospitalização mais curta. Graus 3 a 5 na escala CCD foram associados a um aumento nas readmissões (OR = 3,5; IC 95%: 1,2–10,2), enquanto a cirurgia laparoscópica foi associada a uma diminuição nesse número (OR = 0,2; IC 95%: 0,1–0,8). O ERAS melhorou a adesão às variáveis secundárias de uma forma estatisticamente significativa: aumento no número de cirurgias laparoscópicas; maior uso de analgesia regional no período intraoperatório; adesão precoce à deambulação; início mais rápido da dieta líquida oral e analgesia por via oral; finalmente, menor uso de opioides.

Conclusões: O protocolo ERAS e a cirurgia laparoscópica diminuíram o tempo de internação sem aumentar a taxa de readmissão de 30 dias. Um grau severo na escala CCD aumentou a hospitalização e readmissões.

Introduction

Over the last decade, the enhanced recovery after surgery (ERAS) programs have generated a true revolution in colorectal surgery.[1–4] These so-called "bundled care initiatives" are characterized by patient care rooted in dynamic evidence-based literature and re-evaluation of traditional practices with the goal of decreasing Length of Hospital Stay (LOS) and improving patient outcomes. Traditionally known as fast-track surgery pathways, these programs were first implemented in clinical practice and described by Kehlet in 1997,[5] and have been referred to as ERAS programs to emphasize the quality of patient recovery rather than the speed of discharge.[6–12] Along with all the benefits of ERAS, it is known that there are significant limitations in implementing these protocols, due to the fact that compliance of all interventions may be difficult to achieve for each patient.[1]

In 2014 the Spanish Ministry of Health, Social Services and Equality launched de RICA (Spanish acronym of Enhanced Recovery after Abdominal Surgery)[13] guidelines. This program provided a standardized pathway that guided the perioperative management of patients undergoing major abdominal elective colorectal surgery, excluding urgent and palliative surgery.

In December 2015 a multidisciplinary committee was created at the University Hospital of Guadalajara, comprising of colorectal surgeons, anesthesiologist, nurses and nutritional and hematology service providers to develop a protocol to adapt RICA guidelines[13] to our hospital and evaluate the results of its implementation.

We present a multi-disciplinary and iterative approach to implementing an ERAS protocol among patients undergoing elective abdominal colorectal surgery at the University Hospital of Guadalajara, Spain. The main objective of our study was to evaluate the results of the implementation of this program (ERAS group) compared to the historical cohort of the same hospital with standard care (preERAS group), in relation to reduce hospital Length Of Stay (LOS), 30 days readmissions rate and perioperative Clavien–Dindo Complications (CDC)[14] (Table 1[b]). The secondary objectives were to analyze the impact of several confusion factors such as male gender, age, ERAS protocol, laparoscopic surgery and severe CDC,[14] in LOS and 30 days readmission rate.

Materials and methods

The Ethics Committee of the University Hospital of Guadalajara, Spain, approved this study on 25 April 2016. All patients provided written informed consent. The ERAS program was introduced in our hospital in May 2016. Since then, all patients operated on elective colorectal surgery have been included in the ERAS protocol. For this study we compared the first 121 consecutive patients (ERAS group) that underwent elective colorectal surgery between May 2016 to January 2017 with 135 consecutive patients (preERAS group) that have undergone surgery prior to the implementation, between January and December 2015. Data from the preERAS group was collected in retrospect from the database of the hospital computer system. We chose to exclude data collected from January to April 2016 in order to avoid bias. At that stage, measures of the ERAS program were already rolled out in order to allow for adoption and training. The inclusion criteria were: elective colorectal surgery; age 18 years or older; without cognitive impairment; and ASA (American Society of Anesthesiologist) I–III. The exclusion criteria were: ASA IV; urgent surgery; and concomitant surgical procedures (see demographic characteristic of patients in Table 2).

In December 2015 a multidisciplinary committee (comprising of colorectal surgeons, anesthesiologists, nurses and nutritional and hematology service providers) developed a protocol for the perioperative management of patient having abdominal elective colorectal surgery with 20 interventions (Table 3) based on the RICA guide[13] and the ERAS society recommendations.[4] Patients could be discharged if they met the following criteria: good mobilization; adequate oral intake for liquids and solids; recovered gastrointestinal transit minimally for passing gas; normal urinary outputs; no wound problems; good pain control with oral medication; absence of fever in the last 48 h; and C-reactive protein showing a decreasing trend in the previous laboratory test. It was necessary that the patient and his family feel comfortable with the discharge and the information given regarding possible complications and early detection.[4,12,14]

A specific preanesthesia consultation was created for patients in the ERAS group where they received oral and written information and were included in different protocols (i.e. nutritional optimization, preoperative anemia, use of spirometer, no tobacco and alcohol consumption) to optimize their physical conditions before surgery. Some patients in the ERAS group did not receive this specific consultation due to logistical difficulties. As a result these patients were seen in a normal pre-anesthetic consultation, as was the case for the preERAS group. All patients of the ERAS group were included in the ERAS protocol when they entered the hospital the day prior to surgery. This consultation did not exist in the preERAS group. These patients underwent a routine preoperative consultation, with the general standard of care, but without ERAS protocols.

The primary assessment criteria of our study were the average hospital stay, the presence of severe CDC[13] and 30 days readmission rate. Additional operative variables were also recorded in both groups, preERAS and ERAS: length of procedure in minutes (defined as the time from when a patient enters the operating room until its departure to the recovery room after the surgery), the length of surgery in minutes (defined as the time from which the surgeon initiates the surgery until completion), optimization of preoperative anemia through oral or intravenous iron treatment or erythropoietin, prophylactic treatment to prevent deep venous thrombosis, antibiotic prophylaxis, number of patients with drainage and nasogastric tube after the surgery, number of patients with full mechanical preparation of colon, intraoperative fluids (colloids and crystalloids [mL]), regional analgesia used during the intraoperative and perioperative period, adherence to ambulation, respiratory physiotherapy with the spirometer, withdrawal of the urinary catheterization with a Foley catheter, onset of oral liquid diet, onset of analgesia by mouth, number of patients who required opioids during the postoperative period, stoma construction and the use of a laparoscopic surgical approach were also recorded. We quantified the degree of pain in the ERAS group on a ten-point scale in line 1 as the least intense pain and 10 the most intense pain. There were some variables (minimizing opioid administration, numeric quantification of pain, antiemetic prophylaxis) that could not be registered in the preERAS group because these data were no recorded in routine hospital database.

Short-term postoperative complications were graded using the Clavien–Dindo classification[13]; grades 3–5 were considered severe complications. LOS and rate of readmissions during the first 30 days postoperative period for any cause were documented. Total LOS was defined as time from admission to discharge. All our patients were admitted to the hospital one day before surgery, so LOS includes the day before surgery and the day of surgery itself.

Table 1 – Clavien–Dindo classification of surgical complications.

Grades	Definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions. Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
II	Requiring pharmacological treatment with drugs other than such allowed for Grade I complications. Blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic or radiological intervention
IV	Life-threatening complication requiring ICU (intensive care unit) management
V	Death

Table 2 – Demographic analysis and details of surgery.

	PreERAS group (n = 135)	ERAS group (n = 121)	p-value
Age	68.4 ± 12.3	68.4 ± 13.4	0.169
Female	94 (69.7%)	77 (63.6%)	0.309
Body mass index	27.4 ± 3.9	26.7 ± 4.6	0.331
ASA			0.325
Grade 1	10 (7.4%)	12 (9.9%)	
Grade 2	86 (64.7%)	66 (54.6%)	
Grade 3	39 (28.9%)	43 (35.5%)	
Smokers	30 (22.2%)	16 (13.2%)	0.061
Alcohol intake	14 (10.4%)	20 (16.5%)	0.15
Diabetes	44 (32.6%)	28 (23.1%)	0.093
Hypertension	79 (58.5%)	77 (63.6%)	0.373
Chronic heart disease	24 (17.8%)	23 (19.1%)	0.8
Pulmonary disease	21 (15.6%)	21 (17.4%)	0.69
Renal disease			0.8
CrCl <50 mL/min	17 (12.6%)	14 (11.6%)	
CrCl >50 mL/min	118 (87.4%)	107 (88.4%)	
Anticoagulant therapy	16 (11.9%)	9 (7.4%)	0.24
Preoperative hemoglobin	13.3 (8.6–16.6)	13.1 (8.5–16.7)	0.73
Diagnosis			0.309
Colorectal cancer	116 (85.9%)	109 (90.1%)	
Reconstruction of transit	19 (14.1%)	6 (4.9%)	
Inflammatory bowel disease	0	4 (3.3%)	
Diverticular disease	0	2 (1.7%)	
Type of surgery			0.163
Ileocecal resection	0	1 (0.8%)	
Subtotal colectomy	2 (1.5%)	1 (0.8%)	
Total colectomy	1 (0.7%)	0	
Reconstruction of transit	19 (14.1%)	7 (5.8%)	
Right colectomy	29 (21.5%)	36 (29.8%)	
Left colectomy	16 (11.9%)	19 (15.7%)	
Resection of the colon	1 (0.7%)	1 (0.8%)	
Sigmoidectomy	20 (14.8%)	26 (21.5%)	
Low anterior resection	38 (28.2%)	23 (19%)	
Hartmann	0	1 (0.8%)	
Abdominoperineal resection	9 (6.7%)	6 (5%)	
With stoma	34 (25.2%)	20 (16.5%)	0.09
Operative approach			0.006
Laparoscopic	27 (20%)	45 (37.2%)	
Open surgery	105 (77.8%)	74 (61.2%)	
Reconversion from laparoscopic to open surgery	3 (2.2%)	2 (1.7%)	
Length of procedure (min)	244.1 ± 72.5	239.9 ± 82.6	0.67
Length of surgery (min)	219.5 ± 70	213.8 ± 83.3	0.56

CrCl, Creatinine Clearance.

Statistical analysis

Results are presented as number of patients (%) or mean ± standard deviation. Chi-square and Fisher exact test were applied for the study of categorical variables and the Student *t* test was used for normally distributed quantitative variables. Multivariate analysis was performed by lineal regression in the case of LOS and by logistic regression in the case of 30 days readmission rate and 3–5 CDC, introducing as independent variables: ERAS protocol, age, male gender, laparoscopy and 3–5 CDC. Results were considered statistically significant when *p* value was found to be <0.05. SPSS software (version 15.0, SPSS Inc.) was used for statistical analysis.

Results

Patient's characteristics are shown in Table 2. The two groups were well balanced and no statistical differences between them were found with the exception of the operative approach, with increased use of laparoscopy in the ERAS group (20% vs. 37.2%, $p = 0.006$). The length of procedure in minutes (244.1 ± 72.5 vs. 239.9 ± 82.6, $p = 0.67$) and the length of surgery in minutes (219.5 ± 70 vs. 213 ± 83.3, $p = 0.56$) were similar in the two groups.

Table 3 – Compliance rates with ERAS Interventions in the ERAS group and program Adherence Measures comparing Pre ERAS and ERAS group.

Variable	Pre ERAS ($p = 135$)	ERAS ($p = 121$)	p-value
1. Intensive preoperative advice, written instructions and an informational pamphlet	0	95 (78.5%)	<0.001
2. Drink clear liquid until 2 h prior to the time of procedure and solids until 6 h	0	121 (100%)	<0.001
3. Evaluation of nutritional status	0	95 (78.5%)	<0.001
4. Protocol of optimization of preoperative anemia (with oral or intravenous iron of erythropoietin)	0	95 (78.5%)	<0.001
Patients who received in the preoperative period			
Oral iron	21 (15.6%)	16 (13.2%)	0.722
Intravenous iron	3 (2.23%)	31 (25.6%)	<0.001
Erythropoietin	0	2 (1.6%)	0.22
5. Use of incentive spirometer			
Preoperative period	0	95 (78.5%)	<0.001
POD 0	8 (5.9%)	107 (88.4%)	<0.001
POD 1	43 (31.9%)	111 (91.7%)	<0.001
POD 2	52 (38.5%)	113 (93.4%)	<0.001
6. Avoidance of full mechanical preparation for colon resection, with the exception of left sided and rectal lesions	111 (82.2%)	77 (63.6%)	0.001
7. Administrations of carbohydrate-rich drinks two hours prior to surgery	0	96 (79.3%)	<0.001
8. DVT prophylaxis with subcutaneous heparin from the day prior to the surgery	131 (97%)	121 (100%)	0.056
9. Compression stockings from the day prior to the surgery	0	112 (92.6%)	<0.001
10. Intraoperative pneumatic legs compression to DVT prophylaxis	0	63 (52.1%)	<0.001
11. Intraoperative warm air body heating	0	114 (94.2%)	<0.001
12. Restrictive intraoperative fluid therapy (zero balance: fluid replacement with crystalloids: 3.5 mL/kg/h in laparoscopic surgery and 5–7 mL/kg/h in open surgery)	0	121 (100%)	<0.001
Intraoperative fluids (mL of crystalloids and colloids) (mean ± SD)	2143.7 ± 860.6	1575.83 ± 868.8	<0.001
13. Avoidance of nasogastric tubes (patients without nasogastric tubes)	118 (87.4%)	102 (84.2%)	0.502
14. Avoidance of drains (patients without drains)	16 (11.9%)	16 (13.2%)	0.74
Withdrawal of drainage in the postoperative period, days (mean ± SD)	6.5 ± 2.9	6.1 ± 3	0.270
15. Minimizing opioids administration	–[a]	90 (74.4%)	–[a]
Patients requiring opioids			
POD 0	106 (78.5%)	44 (36.4%)	<0.001
POD 1	88 (65.2%)	44 (36.4%)	<0.001
POD 2	84 (62.2%)	43 (35.5%)	<0.001
16. Antiemetic prophylaxis	–[a]	121 (100%)	–[a]
17. Taking in oral fluids about POD 0 and soft-food diet in POD 1	13 (9.6%)	45 (37.2%)	<0.001
Onset of oral liquid diet			
POD 1	13 (9.6%)	45 (37.2%)	<0.001
POD 2	56 (41.4%)	55 (45.5%)	0.484
Onset of analgesia by mouth, days (mean ± SD)	6.1 ± 3	4.9 ± 1.9	0.009
18. Early mobilization (from bed to the sofa)			
POD 0	2 (1.5%)	52 (43%)	<0.001
POD 1	82 (60.7%)	89 (76.6%)	0.023
19. Urinary catheter removal in			
POD 0	7 (5.2%)	1 (0.8%)	0.07
POD 1	18 (13.3%)	31 (25.6%)	0.016
20. Multimodal analgesia (thoracic epidural catheter (T7–T10) in open surgery)	53 (39.3%)	49 (40.5%)	0.84
Other analgesia techniques used during the intraoperative period			
TAP block	3 (2.2%)	10 (8.3%)	0.028
Wound infiltration with local anesthetic	3 (2.2%)	31 (27.6%)	0.001
Regional analgesia used during the postoperative period			
NSAIDs	43 (31.9%)	43 (35.5%)	0.533
Epidural	53 (39.3%)	44 (36.4%)	0.634
TAP blocks	1 (0.7%)	5 (4.1%)	0.104
PCA with morphine iv	38 (28.2%)	28 (23.1%)	0.360

DVT, Deep Vein Thrombosis; PCA, Patient-Controlled Analgesia; POD, Postoperative day; POD 0, 6 h after the surgery; POD 1, the first postoperative day; POD 2, the second postoperative day; TAP, Transverse Abdominis Plane; iv, intravenous.

[a] This variable could not be quantified because data from the preERAS group was collected in retrospect from the database of the hospital computer system.

Table 3 shows the compliance with the ERAS variables of our protocol between the two groups. The ERAS group had a global compliance 74.3%. All the patients of the ERAS group were given a nutritional-based screening test, but only 20 (16.5%) of them required nutritional optimization with specific shakes.

Opioids consumption in the postoperative period was lower in the ERAS group probably due to an increase in regional analgesia in these patients (Table 3). However, we could not determine any change in the degree of pain between preERAS and ERAS patients because we were only able to measure the grade of pain for the latter. This degree of pain was rated by ERAS patients on a scale from 10 (the worst pain) to 0 (no pain). This showed as mean ± DS and median (range): 2.3 ± 1.9; 2 (0–8).

Table 4 describes the evolution in the postoperative period (univariate analysis). The ERAS group presents a reduction in mean total hospital LOS (from 11 to 9.8 days, $p = 0.018$) but the 30 days readmission rate 15 (11.1%) vs. 12 (9.9%), $p = 0.756$ and complications in the postoperative period were not reduced 49 (36.3%) vs. 38 (31.4%), $p = 0.49$. In addition, the rate of medical 8 (5.9%) vs. 9 (7.4%), $p = 0.669$ or surgical complications 41 (30.4%) vs. 29 (24%), $p = 0.178$; did not decrease. The most common complications were paralytic ileus 10 (7.4%) vs. 2 (1.7%), $p = 0.030$); and suture dehiscence 14 (10.4%) vs. 11 (9.1%), $p = 0.756$) (Table 4).

Tables 5–7 show the results of the multivariate analysis. Age and 3–5 CDC were independently associated with a longer LOS, while male gender, ERAS protocol and laparoscopic surgery were independently associated with decreased LOS. 3–5 CDC increased 30 days readmission rate (OR = 3.5, 95% CI 1.2 to −10.2) while laparoscopic surgery decreased 30 days readmission rate (OR = 0.2, 95% CI 0.1 to 0.8) but could increase severe CDC.

The ERAS program improved compliance with the following secondary variables in a statistically significant way: more laparoscopic surgery, more regional analgesia in the intraoperative period, earlier adherence to ambulation, faster onset of oral liquid diet and analgesia by mouth and lower requirements of opioids (Table 3).

Discussion

Our development of a multidisciplinary, evidence-based, ERAS program at a major tertiary medical center performing elective colorectal surgery was associated with shortened LOS without increasing 30 days readmission rate or the number of postoperative complications. The results are consistent with findings from other medical centers.[1,6,12,15–17] LOS and readmissions have often been used as a benchmark of the success of a surgical protocol. A shorter LOS is related to a reduction in hospital costs and greater patient and family satisfaction, because the patient avoids unnecessary stress and can return to normal life sooner. It is very important to assess the rate of readmissions to objectify that the decrease in LOS is not done at the expense of a decrease in patient safety. A high rate of readmissions is an indicator of poor quality of care.[15–17,6]

Some studies suggest that strict adherence to the ERAS protocol was associated with reduced LOS and improved outcome in elective colon surgery for malignancy. The degree of compliance of the ERAS programs influences the outcome of the recovery, which is more beneficial when all the items are met as a whole, which also decreases the LOS and costs. These benefits were lost when protocol adherence was lower. Keeping adherence optimal remains an ongoing challenge that requires repeated training and dedicated personnel.[18,19] We have obtained a degree of compliance of 74%, with more than 16 variables in which a compliance of more than 70% has been achieved. One of our objectives is to improve the degree of compliance with the ERAS protocol in order to try to improve our results.

There are several articles that have analyzed the impact of ERAS protocol in LOS. Some studies have demonstrated a further decrease in hospital LOS,[6,20–22] but others did not.[23,24] Laparoscopic surgery has also been shown to reduce LOS and readmissions. The smaller incision associated with laparoscopic surgery may cause less pain and ileus, and may promote earlier return of normal activity. Laparoscopic surgery also helps us to better control pain, thus facilitating rapid mobilization of patients and allowed an earlier onset of oral analgesia in the ERAS group.[25,26] However, laparoscopy can increase surgical time. In our study however, despite the existence of more laparoscopic surgery in the ERAS group, no differences were found in the surgical time in both groups. Theoretically, the combination of the ERAS program care with laparoscopy might be the most optimal combination.[15,27–31] In our multivariate analysis, age and 3–5 CDC were independently associated with longer LOS and male gender, the ERAS protocol and laparoscopic surgery with a decrease in LOS. In other words, the use of the ERAS protocol and laparoscopic surgery were independent predictors of less LOS. In addition, laparoscopy reduced readmission in an independent way. There are few studies that have performed a multivariate analysis to compare these results. Jurt et al.[32] showed that a minimal invasive approach was further associated with reduced hospital stay (OR = 0.5; 95% CI 0.4–0.7) and fewer major complications (OR = 0.58; 95% CI 0.4–0.8). Others articles also confirm the beneficial effect on laparoscopic surgery on hospital stay and complications.[6,26,27] Since 2005, studies have shown inconsistent findings on this matter, but no study could convincingly identify any significant differences in clinical outcomes between patients that had open or laparoscopic colorectal surgery within an ERAS program. The Cochrane review of 2011 was not conclusive regarding the role for minimally invasive surgery (i.e. laparoscopy) within a research sample that included ERAS protocols.[33] This suggests that laparoscopy alone might not have the great importance attributed to it,[18] and benefits attributed to this kind of approach could become more clinically relevant in the context of ERAS programs. In our study, laparoscopic approach was independently associated with an increase in severe complications in multivariate analysis. However, univariate analysis could not find differences between open and laparoscopic approach in terms of complications. Surgeons of our hospital have extensive experience in the use of laparoscopic surgery, and the study was not designed to analyze the

Table 4 – Evolution in the postoperative period (univariate analysis).

Variable	Pre ERAS	ERAS	*p*-value
With complications	49 (36.3%)	38 (31.4%)	0.49
Clavien–Dindo complications			0.174
Grade 1	21 (15.5%)	8 (6.6%)	
Grade 2	13 (9.6%)	17 (14%)	
Grade 3	14 (10.4%)	11 (9.1%)	
Grade 4	0 (0%)	0 (0%)	
Grade 5	1 (0.7%)	2 (1.7%)	
Complications			
1. *Medical complications*	8 (5.9%)	9 (7.4%)	0.669
Hematuria	2 (1.5%)	1 (0.8%)	
Urinary tract infection	3 (2.2%)	1 (0.8%)	
Delirium	0	1 (0.8%)	
Liver failure	0	1 (0.8%)	
Urticaria	2 (1.5%)	3 (2.5%)	
Pneumonia	1 (0.7%)	2 (1.7%)	
2. *Surgical complications*	41 (30.4%)	29 (24%)	0.178
Paralytic ileus	10 (7.4%)	2 (1.7%)	
Surgical wound infection	8 (5.9%)	2 (1.7%)	
Abdominal abscess	4 (3%)	3 (2.5%)	
Emphysematous colitis	0	1 (0.8%)	
Intestinal fistula	4 (3%)	8 (6.6%)	
Anastomotic dehiscence	14 (10.4%)	11 (9.1%)	
Death	1 (0.7%)	2 (1.7%)	
Mortality at 30 days	1 (0.7%)	2 (1.7%)	0.498
LOS, days (mean ± SD)	11 ± 3.8	9.8 ± 3.7	0.018
Readmission rate at 30 day all cause	15 (11.1%)	12 (9.9%)	0.756
Readmission rate reoperation for any indication within 30 days	6 (4.4%)	6 (5%)	0.832

Table 5 – Multivariate lineal regression showing the effect of ERAS program on LOS.

LOS	Beta estimates	*p*	95% CI	
ERAS protocol	−0.91	0.031	−1.74	−0.083
Male sex	−0.89	0.046	−1.77	−0.02
Age	0.041	0.012	0.009	0.074
Laparoscopy	−1.3	0.006	−2.23	−0.39
3–5 Clavien–Dindo complications	6.7	<0.001	5.41	−8.05

Dependent variable, LOS.

Table 6 – Multivariate logistic regression showing the effect of ERAS program on readmissions.

Readmissions at 30 days	OR	*p*	95% CI	OR
ERAS protocol	1.1	0.9	0.5	2.5
Male sex	0.9	0.8	0.4	2.2
Age	0.98	0.2	0.95	1
Laparoscopy	0.2	0.02	0.1	0.8
3–5 Clavien–Dindo complications	3.5	0.021	1.2	10.2

Dependent variable, Readmissions at 30 days.

Table 7 – Multivariate logistic regression showing the effect of ERAS program on 3–5 Clavien–Dindo complications.

3–5 Clavien–Dindo	OR	*p*	95% CI	OR
ERAS protocol	1.79	0.257	0.65	4.97
Male sex	1.26	0.659	0.45	3.55
Age	1.01	0.594	0.96	1.06
Laparoscopy	4.13	0.013	1.35	12.61
LOS	1.46	0.000	1.30	1.65

Dependent variable: 3–5 Clavien–Dindo complications.

outcomes of laparoscopic approach, but a continuous analysis or our results is necessary and it will help to continue improving.

Postoperative 3–5 CDC were the variable that clearly explains the longer LOS and readmissions. This may be because serious complications that require surgical reinterventions or ICU admission are treated in a more conventional way, thus eliminating the effect of the ERAS program on the patient.

Many studies have excluded elderly patients from ERAS pathways. The reason for such exclusion was that adherence to protocols in elderly patients was assumed to be unfeasible due to physical impairments or associated comorbidities. However, currently more than 70% of colorectal cancers are primarily diagnosed among patients >65 years, and it seems reasonable that ERAS should be targeting elderly patients with associated comorbidities, rather than young, healthy patients.[15–17,6]

One of the most important items included into ERAS protocols is the improvement in the oral and written information given to patients by health care personnel prior to surgery. Preoperative counseling may decrease fear and anxiety of patients before surgery.[15,16]

Optimizing perioperative pain management while reducing opioids use was one of the major goals of the ERAS program. We decreased opioids consumption in the postoperative period in favor of an increase in regional analgesia.[34–39] Opioid side effects reduction (drowsiness, nausea, ileo, etc.) could allow earlier mobilization and oral intake, contributing to a better recovery and earlier hospital discharge. Early mobilization and diet advancement have become a foundation of any recovery protocol.[12,40] We also achieved the implementation of these variables in a significant way in the ERAS group.

Many of the recommendations in the ERAS protocols are a radical change from the usual practice. In fact, despite strenuous efforts of the study coordinators, there have been some measures that almost could not be implemented. For example: the restrictive use of abdominal drains and nasogastric tubes; an increased use of epidural catheters; and the withdrawal of the urinary catheterization with a Foley Catheter in POD 0. Arguably, a much longer training period is necessary to break with the longstanding practices in traditional care.[12]

Limitations

Our sample size is small and consists of the first 121 patients to whom we apply the protocol. We would need to increase the patient's compliance with our protocol in order to improve our results. High or full implementation of the ERAS protocol could significantly improve short-term outcomes and we have to work very hard to achieve this goal and then analyze it.

For future studies, we should analyze the effect of individual ERAS components on outcomes, in order to identify the most efficient strategies and focus our efforts on them.

In conclusion, ERAS program was associated with shortened LOS without increasing 30 days readmission rate. ERAS protocol and laparoscopic surgery decreased LOS in an independent way and age and severe CDC increased LOS. Of all these variables, only laparoscopic surgery decreased readmissions while severe complications increased them.

Conflicts of interest

The authors declare no conflicts of interest.

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