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The Impact of the Enhanced Recovery After Surgery (ERAS) Protocol on Colorectal Surgery in a Portuguese Tertiary Hospital

Impacto da Aplicação do Programa ERAS na Cirurgia Colorrectal de um Centro Hospitalar Terciário

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ABSTRACT

Introduction: The benefits of the multimodal Enhanced Recovery After Surgery® (ERAS) program have been described all over the world. The adoption of several perioperative strategies translates into an improvement in the quality of the healthcare provided. The aim of this study was to report the results of the implementation of the ERAS® program for colorectal surgery in a tertiary hospital.

Material and Methods: In this single-center observational study, 534 patients who underwent colorectal surgery between December 2018 and May 2021 were included. Two groups were considered: before and after the implementation of the ERAS® program. The primary outcome measure was 30-day morbidity. The length of hospital stay, readmission rate, reintervention and mortality among the two groups were also evaluated.

Results: The pre-ERAS group included 102 patients and the ERAS group included 432 patients. There was a statistically significant reduction in morbidity at 30 days (37.3% *vs* 26.5%, $p < 0.05$), length of stay (7 days *vs* 5 days, $p < 0.001$) and readmission rate (12.9% *vs* 6%, $p < 0.05$) after the implementation of the ERAS program.

Conclusion: The ERAS® protocol for colorectal surgery was successfully and safely implemented in our hospital, contributing to an improvement in perioperative care provided to patients.

Keywords: Anesthesia; Colorectal Surgery/methods; Enhanced Recovery After Surgery; Perioperative Care/methods

RESUMO

Introdução: Os benefícios do programa multimodal *Enhanced Recovery After Surgery*® (ERAS) têm sido descritos em todo o mundo. A adoção de várias estratégias peri-operatórias traduz-se numa melhoria dos cuidados de saúde prestados com ganhos para o doente e para a instituição. O objetivo deste estudo foi reportar os resultados da implementação do programa ERAS® na cirurgia colorretal num hospital terciário.

Material e Métodos: Neste estudo unicêntrico observacional foram incluídos 534 doentes submetidos a cirurgia colorretal entre dezembro 2018 e maio de 2021. Foram criados dois grupos: antes e depois da implementação do programa ERAS® com o objetivo primário de comparar a morbilidade aos 30 dias. Foi também avaliado o tempo de internamento, a taxa de reinternamento, reintervenção e a mortalidade entre os grupos.

Resultados: O grupo pré-ERAS era constituído por 102 doentes e o grupo ERAS por 432 doentes. Verificou-se uma redução significativa na morbilidade aos 30 dias (37,3% *vs* 26,5%, $p < 0,05$), no tempo de internamento (7 dias *vs* 5 dias, $p < 0,001$) e na taxa de readmissão (12,9% *vs* 6%, $p < 0,05$) após a implementação do programa.

Conclusão: O protocolo ERAS® na cirurgia colorretal foi implementado com sucesso e segurança no nosso hospital, contribuindo para uma melhoria dos cuidados peri-operatórios prestados aos doentes.

Palavras-chave: Anestesia; Cirurgia Colorretal/métodos; Cuidados Perioperatórios; Recuperação Pós-Cirúrgica Melhorada

INTRODUCTION

Enhanced Recovery After Surgery® (ERAS) represents a paradigm shift in surgical patient care and can result in substantial benefits in both clinical outcomes and cost-effectiveness through optimization of the perioperative period.[1]

The ERAS colorectal program, established in 2010, aims to improve recovery after surgery through a multidisciplinary framework and multimodal treatments based on interventions in the preoperative, intraoperative and postoperative scenario.[2] For patients to receive a holistic evaluation, they need to be assessed preoperatively by a surgeon, an anesthesiologist, a nurse skilled in the preoperative preparation of patients, a physiatrist, a nutritionist and a social worker. This ensures the early identification and effective clinical management of 'higher-risk' patients and reduces variation in practice.[3] In the intraoperative phase, in addition to minimally invasive procedures and goal directed fluid therapy, patients have an evidence-based and procedure-specific analgesic regimens, which included regional analgesia.[4,5] In the postoperative scenario, the key protocol elements are

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early feeding, early mobilization and opioid-sparing analgesia.

Different meta-analysis demonstrated that minor and major postoperative complications after major abdominal surgery increased mortality, decreased health related quality of life and increased healthcare expenditure.[6] For a range of surgical disciplines, there is evidence highlighting the effect of the ERAS program in improving preoperative well-being and patient outcomes, namely decreased length of stay, 30-day morbidity and readmissions.[7]

The ERAS program for colorectal surgery was implemented at our institution with the aim of reducing morbidity and length of stay and reducing healthcare expenditure. The aim of this study was to report the impact of this program's implementation in our institution.

MATERIAL AND METHODS

This study was reported according to the STROBE checklist. Institutional approval was obtained for the conduct of the study as an audit of practice.

Patient selection

In this cohort study, patients undergoing colorectal surgery at a single Portuguese center between December 2018 and May 2021 were prospectively included in an electronic database. All consecutive adult patients (aged over 18) undergoing colorectal surgery were included regardless of the surgical approach [open, laparoscopic, single incision laparoscopic surgery (SILS)] or surgery for malignant disease. Data collected included demographic and clinical data: age, body mass index (BMI), gender, history of smoking, diabetes or other comorbidities, Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity risk (P-POSSUM), American Society of Anesthesiologist (ASA) physical status, diagnosis, disease location and use of neoadjuvant treatment; preoperative, intraoperative and postoperative variables related with compliance; and surgical outcomes such as surgical type and approach, creation of stoma and duration of surgery. Emergency surgeries were excluded.

Patients in the post implementation ERAS program (ERAS group) were compared with 102 consecutive patients undergoing traditional care, before the implementation of ERAS (pre-ERAS group), between December 2018 and May 2021.

The primary outcome measure was any 30-day morbidity, which was classified *a priori* according to the Clavien-Dindo (CD) system specific to abdominal surgery.[8] Minor morbidity was defined as the occurrence of a CD grade I or II complication, and major morbidity was defined as the occurrence of a grade III or IV complication. Postoperative length of stay (LOS) was considered a secondary outcome measure. Other secondary outcome measures included 30-day readmission, reintervention, and 30-day mortality.

Enhanced recovery after surgery

All patients in the pre-ERAS group followed the institution's generic protocol which included pre-operative tests, skin preparation, bowel preparation, multidrug resistant organisms screening as per national guidelines, bowel preparation, venous and antibiotic prophylaxis. No intra-operative or postoperative strategies were formally adopted in this group.

In the ERAS group, the patients followed a standardized protocol divided into preoperative, intraoperative, and postoperative phases (Fig. 1).

Preoperative phase

All patients were admitted to hospital on the day before their surgery, maintained oral diet and started a therapeutic regimen according to patient comorbidities and surgical intervention. Although the ERAS society recommends against the use of mechanical bowel preparation (MBP), our protocol included MBP in combination with oral antibiotics for all patients. Up to two hours before induction of anesthesia, patients were given complex carbohydrate drinks if not contraindicated and routine administration of preanesthetic sedative medication was not given.

Perioperative phase

Prophylactic antibiotics were given within 60 minutes prior to induction. Minimally invasive surgery was used whenever possible. Abdominal trunk blocks such as the transversus abdominis plane (TAP) block were performed in laparoscopic surgery and rectus sheath block in open surgery. Intravenous non-steroidal anti-inflammatory drugs and paracetamol were used as adjuncts to pain relief.

Balanced crystalloid solution and vasopressors were administered when needed to avoid intraoperative hypoperfusion. Normothermia was maintained through active warming devices and venous thromboembolism prophylaxis included pharmacologic and nonpharmacologic measures. Urinary catheters were placed but routinely removed within 24 to 72 hours and if intra-abdominal drains were used, they were removed as soon as possible.

Postoperative phase

On the day of the surgery, patients started drinking water and liquids and were seated for the first time two to four hours after surgery. Intravenous fluids were stopped on the first postoperative day. Solid oral intake was introduced 48 to 72 hours after surgery.

A standardized analgesic regimen was used consisting of acetaminophen and non-steroidal anti-inflammatory

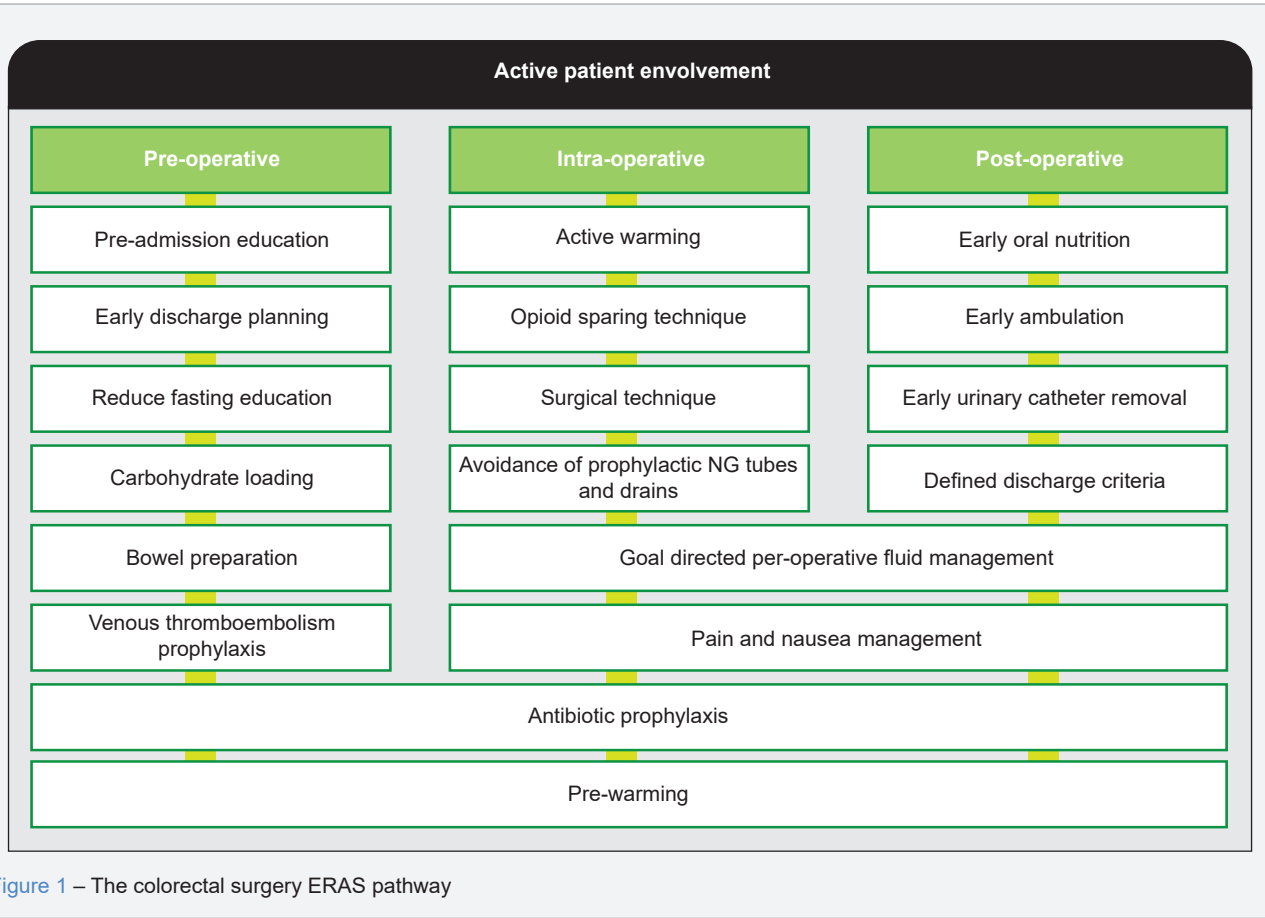

Figure 1 – The colorectal surgery ERAS pathway

drugs. Opiates were avoided when possible and epidural blockades, when used, were continued until postoperative day two. Ileus was defined as a transient cessation of bowel motility after surgery.[9] A multimodal approach to prevent postoperative ileus, nausea and vomiting was used. This included the use of antiemetic agents (metoclopramide), peripherally acting l-opioid receptor antagonists and bisacodyl.[2] Wound infection diagnosis was made according to CDC definitions.[10]

Statistical methods

Continuous variables were expressed as median and interquartile range, and normality was assessed with the Kolmogorov-Smirnov test. Categoric variables were expressed as count and percentages. The group of patients that underwent surgery after the protocol implementation (ERAS group) was compared with a conventional care control group (pre-ERAS group). The analysis between groups was conducted using the Mann–Whitney U test for continuous variables that were not normally distributed. Categorical variables were compared with the Pearson's chi-square test or Fisher exact test as appropriate. Univariate analysis was also performed to identify significant variables for predictors of morbidity at 30 days. A *p*-value of less than 0.05 was considered statistically significant. Bivariate analysis followed by binary regression analysis were used to identify predictors of morbidity and in-hospital mortality.

RESULTS

A total of 534 consecutive patients (102 cases in the pre-ERAS 432 cases in the ERAS group) were included during the study period. Table 1 shows patient demographics, comorbidities and procedural characteristics in the pre-ERAS and ERAS program.

Clinical characteristics

The median age was 66 years (IQR 57.0 – 78.0) in the pre-ERAS group and 68 years (IQR 57.0 – 77.0) in the ERAS group. Most patients had cancer (76.0% in the pre-ERAS group and 72.0% in the ERAS group) The median body mass index (BMI) was 26.4 kg/m2 (IQR 24.2 – 29.7) in the pre-ERAS group and 26.2 kg/m2 (IQR 23.4 – 29.2) in the ERAS group (both overweight). Alcohol consumption was significant higher in the pre-ERAS group (*p*-value < 0.001).

Regarding comorbidities, patients in the ERAS group

Table 1 – Clinicopathological characteristics of patients.

	Pre-ERAS (n = 102)	**ERAS** (n = 432)	***p*-value**
Age, years – median (IQR)	66 (57.0 – 78.0)	68 (57.0 – 77.0)	0.912
BMI, kg/m^2 – median (IQR)	26.4 (24.2 – 29.7)	26.2 (23.4 – 29.2)	0.498
Gender, n (%)			0.276
Female	31 (30.4)	156 (36.1)	
Male	71 (69.6)	276 (63.9)	
Smoker, n (%)	7 (8.6)	48 (11.1)	0.510
Alcohol use, n (%)	12 (15.6)	9 (2.1)	**< 0.001**
Comorbidities, n (%)			
Cardiovascular	3 (2.9)	19 (4.4)	0.781
Diabetes	23 (22.5)	104 (24.2)	0.727
Pulmonary disease	2 (2.0)	7 (1.6)	0.684
Immunosuppressive treatment	4 (4.7)	16 (3.7)	0.758
P-POSSUM mortality risk, % (IQR)	3.5 (2.0 – 9.0)	12,0 (6.0 – 24.0)	**< 0.001**
ASA, n (%)			**< 0.001**
I	6 (8.8)	11 (2.6)	
II	39 (57.4)	211 (49.3)	
III	23 (33.8)	194 (45.3)	
IV	0 (0.0)	12 (2.8)	
Diagnosis, n (%)			0.423
Benign	24 (24.0)	118 (28.0)	
Malign	76 (76.0)	304 (72.0)	
Disease location, n (%)			0.104
Colon	63 (62.4)	294 (68.5)	
Rectum	34 (33.7)	130 (30.3)	
Colon and rectum	4 (4.0)	5 (1.2)	
Neoadjuvant radio-chemotherapy[1], n (%)	18 (18.0)	64 (14.8)	0.443

[1] Some missing values were found in the pre-ERAS and the ERAS groups

had a higher proportion of cardiac disease and diabetes, but without statistical significance. In terms of preanesthetic comorbidities, the ASA physical status classification system was used. Most patients in the ERAS group were ASA grade II (49.3%) or ASA grade III (45.3%). In the ERAS group, 12 patients (2.8%) were classified as ASA IV. In the pre-ERAS group, no patients were classified as ASA IV. There were no patients classified as ASA grade V.

Concerning P-POSSUM, the median level in the pre-ERAS group was 3.5% compared with 12% in the ERAS group.

There were no baseline statistically significant differences between groups in age, gender, BMI, and comorbidities but there was a statistically significant difference between P-POSSUM values and ASA score (Table 1).

Perioperative protocol and ERAS compliance

Compliance with individual items is shown in Table 2. As only a few ERAS program items were included in the pre-ERAS group, relatively low compliance wasfound for the variables pre-operative nutritional assessment, nutritional support with preoperative oral carbohydrate treatment (0%) and no/selective bowel preparation (21.6%).

Concerning the intraoperative phase, the use of nerve blocks and local anesthesia also increased (2.9% *vs* 62.6%, *p*-value < 0.001) and there was a statistically significant difference in the use of systemic opioids given. Regarding nausea and vomiting prophylaxis there was also a statistically significant difference (49% *vs* 71.8%, *p*-value < 0.001).

During the postoperative period there was a significant decrease in the median duration of intravenous fluid

Table 2 – Perioperative protocol and ERAS compliance

	Pre-ERAS (n = 102)	ERAS (n = 432)	*p*-value
Pre-operative			
No bowel preparation done, n (%)	22 (21.6)	78 (18.1)	0 413
Preoperative oral carbohydrate treatment, n (%)	0 (0)	336 (77.8)	**< 0.001**
No preoperative sedative medication, n (%)	69 (67.6)	428 (99.1)	**< 0 001**
Thrombosis prophylaxis, n (%)	99 (97.1)	432 (100)	**0 007**
Antibiotic prophylaxis, n (%)	54 (52.9)	247 (57.3)	0 424
Intra-operative			
No epidural or spinal used unless applicable[1], n (%)	96 (95)	411 (95.1)	1.000
Lumbar supplementary analgesia[1], n (%)	3 (3)	9 (2.1)	0.707
Nerve blocks or local anesthesia[1], n (%)	3 (2.9)	270 (62.6)	**< 0.001**
No long-acting systemic opioids given[1], n (%)	19 (76.0)	432 (100.0)[1]	**< 0.001**
PONV prophylaxis administered, n (%)	50 (49.0)	310 (71.8)	**< 0.001**
Forced-air heating cover used, n (%)	94 (93.1)	411 (96.5)	0.161
Total fluid volume, mL – median (IQR)	1250 (762.5 – 2237.5)	1400 (1000 – 1900)	0.256
Post-operative			
No NG tube used postoperatively, n (%)	49 (48)	410 (94.9)	**< 0.001**
Stimulation of gut motility[2], n (%)	7 (7.9)	375 (93.3)	**< 0.001**
Balanced fluids day 0, ml – median (IQR)	2315 (437.5 – 3603.8)	2160 (1641.75 – 2800.00)	0.930
Duration of IV fluid infusion, nights – median (IQR)	6 (4 – 7)	1 (1 – 1)	**< 0.001**
Oral intake on day 0, mL – median (IQR)	0 (0)	200 (200 – 300)	**< 0.001**
Mobilization at all on day of surgery	0 (0)	312 (73.2)	**< 0.001**

[1] Some missing values were found in the pre-ERAS and the ERAS groups
[2] Intravenous or oral laxatives as bisacodyl

therapy in the ERAS group (six days versus one day, *p*-value < 0.001) as well as an increase in the median volume of oral fluids intake on the day of surgery (0 mL *vs* 200 mL, *p*-value < 0.001). This group also had a statistically significant increase in stimulation of gut mobility, avoidance of nasogastric tubes as well as earlier mobilization (*p*-value < 0.001).

Surgical outcomes

Procedural characteristics are represented in Table 3. There were more colon procedures in the ERAS group and the most common procedures were right hemicolectomy (27.6%), rectal anterior resection (20.9%) and sigmoidectomy (19.1%). No difference was found in operative time between the two groups (180 *vs* 180 min, *p*-value 0.818).

Surgical approach changed after ERAS program implementation (*p*-value < 0.001) with laparoscopic procedures becoming more common (43.1% *vs* 73.1%).

Morbidity and mortality

The primary outcome of this study was 30-day morbidity, which was classified *a priori* according to the Clavien-Dindo system specific to abdominal surgery. Summary of postoperative complications at30 days is listed in Table 4 for both groups.

According to the CD classification, there was a statistically significant difference in surgical complications (*p*-value 0.004) and the rate of overall complications was lower in patients included in the ERAS protocol (37.3% *vs* 26.5%, *p*-value 0.003) In the pre-ERAS group, 56.8% of patients had CD complications classified as grade I compared with 20.5% in the ERAS group. Only one case in the pre-ERAS group and three cases in the ERAS group resulted in death after the operation, and patients with other complications in both groups were discharged successfully after conservative treatment or surgical interventions. No statistically significant difference in mortality was observed between groups.

Table 3 – Procedural characteristics

	Pre-ERAS (n = 102)	ERAS (n = 432)	*p*-value
Surgery, n (%)			**0.009**
Right colectomy	24 (24.0)	119 (27.6)	
Left colectomy	4 (4.0)	26 (6.0)	
Sigmoidectomy	13 (13.0)	82 (19.1)	
Rectal anterior resection	26 (26.0)	90 (20.9)	
Abdominoperineal resection	7 (7.0)	27 (6.3)	
TAMIS	0 (0)	11 (2.6)	
Protocolectomy	3 (3.0)	4 (0.9)	
Total/ Subtotal colectomy	8 (8.0)	13 (3.0)	
Ostomy closure	14 (14.0)	48 (11.1)	
Protopexy	1 (1.0)	1 (0.2)	
Exploratory laparoscopy/laparotomy	0 (0)	9 (2.1)	
Stoma, n (%)			0.285
No	82 (81.2)	348 (80.9)	
Ileostomy	14 (13.9)	44 (10.2)	
Colostomy	5 (5.0)	38 (8.8)	
Surgical approach, n (%)			**< 0.001**
Open	46 (45.1)	76 (17.6)	
Laparoscopic	44 (43.1)	316 (73.1)	
SILS (single incision laparoscopic surgery)	0 (0)	7 (1.6)	
Through stoma	12 (11.8)	33 (7.6)	
Duration of surgery, minutes, median (IQR)	180 (125 – 250)	180 (120 – 240)	0.818

Surgical complications included surgical wound infection, intra-abdominal abscess, anastomotic dehiscence, and bleeding. The presence of ileus in the pre-ERAS group was not evaluated, so this variable was not included in surgical complications.

The median LOS in the pre-ERAS group was 7 (5 - 10,25) days compared with 5 days (4 - 9 days) in the ERAS group. The difference in median LOS between the two groups was statistically significant ($p < 0.001$). On the other hand, four patients (3.9%) in the traditional pathway and 24 (5.6%) in the ERAS group required reoperation. Causes for reoperations included hemorrhage, intestinal obstruction, anastomotic leak, and abscess.

The rate of 30-day readmissions was 12.9% (13 patients) in the pre-ERAS group and 6.0% (26 patients) in the ERAS group. The difference between the two groups was statistically significant ($p < 0.05$) (Table 5).

A regression was performed to adjust the results for possible confounding factors, as shown in Table 6.

Linear logistic regressions were adjusted considering P-POSSUM and ASA score as independent variables. The application of the ERAS program (category coded as “1” in the database) compared with pre-ERAS (refers to the independent variable, the category with “0” in the database) had a shorter average of 2.06 days ($10^{0,143}$) in the LOS.

A multivariate logistic regression model was performed to predict hospital readmission, which were not associated with P-POSSUM (OR -0.012, 95% CI 0.885 – 1.104, *p*-value 0.834) or ASA score (OR 0.478, 95% CI 0.877 – 2.966, *p*-value 0.124).

DISCUSSION

This retrospective review of a prospectively collected database has provided an insight into the preoperative, intraoperative, and postoperative factors including patient demographics, disease state, and ERAS compliance that may influence the outcomes achieved in a colorectal ERAS program. With key outcome and process data collection we were able to make a continuous improvement to the program.

The ERAS program has been introduced to optimize both physical and psychological well-being of patients prior

Table 4 – Postoperative outcomes in the Pre-ERAS and ERAS groups

Complications	**Pre-ERAS** (n = 102)	**ERAS** (n = 432)	***p*-value**
Overall, n (%)	38 (37.3)	114 (26.5)	**0.003**
Anesthetic, n (%)	0 (0.0)	4 (3.2)	1
Surgical, n (%)	12 (11.8)	41 (9.5)	0.494
Type of complication, n (%)			
Cardiovascular	1 (1)	17 (3.9)	0.220
Respiratory	4 (3.9)	37 (8.6)	0.113
Renal	1 (1)	24 (5.6)	0.064
Psychiatric	8 (7.8)	12 (2.8)	**0.036**
Tromboembolic complications	0 (0)	2 (0.5)	1
Ileus	NA	48 (11.1)	**NA**
Nausea and vomiting PONV,	18 (17.6)	14 (3.2)	**< 0.001**
Wound infection, n (%)	6 (8.1)	16 (4.2)	1
Dehiscence, n (%)	2 (2.0)	15 (3.5)	0.753
Intraabdominal abcess, n (%)	1 (1)	16 (3.7)	0.217
Clavien-Dindo			**0.004**
I	21 (56.8)	32 (20.5)	
II	10 (27.0)	76 (48.7)	
III	5 (13.5)	38 (24.3)	
IV	0 (0)	7 (4.5)	
V/ Mortality	1 (2.7)	3 (1.9)	

to colorectal surgery. This study was designed to report on the collective impact of ERAS implementation across the perioperative period. It has also specifically examined the impact of a multimodal approach on clinical and functional outcomes following colorectal surgery.

Compliance rates in each prehabilitation modality have been evaluated, to assess the potential effect on outcomes. The main findings of the study comprised a considerable reduction in the hospital LOS without an increase in the complications rate compared to our previous standards.

ERAS describes multimodal protocols designed to optimize patients perioperatively with the goal improving of postoperative recovery. The goal of ERAS protocols lies in reducing both intra- and postoperative adverse events, which have the potential to impair patients' perioperative well-being and to delay discharge.

The ERAS protocol includes administration of antibiotic prophylaxis and thromboprophylaxis, prevention of hypothermia and fluid imbalance, as well as operative measures that help decrease colorectal complications.[11-13] The most common complications reported in colorectal surgery are wound infection and ileus.[14] Ileus was the most frequent complication (11%) in the ERAS group. The incidence found in our study was not higher than that described in the literature (10% - 30%).[15] Moreover, and despite being associated with nausea/vomiting, pain and failure of oral food intake, there was no increase in these parameters in the ERAS group.[16] The ERAS® Society does not recommend bowel preparation as a routine on colorectal surgery, but it is still controversial depending on the location of the lesion and the surgical approach.[17] Some studies suggested that preparation is linked to adverse effects such as prolonged ileus and patient distress without any evidence of advantages and should not be used routinely.[18]

The analysis of some studies showed that the ERAS pathway was associated with a reduction of morbidity, particularly associated with a reduced number of surgical complications.[19-22] In our study, we found similar results to those previously reported in other studies.

Our study included a wide range of patients that are representative of daily practice. By analyzing the data, it is possible to infer that patients in the ERAS group were more complex than those in the control group, with more comorbidities and at greater cardiovascular risk. More patients in the ERAS group had cardiac disease, a known predictive factor for postoperative mortality according to the Lee Index, and higher ASA and P-POSSUM scores.[23] The ASA grade and the P-POSSUM score have been

Table 5 – Main outcomes in the Pre-ERAS and ERAS groups

	Pre-ERAS (n = 102)	ERAS (n = 432)	*p*-value
Length of stay, days median, (Q1 – Q3)	7 (5 – 10.25)	5 (4 – 9)	**< 0.001**
Readmission, n (%)	13 (12.9)	26 (6.0)	**0.018**
Reoperation, n (%)	4 (3.9)	24 (5.6)	0.505

Table 6 – Main simple and multiple linear regression model for length of stay[1]

	Non-adjusted model ß (95% CI)	*p*-value	Adjusted model ß (95% CI)	*p*-value
ERAS Protocol (yes)	-0.143 (-0.21 – 0.77)	**< 0.001**	-0.204 (-0.279 – 0.129)	**< 0.001**
P-POSSUM	-	-	0.021 (0.013 – 0.029)	**< 0.001**
ASA score[2] (mild)	-	-	0.001 (0 – 0.002)	0.091

[1] The authors performed a logarithmic transformation of LOS
[2] ASA score was treated as categorical one (ASA < 2 being recoded as 'healthy' and ASA < 2 as 'mild')

considered a useful adjunct to informed consent and for monitoring surgical performance. The hypothesis that preoperative morbidity defined by P-POSSUM and ASA score should have influenced the results was considered. For this reason, a linear and multiple logistic regression was performed according to the outcomes. We found that morbidity does not seem to affect the percentage of readmissions ($p > 0.05$). The P-POSSUM was recognized as a confounding factor but not the ASA score for LOS. The P-POSSUM is a wider and more inclusive scale, considering physiological and surgical factors, and is not directly associated with physiological status. For this reason, the authors considered that the ERAS programs are very beneficial in patients with comorbidities because they lead to optimization of all comorbidities. Probably the worst patients benefit more than healthier patients.

There were significant differences between the two groups in terms of overall complications and morbidity assessed by the CD classification. In terms of medical complications, there was a significant difference in psychiatric complications and PONV.

Postoperative delirium is increasingly recognized in surgical practice, particularly in the elderly population who have pre-existing cognitive dysfunction.[24] Preventive measures such as avoidance of prolonged fasting, deep anaesthesia, disturbance of the sleep–wake cycle or delirogenic medications like benzodiazepines can probably explain why psychiatric complications decreased.

The multimodal approach to PONV within the ERAS pathway contains the use of antiemetics. Other factors like the reduction of preoperative fasting, carbohydrate loading, adequate hydration and the use of regional anaesthetic techniques and the use of non-steroidal anti-inflammatory drugs (NSAIDs) as opioid-sparing strategies may influence the prevalence of PONV.[8]

In agreement with other studies, there was a significant decrease in the rate of medical but not of surgical complications.[25-27] The multidisciplinary team was the key for these results. While surgeons were focused on disease, surgery planning, improvement of technical and laparoscopic skills and treatment, anesthesiologists and other professionals prepared patients to surgical aggression. They focused on medical optimization, reduced the level of anxiety and tried to achieve a better compliance with the ERAS protocol.

In the present study, minimally invasive surgery was performed more frequently in the ERAS program (p-value < 0.001). Meta-analysis and international databases showed that laparoscopic colorectal resection has several advantages, such as a substantial reduction of the total LOS and the number of complications.[28,29] The laparoscopic learning curve is usually related with a higher complications rate, but our colorectal team increased the number of laparoscopic procedures without impairment of surgical time, comorbidities, and reoperation rate.[30] Moreover, the ERAS program being a 'multimodal prehabilitation' had an additive effect by improving patient safety after discharge.[27]

In our study, everything helped patients to recover faster. The absence of urinary catheters and surgical drains facilitated early mobilization. Patients were also encouraged to promptly resume independent drinking and eating, and the standard practice has been modified to abolish routine use of post-operative nasogastric tubes. The anesthetic technique allowed early mobility on postoperative day one. A multimodal opioid-sparing analgesic scheme was implemented: the use of peripheral nerve blocks or local anesthesia increased from 2.9% to 66.5%. Peripheral abdominal

wall block was the most commonly used analgesic technique in laparoscopic procedures. Anesthesiologists performed it using ultrasound and surgeons performed it under direct laparoscopic visualization.

There is currently no consensus on the optimal analgesic package for patients who undergo laparoscopic colorectal surgery within enhanced recovery programs, although some authors defend that the sparing of opioids in abdominal surgery leads to a decreased rate of postoperative ileus.[31,32]

Some reports show that the short- and long-term prognoses are closely related with ERAS program compliance.[33] In this study, it has been shown that compliance rates were higher in the ERAS group (Table 2), which perhaps influenced the earlier discharge favorably, the LOS and readmissions in a tertiary hospital. There was a statistically significant decrease in LOS from a median of seven to five days for all elective colorectal patients. This shorter LOS in the ERAS group may have been associated with a quicker return to normal daily activities and decreased use of healthcare services, an important consideration in the current era of cost-containment in healthcare. This shorter length of stay was not associated with a higher percentage of readmissions, which reflects the safety of this program.

Study limitations

All colorectal patients in our institution are on an ERAS pathway regardless of procedure, comorbidities or surgical approach, and our study reports consecutive patients admitted under our care over a two-year period. A randomized controlled trial would have been ideal but there would have been considerable contamination between control and study groups managed in the same institution, on the same ward, by the same team.

We also identified a lack of information about primary and secondary outcomes before the implementation of the ERAS protocol.

We were unable to analyze how comorbidities interacted with the efficacy of our protocol in either group.

We have not introduced a measure of patient satisfaction at our institution. Patient generated data on quality of life or functional status would contextualize the actual benefit of ERAS according to the patient.

CONCLUSION

The integration of this protocol produced favorable results in our hospital. Due to protocols and the coordination between different specialties, it was possible to perform high complexity surgeries safely in patients with more comorbidities and higher mortality risk.

The ERAS pathway revealed positive results regarding the reduction of complications, LOS and readmissions, emphasized ERAS principles as reduction of surgical stress, maintenance of physiological functions and optimized recovery. The implementation of the ERAS protocol allowed patients with comorbidities and a higher perioperative risk to have surgery safely.

The authors believe that the homogenization of practices across all surgical departments has made it possible to obtain optimal compliance and to assess its real impact on outcomes in patients undergoing colorectal surgery.

With an optimal organizational model and multi-disciplinary surgical care, patients are treated effectively and efficiently. Traditional care pathways are abandoned, and the adoption of new strategies and concepts allows a quicker postoperative recovery and shortens hospitalization days.

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AUTHOR CONTRIBUTIONS

CL e MVG: Design of the work, data acquisition and processing, statistical work and drafting of the paper, approval of the final version of the manuscript.

MR, AA, LIS, JGT: Critical review of the manuscript and approval of the final version of the manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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