











ORIGINAL ARTICLE

Association between clinical outcomes and compliance with the Enhanced Recovery After Surgery (ERAS) protocol in colorectal procedures: A multicenter study

Asociación entre desenlaces clínicos y cumplimiento del protocolo de recuperación mejorada después de la cirugía (ERAS) en procedimientos colorrectales: estudio multicéntrico

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Abstract

Introduction. Enhanced Recovery After Surgery (ERAS) protocol has been designed as an innovation in health after demonstrating that the improvement in medical devices and the refinement of techniques reached the plateau in reducing complications. With these strategies of perioperative medicine, in colorectal surgery morbidity and hospital stay are reduced. The aim of the study was to evaluate whether the rate of adherence to the ERAS protocol is associated with surgical outcomes.

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Methods. Multicenter, observational, retrospective cohort study (2015-2019), in five Latin American hospitals certified by the ERAS Society. The incidence of surgical complications during the immediate postoperative period (30 days) and length of hospital stay were calculated. Bivariate analyzes and multivariate logistic regression were used to assess factors associated with complication rates.

Results. 648 patients were included in the study in five ERAS hospitals, with an average age of 61 years and a higher percentage of men (51%). Overall compliance with the ERAS protocol was 75% and the average stay was 6.2 days (median: 4 days). There was optimal compliance with the ERAS protocol (equal to or greater than 80%) in 23.6% of the patients. Anastomotic leak was documented in 4%, infectious complications in 8.4%, ileus in 5.7%, readmission in 10.2%, and mortality in 1.1%. Multivariate analysis showed that optimal adherence levels to the ERAS protocol significantly reduce the appearance of complications such as anastomotic leakage (OR 0.08; 95% CI 0.01-0.48; $p=0.005$) and infectious complications (OR 0.17; 95% CI 0.03-0.76; $p=0.046$).

Discussion. The results suggest that compliance with the ERAS program greater than 80% is associated with a lower frequency of complications in patients with elective colorectal surgery.

Keywords: enhanced recovery after surgery; colonic diseases; colorectal surgery; measures of association, exposure, risk or outcome; clinical protocols; treatment adherence and compliance.

Resumen

Introducción. Los protocolos de recuperación mejorada después de cirugía se han diseñado como una innovación en salud tras demostrarse que la mejora en los dispositivos médicos y la depuración de técnicas alcanzaron la meseta en disminución de complicaciones. Con estas estrategias de la medicina perioperatoria, en cirugía colorrectal se reducen la morbilidad y estancia hospitalaria. El objetivo del estudio fue evaluar si la tasa de adherencia al programa de recuperación mejorada después de la cirugía (ERAS) está asociada con los resultados quirúrgicos.

Métodos. Estudio multicéntrico, observacional, retrospectivo de cohorte (2015-2019), en cinco hospitales latinoamericanos certificados por la sociedad ERAS. Se calculó la incidencia de complicaciones quirúrgicas durante el posquirúrgico inmediato (30 días) y la duración de la estancia hospitalaria. Se utilizaron análisis bivariado y regresión logística multivariada para evaluar los factores asociados con la tasa de complicaciones.

Resultados. Fueron incluidos en el estudio 648 pacientes en cinco hospitales ERAS, con edad promedio de 61 años y mayor porcentaje de hombres (51 %). El cumplimiento global al protocolo ERAS fue de 75 % y la estancia promedio de 6,2 días (mediana: 4 días). Se tuvo un cumplimiento óptimo del protocolo ERAS (igual o mayor al 80 %) en 23,6 % de los pacientes. Se documentó fuga de la anastomosis en 4 %, complicaciones infecciosas en 8,4 %, íleo en 5,7 %, reingreso en 10,2 % y mortalidad de 1,1 %. El análisis multivariado mostró que los niveles de adherencia óptima al protocolo ERAS reducen significativamente la aparición de complicaciones como fuga de la anastomosis (OR 0,08; IC 95 % 0,01-0,48; $p=0,005$) y complicaciones infecciosas (OR 0,17; IC 95 % 0,03-0,76; $p=0,046$).

Discusión. Los resultados sugieren que un cumplimiento del programa ERAS mayor al 80 % se asocia a menor frecuencia de complicaciones en pacientes con cirugía electiva colorrectal.

Palabras clave: recuperación mejorada después de la cirugía; enfermedades del colon; cirugía colorrectal; medidas de asociación, exposición, riesgo o desenlace; protocolos clínicos; cumplimiento y adherencia al tratamiento.

Introduction

Historically, the evolution of colorectal surgery has been linked to anatomical knowledge and to advance the surgical technique and technological development of best equipment. Mortality

has gone from 50% at the beginning of the 20th century to 4.6% today¹⁻³, in relation to improvements in early detection, chemotherapy and support measures. All these perioperative care measures have proved decrease surgical morbi-

dity and mortality, which are optimized with the generation of multimodal intervention strategies, known as ERAS protocol (Enhanced Recovery After Surgery)⁴. The surgical and non-surgical complications, increase costs and demand for services, have a direct impact on patients, their relatives, and on the health system^{5,6}.

The ERAS protocol proposes a multidisciplinary approach, designed to reduce and counteract the deleterious effect caused by catabolism secondary to a response before the surgical trauma, optimizing patients in their basal physiological values (Figure 1). The results are translated into reduced morbidity rates, fewer complications related to care, faster recovery and shorter hospital stay^{4,12}.

The ERAS protocol contains several elements, formulated with the best scientific evidence, that are distributed for application on

patients undergoing colorectal surgery, from the mediate and immediate preoperative to the intra and postoperative, with emphasis to modulate the surgical stress¹². A multidisciplinary team, formed by a surgeon, anesthesiologist, nurse, nutritionist and physical therapist, is in charge of optimize adherence to each of the strategies¹³.

In colorectal surgery there are 24 recommendations included in the management of the patient to be taken to elective surgery:

Pre-admission

1. Cessation of excessive cigarette and alcohol consumption
2. Preoperative nutritional evaluation and nutritional support, if necessary
3. Optimization of treatment and control of chronic basal diseases

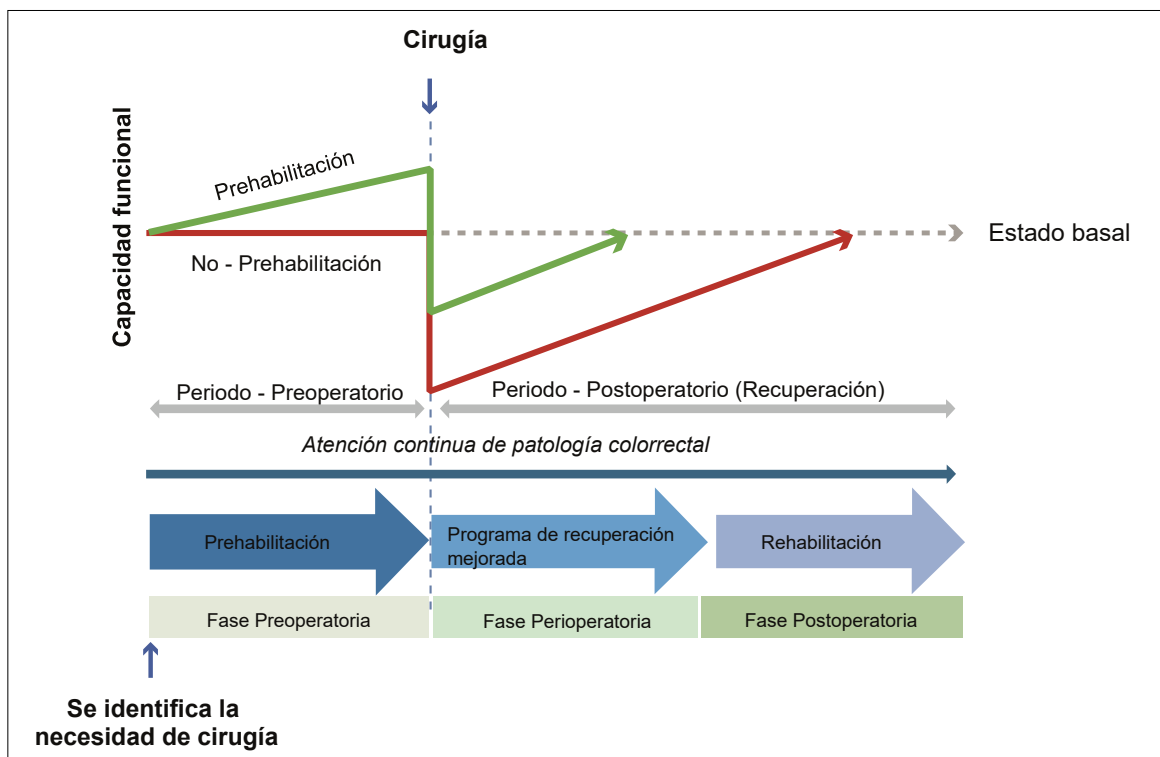


Figure 1. Multimodal pre-habilitation improves functional capacity before and after colorectal surgery.

Source: prepared by the authors.

Preoperative

4. Structured preoperative information and real commitment of the patient and family or caregivers, making them participate and co-responsible of the recovery
5. Decreased fasting time
6. Preoperative prophylaxis against thrombosis
7. Preoperative prophylaxis against infection
8. Prophylaxis against nausea and vomiting

Intraoperative

9. Tend for minimally invasive surgery, not excluding open surgery
10. Standardized anesthesia, avoiding long-lasting opioids
11. Maintain euvolemia
12. Epidural anesthesia for open surgery
13. Restrictive use of surgical site drains
14. Nasogastric tube removal prior to reversal of anesthesia
15. Body temperature control using blankets with hot air flow and warm intravenous infusions

Postoperative

16. Early mobilization (day of surgery)
17. Early intake of oral liquids and solids (offered the day of surgery)
18. Early removal of urinary catheters and intravenous fluids (morning after surgery)
19. Use of coffee, gum, laxatives and peripheral opioid blocking agents (when opioids are used)
20. Protein intake and nutritional supplements rich in energy
21. Multimodal approach to pain control opioids-saver

22. Multimodal approach to nausea control and vomiting
23. Prepare for early discharge
24. Periodic audit of results and processes with the multidisciplinary team of the ERAS program¹³

The standardization of strategies modulate the complexity of the procedure and minimize the stress response surrounding the procedure¹⁴⁻¹⁸. Multiple studies have reported that a compliance with strategies greater than 70% translates into a decrease rate of complications up to 50%¹².

The most recent systematic review and analysis of improved recovery protocols in elective colorectal surgery in adults, both open and laparoscopic, concludes that regarding ERAS protocols, while improving patient outcomes without increasing adverse events, there is no sufficient evidence to determine what components, or combinations, of the multidisciplinary care strategy, are key to get better results for the patient¹⁹. Contrary to these results, other authors question that it is not necessary to have high adherence percentages to the protocol to achieve surgical suitable results²⁰.

Unlike other regions, the ERAS protocols in colorectal surgery have been recently implemented in Latin American countries and the evaluation of the impact, experience and results from the implementation has been little documented²¹. The objective of the study was to measure the degree of adherence to intervention strategies to a program of clinical excellence in surgery and to evaluate whether the rate of adherence to the ERAS program is associated with clinical outcomes, such as surgical results and timing discharge.

Methods**Population**

Retrospective cohort study with adult patients (age 18 and over) brought to elective colorectal surgery during the period 2015-2019. The study

research was developed in five Latin American hospitals, internationally certified and audited by the ERAS International Society as Centers of Excellence in the implementation of the program and protocols from the colorectal surgical pathology management [Clínica Reina Sofía, Bogotá, D.C., Colombia; Hospital Italiano de Buenos Aires, Argentina; Hospital Civil de Guadalajara, México; Médica Uruguaya Corporación de Asistencia Médica (MUCAM), Montevideo and Centro de Asistencia Médica del Oeste de Colombia (CAMOC), Uruguay].

After training and certification as ERAS centers of excellence, the hospitals included in the research began to implement the ERAS protocol at different times during the period analyzed, which clearly means that they have different volumes of practice and by direct connection forced the selection of this cohort design.

The sample size was probabilistic and calculated with the adjusted Westland method for losses and related directly to the number of parameters to include in the multivariate models raised. A random simple sampling with replacement has been made with the registers of the interactive web-based audit system (ERAS – Interactive Audit System®). The calculation of a sample probabilistic and a technique of random sampling are the more efficient alternative in this cohort of non-concurrent nature (meaning that not all subjects enter into the study at the same time), and for that effect, the analysis of data observations could be carried at time zero (t_0), decreasing the cohort bias of this type of study designs.

Individual information was collected on clinical variables, medical-surgical history, surgical procedures, anesthesia and all interventions established in the ERAS protocol for colorectal surgery.

Exclusion criteria were emergency surgery management (bleeding, acute obstruction or perforation), patients with colorectal tumors with criterion of inoperability, planned multi-visceral resection, and patient remitted from other institutions to perform the colorectal surgery

with no previous bond to the protocol from the pre-operative stage.

Statistical analysis

The quantitative variables were analyzed by measures of frequency, central trend and dispersion; categorical data, using proportions; the assumptions of normal distribution of variables of interest, with the Shapiro-Wilk non-parametric test; the correlation between quantitative variables, with the Pearson's Rho coefficient, and the bivariate analyses, with the chi square for independency or Fisher's exact test²². The comparison of quantitative variables was performed with the statistical *t student* or U by Mann Whitney tests. By contrasting hypotheses were considered statistically significant at p values <0.05.

To determine the association between the percentage of adherence to the ERAS protocol there were established four levels: low (0% to 59%), acceptable (60% to 69%), good (70% to 79%), and optimal (80% to 100%). These levels were compared with the complications rate through a multivariate logistic regression model.

The confounding variables were age, sex, body mass index (BMI), score from the ASA functional classification, diagnosis of colorectal cancer, total intravenous fluids administered during intervention, surgical approach (open vs. laparoscopic), anastomotic technique, group (rectum vs. colon and small bowel), administration of opioids in surgery, use of drains at the resection site and prescription of NSAIDs during the postoperative period.

For the outcomes of interest, association measures (odds ratio: OR), both univariate and multivariate, accompanied of its corresponding 95% confidence interval (95% CI). The possibility of interaction was not considered and the multicollinearity between variables was discarded by the factor calculation from inflation of variance (included only $VIF < 10$), to decrease the standard errors in the models. Data was analyzed with the program Stata (StataCorp, College Station, TX, USES) V.15.

Outcomes

The main outcome measured was the presence of an anastomotic leak within 30 days after surgery. Other outcomes analyzed were infections and postoperative ileus.

Results

Between 2015 and 2019, information on 648 patients operated on for colorectal surgical pathology in five Latin American institutions with international accreditation by the ERAS Society was collected. More than half of the patients were men (51%), median age was 63 years and older than 65 accounted for 45% (Table 1). It was history of tobacco consumption in 11% and alcohol consumption in 4%. Most frequent non-transmissible chronic diseases were Diabetes mellitus (10%), 47% of the patients had previous abdominal surgery, and 11% received chemotherapy in the past 6 months.

Table 1. General characteristics of the patients included in the study.

Variable	n	%
Median age (years) and IQR	63	21,5
Age group (years)		
<65	356	54,9
≥ 65	292	45,1
Sex		
Woman	317	48,9
Man	331	51,1
Smoker		
No	567	87,6
Yes	72	11,1
Interruption for surgery	8	1,2
Alcohol consumption		
No	618	95,4
Sí	26	4,0
Interruption for surgery	4	0,6
Medical history		
Diabetes mellitus	66	10,2
Serious heart disease	25	3,9
Severe lung diseases	26	4,0
BMI (Kg/m ²) median and IQR	25,6	6,2
Preoperative chemotherapy	74	11,4
History of abdominal surgery	303	46,8

IQR: Interquartile range (Q3-Q2); BMI: Body Mass Index

In 67% of patients who underwent surgery presented oncological colorectal disease (benign or malignant) (Table 2). The antithrombotic prophylaxis was administered in 66% of the patients. The surgical procedures performed more frequently were right (23%) and left (16%) hemicolectomies. The preferred surgical approach was laparoscopic (66%). The median surgical time was 180 minutes; 10% of patients were transferred to the ICU and the median ICU stay was 4 days. Lastly, 10.2% of patients were re-admitted and the mortality in the cohort was 1.1%.

Table 2. Characteristics related to surgery, anesthesia and outcome of the patients included in the study.

Variable	n	%
Patient with colorectal oncological disease (benign or malignant)	436	67,3
Surgical time (minutes) median and IQR	180	110
Median hospital stay (days) and IQR	4	4
Median ICU stay (days) and IQR	4	4
Thrombosis prophylaxis		
No prophylaxis	216	33,3
Anticoagulant (heparin or LMWH)	75	11,6
Combination of anticoagulant and compression	357	55,1
Surgical approach		
Standard laparoscopy	404	62,4
Open surgery	132	20,4
Approach through existing stoma	74	11,4
Laparoscopic hand-assisted	28	4,3
Conversion (Laparoscopic to open surgery)	10	1,5
ASA functional classification		
I	66	10,2
II	443	68,4
III	118	18,2
IV	6	0,9
No data	15	2,3
Admission to ICU during main stay	69	10,7
Death	7	1,1
Percentage of adherence to the ERAS protocol		
0 % - 59 %	154	23,8
60 % - 69 %	164	25,3
70 % - 79 %	176	27,2
80 % - 100 %	154	23,8

IQR: Interquartile range (Q3-Q2); ICU: Intensive Care Unit; LMWH: low molecular weight heparin; ASA: Functional classification of the American Society of Anesthesiology

Adherence to the ERAS protocol at the five institutions was on average 75% and 23% of the patients registered optimal adherence level (equal to or greater than 80%). Median hospital stay in the cohort was 4 days, however, was greater (8 days) in the group of patients with low adherence (less than 60%) and lower (3 days) in the group of patients with optimal adherence (equal to or greater than 80%) (Kruskal-Wallis $p = 0.008$) (Figure 2). Rho Pearson also presented a negative correlation between the percentages of adherence and duration of the hospital stay ($\rho = -0.42$).

In the bivariate analyses (Table 3), the level of optimal adherence had a shorter surgical time (median = 155 minutes, $p = 0.000$), less volume of fluids administered during the process (median = 800 cc, $p = 0.000$) and less hospital stay (median = 3 days, $p = 0.000$). The frequency of surgical complications was also lower (7.8%, $p = 0.002$), as well as the infections (2.6%, $p = 0.003$).

Lastly, entry to ICU was very low in patients with optimal adherence (2%, $p = 0.000$).

Anastomotic leak

There were 26 cases of anastomotic leak during the 30 postoperative days (26/648 = 4%). Incorporating main predictors to the logistic multivariate model ($R^2 = 0.22$), three predictors were identified as protective factors for the occurrence of leakage: use of the drain in the resection area (OR 0.30; 95% CI 0.09-0.98; $p = 0.048$); good adherence to the ERAS protocol (OR 0.13; 95% CI 0.03-0.57; $p = 0.007$); and optimal adherence (OR 0.08; 95% CI 0.01-0.48; $p = 0.005$) (Figure 3).

Infectious complications

In 55 patients there were infectious complications (55/648 = 8.49%). The final multivariate model ($R^2 = 0.17$) identified three factors that decrease the risk of infectious complications in the post-

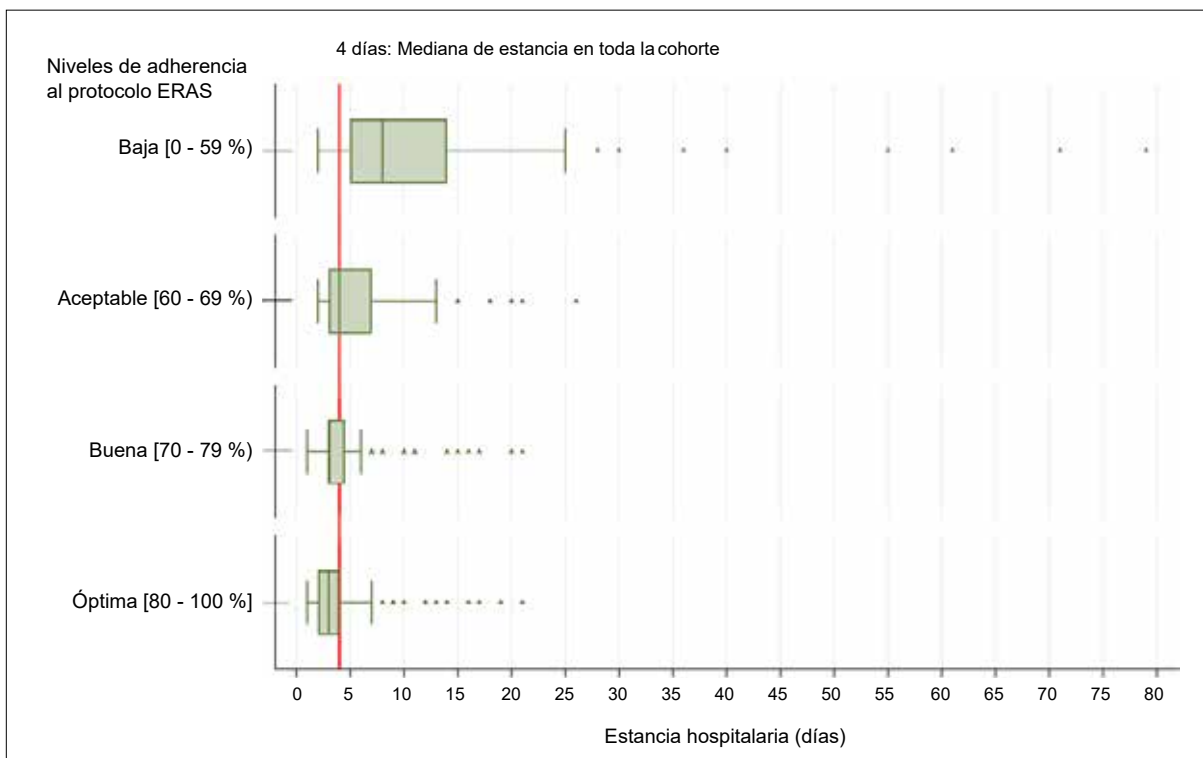


Figure 2. Adherence to the ERAS protocol and its relationship with hospital stay.

Table 3. Comparison between optimal levels of adherence to the ERAS protocol, characteristics of the intervention and complications during the postoperative period in colorectal surgery.

Variable	Total adhesion		p value
	< 80 % (n= 494)	≥ 80 % (n= 154)	
BMI (Kg/m ²), median (IQR)	25,3 (6,6)	26,3 (5,4)	0,193 **
Surgical time (minutes), median (IQR)	190 (125)	155 (76)	0,000 **
Total intravenous fluids during surgery (cc), median (IQR)	1100 (1200)	800 (470)	0,000 **
Intraoperative blood loss (cc), median (IQR)	50 (250)	150 (250)	0,000 **
Hospital stay (days), median (IQR)	4 (4)	3 (5)	0,513 **
Stay during readmission (days), median (IQR)	4 (5)	3 (2)	0,000 **
Stay during readmission (days), median (IQR)	14 (11)	7,5 (8)	0,037 **
Type of complication			
Surgical, n (%)	90 (18,3)	12 (7,8)	0,002
Renal, hepatic, pancreatic and gastrointestinal, n (%)	73 (14,8)	10 (6,5)	0,007
Infectious, n (%)	51 (10,3)	4 (2,6)	0,003
Respiratory, n (%)	17 (3,4)	-	0,020 *
Cardiovascular, n (%)	17 (3,5)	-	0,010 *
Pain, n (%)	16 (3,3)	1 (0,7)	0,059 *
Psychiatric, n (%)	6 (1,2)	-	0,194 *
Related to epidural or spinal anesthesia, n (%)	2 (0,4)	-	0,585 *
Anesthetic, n (%)	2 (0,4)	-	0,585 *
Admission to ICU, n (%)	66 (13,4)	3 (2,0)	0,000
Readmission during the postoperative period, n (%)	52 (10,5)	14 (9,1)	0,607

IQR: Interquartile range (Q₃-Q₂); BMI: Body mass index; ICU: Intensive Care Unit

(**) Wilcoxon rank sum test.

(*) Fisher's exact test when the assumptions to be able to perform the chi square test were not met.

perative period: laparoscopic surgery (OR 0.33; 95% CI 0.13-0.84; p = 0.021), good adherence to the ERAS protocol (OR, 0.27; 95% CI, 0.07-0.95; p = 0.042), and optimal adherence (OR 0.17; 95% CI 0.03-0.76; p = 0.046). The anastomosis between the small bowel and the colon (OR 11.6; 95% CI 1.24-127.99; p = 0.031) was the variable more frequently related to the appearance of infectious complications (Figure 4).

Post-surgical ileus

Ileus affected 37 patients in the postoperative period (37/648 = 5.73%). The multivariate model (R² = 0.09) did not identify variables from the statistical point of view that could be considered as a factor associated with the risk of ileus during the postoperative period (Figure 5).

Discussion

ERAS protocols for highly complex surgeries assign an important value to the postoperative hospital stay indicator as the best way to evaluate the results of its implementation, such as short stays, fewer medical or surgical complications, and fast recovery of the functions of the gastrointestinal tract in the case of colorectal pathology^{13,23,24}. The implementation of ERAS in elective colon and rectal surgery has favored outcomes in patients requiring this type of intervention. In the analyzed cohort, the median hospital stay was 4 days and decreased to 3 days with adhesions greater than 80%. A negative correlation was found between levels of adherence to the ERAS protocol and length of hospital stay²⁵.

Variables	Análisis multivariado*		p valor
	OR	IC 95 %	
Sexo (hombre)	0,71	(0,27-1,87)	0,502
Grupo de edad (≥65 años)	0,44	(0,15-1,24)	0,123
IMC (Kg/m ²)	1,08	(0,99-1,18)	0,054
ASA - II	0,68	(0,16-2,82)	0,596
ASA - III	0,57	(0,09-1,18)	0,542
Enfermedad oncológica colorrectal (Si)	0,98	(0,29-3,23)	0,976
Preparación de colon por vía oral (Si)	0,31	(0,08-1,13)	0,077
Tiempo quirúrgico (minutos)	1,00	(0,99-1,00)	0,110
Enfoque quirúrgico (laparoscópico)	0,59	(0,18-1,92)	0,391
Total de líquido endovenoso en cirugía	0,99	(0,99-1,00)	0,112
Grupo del procedimiento (colon e intestino delgado)	0,80	(0,21-2,93)	0,740
Opiáceos de acción corta en cirugía (remifentanilo)	0,36	(0,12-1,09)	0,071
Opiáceos de acción prolongada	0,41	(0,10-1,56)	0,192
Anastomosis intestino delgado a colon	2,36	(0,19-28,34)	0,497
Anastomosis colon a colon	0,75	(0,03-16,94)	0,860
Anastomosis colon a recto	1,55	(0,06-35,07)	0,780
Técnica anastomótica - Grapadora circular	12,84	(0,70-234,27)	0,085
Técnica anastomótica - Grapadoras lineales	3,50	(0,30-40,14)	0,314
Técnica anastomótica - Grapadora lineal y cierre con sutura manual	13,85	(0,68-281,96)	0,087
Dren en la zona de resección (Si)	0,30	(0,09-0,98)	0,048
Uso postoperatorio de AINES (Si)	0,41	(0,11-1,57)	0,098
Adherencia - (60 % a 70 %)	0,36	(0,09-1,32)	0,125
Adherencia - (70 % a 80 %)	0,13	(0,03-0,57)	0,007
Adherencia - (80 % a 100 %)	0,08	(0,16-0,48)	0,005

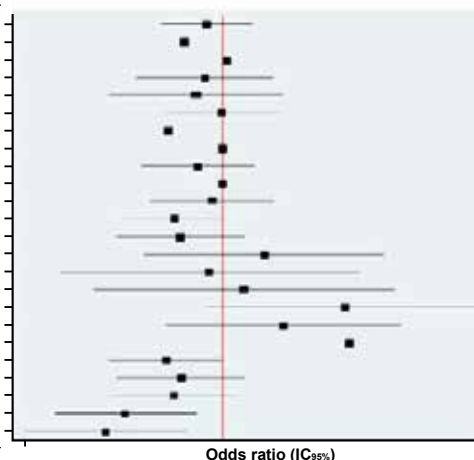


Figure 3. Factors associated with the appearance of anastomotic leak as a complication in elective colorectal surgery with ERAS protocol. Multicenter study (n = 648)

Variables	Análisis multivariado*		p valor
	OR	IC 95 %	
Sexo (Hombre)	0,31	(0,62-2,75)	0,467
Grupo de edad (265 años)	0,61	(0,28-1,33)	0,219
IMC (Kg/m ²)	1,06	(0,99-1,13)	0,085
ASA - II	1,35	(0,33-5,42)	0,672
ASA - III	1,19	(0,24-5,78)	0,826
Enfermedad oncológica colorrectal (Si)	1,2	(0,44-3,27)	0,719
Preparación de colon por vía oral (Si)	0,50	(0,19-1,30)	0,158
Tiempo quirúrgico (minutos)	1,00	(0,99-1,00)	0,841
Enfoque quirúrgico (laparoscópico)	0,33	(0,13-0,84)	0,021
Total de líquido endovenoso en cirugía	1,00	(0,99-1,00)	0,212
Grupo del procedimiento (colon e intestino delgado)	0,46	(0,15-1,42)	0,181
Opiáceos de acción corta en cirugía (remifentanilo)	0,54	(0,23-1,26)	0,156
Opiáceos de acción prolongada	0,93	(0,31-2,74)	0,900
Anastomosis intestino delgado a colon	11,6	(1,24-107,99)	0,031
Anastomosis con reservorio ileoanal (IPAA)	12,41	(0,37-408,15)	0,158
Anastomosis colon a colon	5,16	(0,55-48,24)	0,150
Anastomosis colon a recto	4,95	(0,41-59,28)	0,207
Anastomosis Coloanal	16,67	(0,80-345,16)	0,069
Anastomosis múltiples	12,31	(0,69-216,86)	0,086
Técnica anastomótica - Grapadora circular	1,12	(0,30-4,11)	0,858
Técnica anastomótica - Grapadoras lineales	0,72	(0,20-2,54)	0,620
Técnica anastomótica - Grapadora lineal y cierre con sutura manual	0,81	(0,08-7,73)	0,860
Dren en la zona de resección (Si)	0,38	(0,14-1,01)	0,054
Uso postoperatorio de AINES (Si)	0,77	(0,22-2,62)	0,682
Adherencia - (60 % a 70 %)	0,63	(0,23-1,76)	0,385
Adherencia - (70 % a 80 %)	0,27	(0,07-0,95)	0,042
Adherencia - (80 % a 100 %)	0,17	(0,03-0,76)	0,046

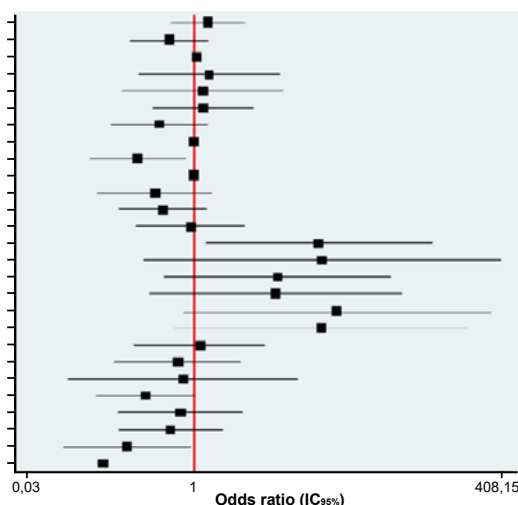


Figure 4. Factors associated with the appearance of infectious complications in elective colorectal surgery with ERAS protocol. Multicenter study (n = 648)

There was a higher incidence of complications with adhesions less than 60%. Although some studies have described good results with low adhesions to the protocol²⁰, the results of our research showed that with equal or superior adhesions of 80%, incidence of complications, hospital stay and others negative outcomes decrease significantly, indicating a clear dose-response re-

lationship^{26,27}. The incidence of the anastomosis leak in the study (4%) was similar to that reported by other multicenter studies²⁸⁻³².

Other studies reported that the lack of balanced fluid therapy (OR 3.8) and early mobilization (OR 20.7), prolonged urinary catheter use (OR 4.5) and the use of drains (OR 2.8) were significantly associated with long stays^{19,20,32,33}.

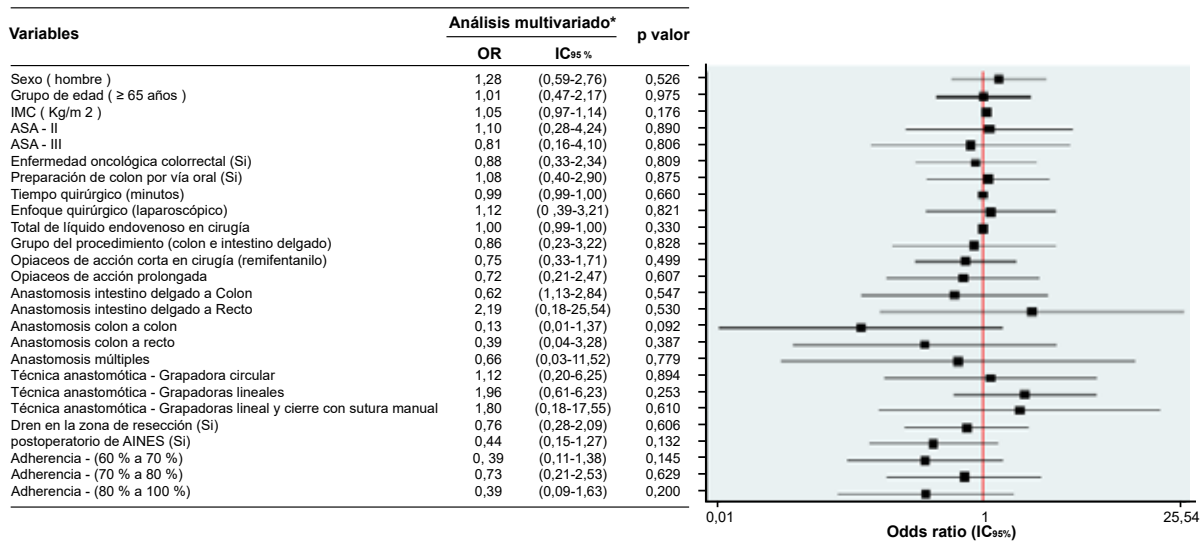


Figure 5. Factors associated with the appearance of prolonged postoperative ileus in elective colorectal surgery with ERAS protocol. Multicenter study (n = 648)

This study showed that, independently of baseline patients' conditions undergoing colon and rectal surgery, with or without oncological disease, or having a condition of physiological fragility such as those found in the elderly, finally was the level of compliance to strategies to the ERAS protocol the main indicator to reach best results in health care and a short hospital stay, and remains the attribute of higher value in institutions with ERAS protocol, which is consistent with the findings widely described in the literature³⁴⁻³⁵.

The expected complications in a surgical procedure are determined by the degree of complexity of the surgery and the expertise of the surgeon, as well as the baseline patients' conditions, diseases and degree of control, systemic compromise and stage of an oncological or chronic degenerative disease, and other identified factors that can be intervened or modified. For all the situations it is extremely important to follow the optimization guidelines in clinical preconditioning or pre-rehabilitation, with the purpose to achieve best outcomes in care, both for the patient as for the institutions that perform these type of procedures^{20,36-39}.

Few studies have evaluated and established a proposal on the necessary number of colorectal surgical procedures for ERAS teams to achieve a suitable learning curve and adherence to the protocol. Some authors mention that a minimum of 76 elective open colorectal surgical procedures are required^{40,41}. So far, most of the studies on ERAS protocols and outcomes in colorectal surgery have focused to evaluate and to compare the level of adherence to the protocol with results such as postoperative hospital length of stay related to main procedure and frequency of complications. This study shows the analysis of the implementation in Latin American institutions and the results in colon and rectal surgery were consistent with the positive findings reported in institutions in developed countries^{13,31,41-44}.

Recent systematic reviews have generated concern about not limiting decisions to the degree of adherence to the program related to the outcomes of interest, but to know the effect of this set of interventions with relationship to the more critical outcomes^{19,26}. However, in high complexity, the results showed that the technical part should be considered as the decisive factor for the success of the procedure, establishing that

the technique in the elaboration of anastomoses, persists as the major risk factor for failure and should be the critical point to be analyzed by surgeons, who should seek to standardize the procedure and define the technological tools that decrease the risk to implement the rational use. Finally, our results can be considered as an evaluation of the impact of the ERAS program in Latin American hospitals in the last four years.

Conclusions

The overall incidence of complications of high impact on elective colon and rectal surgery (leak anastomosis, infectious complications, prolonged ileus and mortality) were very low after the implementation of the ERAS protocol in hospitals in Latin America. Adherence to the ERAS strategies greater than 80% (considered optimal) was identified as the factor statistically associated with decreasing the incidence of anastomotic leakage. This adherence, which has a positive impact on outcomes, helps to reduce fistulas, which represent the complication most feared by the surgeon, ileus may be less, that determines the extension of the stay and less infection of the surgical site (ISO) as an indicator of quality.

The surgical technique is established as the determining factor of the outcome and constitutes the higher factor of confusion for the strategies analysis. Complications during the post-operative period are directly related with the functional responsiveness of the gastrointestinal tract, subjected to the injury of the surgical procedure and to the systemic and emotional response that the procedure generates. Nevertheless, surgical pre-habilitation and rehabilitation during the recovery phase reflect the degree of adherence to the strategies to the ERAS protocol, determine the results of the intervention, which clearly indicates a dose-response relationship.

Compliance with ethical standards

Informed consent: This is a retrospective review of medical records of patients underwent surgery, so there is no risk for patients and does not require obtaining informed consent. The research was

approved by the Institutional Ethics Committee (CEIFUS 513-19).

Conflict of interest: None.

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