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ORIGINAL ARTICLE

Development of an enhanced recovery after surgery (ERAS) protocol in laparoscopic colorectal surgery: results of the first 120 consecutive cases from a university hospital

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Abstract The ERAS® represents a dynamic culmination of upon perioperative care elements, successfully applied to different surgical specialties with shorter hospital stay and lower morbidity rates. The aim of this study is to describe the introduction of the ERAS protocol in colorectal surgery in our hospital analysing our first series. Between September 2014 and June 2016, 120 patients suffering from colorectal diseases were included in the study. Laparoscopic approach was used in all patients if not contraindicated. Patients were discharged when adequate mobilization, canalization, and pain control were obtained. Analysed outcomes were: length of hospital stay, readmission rate, perioperative morbidity, and mortality. Malignant lesions were the most common indication (84.2%; 101/120). Laparoscopic approach was performed in the 95.8% of cases (115/120) with a conversion rate of 4.4% (5/115). Surgical procedures performed were: 36 rectal resections (30%), 36 left colonic resections (30%), 42 right hemicolectomy (35%), and 6 Miles (5%). The median hospital stay was of 4 (3–34) days in the whole series with a morbidity rate of 10% (12/120); four patients experienced Clavien-Dindo $\geq$ IIIa complications; and only one anastomotic leak was observed. No 30-day readmission and no perioperative mortality were recorded. At the univariate analysis, the presence of complications was the only predictive factor for prolonged hospital stay ($p < 0.001$). In our experience, implementation of ERAS protocol for colorectal surgery allows a significant reduction of hospital stay improving perioperative management and postoperative outcomes.

Keywords Enhanced recovery after surgery · Colorectal surgery · Colorectal cancer · Laparoscopy · Hospital stay · Morbidity

Introduction

Perioperative management in colorectal surgery is still under debate. Despite the validation of the enhanced recovery after surgery (ERAS®), first described by Kehlet et al. in 1999, patients undergoing colorectal resection still have to "accept" a 7–10-day postoperative stay in several centers without any true advantages [1].

The ERAS® represents a dynamic culmination of upon perioperative care elements, now being successfully applied to different surgical specialties such as urology, gynecology, gastro-intestinal, hepato-biliary, and pancreatic surgery [2–8]. However, the strongest evidences for ERAS implementation are described in the care of patients undergoing open colorectal surgery [9, 10]. The application of ERAS® in these patients, in fact, leads to a reduction of postoperative morbidity and hospitalization, overall improving outcomes [11–16]. In this setting, minimally invasive colorectal surgery, laparoscopic, or robotics have further reduced the surgical stress resulting in best perioperative outcomes. The combination of ERAS protocol and laparoscopy has now to be considered the optimal strategy for patients undergoing elective colorectal surgery [17, 18].

Despite these scientific evidences, the ERAS protocol in colorectal surgery is struggling to widely impose itself due

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to cultural barriers and to confidence with the results achieved using the traditional postoperative care pathways. To create and fully apply a correct ERAS protocol in colorectal surgery, a complete multidisciplinary collaboration between surgeons, anesthesiologist, nutritionist, and nurses is absolutely necessary [11]. For these reasons, the protocol itself has to be considered certainly demanding in terms of department, in-hospital organization, and allocation of resources [19].

The aim of this study is to describe the adoption and implementation of the ERAS protocol in colorectal surgery in our hospital performing a prospective evaluation of its results, describing our department organization.

Methods

From September 2014, the ERAS protocol for Colorectal Surgery was created and applied in our Day and Week Surgery unit. Our unit is an autonomous department with its own organization, with a case load of around 1600 procedures per year. The nursing staff is specialized in standardized care pathways resulting in a shorter hospitalization of patients treated for several different procedures such as cholecystectomy, proctological diseases, hernia repair, and thyroid surgery. Colorectal surgery was recently introduced in our department thanks to the application of the ERAS protocol, which allows the optimization of the perioperative management for colorectal diseases. Especially, to reduce the sanitary cost achieving an optimal management, aim of the department is to obtain the discharge of all the patients on Saturday morning, closing the activity (whether of medical and nursing staff).

The first step to start with the ERAS protocol was the creation of a multidisciplinary team composed by: two senior surgeons, three residents in surgery, two anaesthesiologists, and the nursing staff.

Inclusion criteria

All patients treated electively for benign or malignant colorectal disease were included in the study. Patients defined as ASA IV and presenting as emergent were excluded. All patients had to sign an informed consent during the preoperative evaluation regarding the type of operation proposed and the ERAS protocol application.

Preoperative evaluation

All the patients included in the ERAS protocol underwent a preoperative multidisciplinary evaluation performed by the ERAS team. During this evaluation, a brochure regarding all the step of the ERAS protocol was given to the patients. All the informations regarding the preoperative step to follow, such as smoking quit or alcohol use, the bowel preparation, and the department organization, were clearly described in the brochure. Moreover, a table with all the postoperative ERAS step that the patients needed to follow during the hospitalization was given.

Bowel preparation

According to the last published ERAS guidelines for colorectal surgery [9, 10], no bowel preparation was administered except for a 5-day residual free diet. An evacuating enema (120 mL) the night before and the morning of surgery was added in patients undergoing rectal resection with or without a planned ileostomy. All patients were allowed regular diet until 6 h and clear fluids until 2 h before surgery. Carbohydrate load was not administered, because this was not available in our hospital.

Thromboembolism prophylaxis with low molecular weight heparins was administered according to patient's comorbidities.

Antibiotic prophylaxis with cefazolin and metronidazole, in agreement with our hospital guidelines, was always administered perioperatively.

Anaesthesiologic protocol

No premedication was administered. Three different types of anesthesiology technique were used and compared: general anesthesia with infiltration of the surgical incision; epidural catheter for patients treated for left colon or rectal resection; and TAP (Transversus abdominis plane) block for right hemicolectomy [20]. In all cases restricted intraoperative fluid administration (6–8 ml/kg/h), prevention of hypothermia during surgery and anti-emetic prophylaxis were used. Moreover, no opioids were used during all the perioperative period. Immediate postoperative monitoring was performed in the recovery room where the Visual Analogue Scale (VAS) for pain recognition was routinely evaluated by the anesthesiologist [21].

Surgical technique

Laparoscopic approach with a 4-trocar technique was always the first choice when not contraindicated. Abdominal drainage was routinely placed for left hemicolectomy and rectal resections. If open approach was deemed necessary, a midline incision was preferred. Nasogastric tube was placed immediately after anesthesia and removed always upon awakening. A bladder catheter was always placed before the incision.

Postoperative care

Analgesia control was obtained using intravenous paracetamol or ketorolac administration when necessary. No opioids were administered. If present, epidural bupivacaine infusion was prolonged until the 1st postoperative day (POD) with eventual association of non-steroidal anti-inflammatory drugs. The VAS scale was routinely evaluated the 1st POD by the surgeons.

On the 1st POD, bladder catheter was removed and urinary output monitored. An immediate postoperative liquid diet and mobilization were administered 4 h after surgery. Withdrawal of intravenous infusions (0.7–1 ml/kg/h) was obtained during the 1st POD and a light semiliquid meal was allowed.

From the 2nd POD a free diet was administered and patient mobilization was further encouraged and increased gradually. All the meals had to be consumed sitting at the table. From the 3rd POD, an evacuating enema was administered after right hemicolectomy. Vaseline oil during the meal was used for left colon and rectal resection.

Blood works were routinely performed on the 1st and 3rd POD.

Discharge criteria were: normal vital signs and blood works, absence of complications or symptoms, autonomous adequate walking and feeding, spontaneous diuresis, and complete canalization. Moreover, a good pain control had to be obtained using only oral medications (paracetamol).

After the discharge for all the patients, an outpatient clinic evaluation was planned at 7 and 15 days from the operation. Moreover, a 30-day follow-up was performed by phone and all the patients treated for malignant disease were discussed at the multidisciplinary oncological meeting and included in the oncological follow-up of our hospital

Statistical analysis

All the perioperative data were registered in a prospective database and analysed. Postoperative complications were defined using the Clavien–Dindo Classification [22].

To evaluate the evolution of the application of our protocol, the series was divided into two different groups: Period 1 (first half of the cases) and Period 2 (last cases performed).

Continuous variables were presented as mean ± standard deviation or median (range) when appropriate and categorical variables were presented as frequency (percentage). The one-way analysis of variance (ANOVA) test, the Chi-square test, and the *t* Student's test were used when appropriate for comparisons. Univariate analysis was performed through a stepwise linear regression model using length of hospital stay as dependent variable and age >65 years and BMI <25 kg/m [2], Male gender, ASA score, intraoperative infusions >1600 ml, presence of complications, laparoscopy and indications (Benign/Malignant) as independent factors. Statistical analysis was carried out using SPSS software (Version 20.0. Armonk, NY: IBM Corp) for MacOsX. The significance level was set at $p < 0.05$.

Results

From September 2014 to June 2016, 120 cases were included in the study and analysed. Patients' characteristics are summarized in Table 1. The 84.2% of patients (101/120) were treated for malignant disease, while the 15.8% (19/120) presented benign disease such as diverticular stenosis or complete rectal prolapse (who underwent a Frykman–Goldberg procedure).

One hundred and fifteen patients (95.8%) were operated laparoscopically with a conversion rate of 4.4% (5/115) due to oncological reasons or presence of strong adhesions.

Types of procedures performed with mean operative time are depicted in Table 2. Temporary ileostomy was

Table 1 Patients' Characteristics

Preoperative characteristics	
Age (years)	64.2 ± 12.5
BMI (Kg/m^2)	26.1 ± 4.6
Gender	
Female	48.3% (58/120)
Male	51.6% (62/120)
ASA Score	
1	1.6% (2/120)
2	41.7% (50/120)
3	56.7% (68/120)
Mean ASA Score	2.5 ± 0.5
Indications	
Malignant	84.2% (101/120)
Benign	15.8% (19/120)

Table 2 Type of operation with mean operative time (min)

Type of procedure	*n* (%)	mean OT (min ± SD)
Right hemicolectomy	42/120 (35%)	132.5 ± 44.9
Left hemicolectomy	23/120 (19.2%)	152.9 ± 32.9
Sigmoidectomy	13/120 (10.8%)	122.9 ± 17.9
Rectal resection	36/120 (30%)	194.9 ± 59.2
Miles	6/120 (5%)	213.3 ± 34.8

* *p* comparison local infiltration vs TAP-Block/Epidural

Table 3 Anaesthesiology results

Anaesthesiologic technique	*n* (%)	Intra-op. infusions (ml)	*p**	VAS recov. room	*p**
Local infiltration of surg. incisions	41/120 (34.2%)	1821.9 ± 713.6	0.6	2.8 ± 0.6	**<0.001**
TAP-block	30/120 (25%)	1560 ± 487.6		2.2 ± 0.4	
Epidural anaesthesia	49/120 (40.8%)	1465.8 ± 708		2.1 ± 0.3	

performed in 12 patients; all of these underwent a rectal resection for rectal cancer after neoadjuvant chemo-radio therapy.

With a mean intraoperative infusions of 1631 ± 682.3 ml and a mean VAS scale recorded in the recovery room of 2.4 ± 0.6; Anaesthesiology results are summarized in Table 3. The use of epidural anaesthesia and the TAP-block lead to a significant reduction of the VAS score recorded in the recovery room compared to infiltration of surgical incisions (Table 3).

The mean VAS score observed in the 1st POD was of 2.6 ± 0.8, bladder catheter was removed always during the 1st POD and the first flatus was obtained after a mean of 1.9 ± 0.7 POD. A complete canalization was obtained after a mean of 3.3 ± 1.2 POD. The median hospital stay (HS) was 4 days (3–34) and the length of HS according to the different operations performed is depicted in Table 4.

With a morbidity rate of 10% (12/120), 4 patients (3.3%) experienced major complications (Clavien–Dindo ≥ IIIa): one colostomy sub-occlusion after miles treated by nasogastric tube and endoscopic evaluation due to bowel edema (IIIa); one ureteral lesion during rectal resection treated by stent placement (IIIb); one anastomotic fistula treated performing an ileostomy (IIIb); and one perioperative myocardial ischemic attack treated by coronary stent placement (IV); moreover, 8 patients experienced minor complications (CD II) represented, respectively, by: postoperative nausea and vomiting during the 4th POD treated with nasogastric tube placement in two patients; dural lesion during epidural catheter positioning, treated by immobilization and non-steroidal anti-inflammatory drugs due to the presence of headache until the 3rd POD; Urinary infection in four cases. Moreover, one patient experiences an anastomotic leak after anterior rectal resection with ileostomy. No treatment was needed in this case, except for antibiotics and the drainage was left in place until complete resolution with discharge after 8 days (CD grade II).

Table 4 Postoperative hospital stay

Type of procedure	Median HS (days)
Right hemicolectomy	4 (3–8)
Left hemicolectomy	4 (4–15)
Sigmoidectomy	4 (4–5)
Rectal resection	5 (4–34)
Miles	5 (4–6)

No perioperative mortality was recorded and no 30-day rehospitalizations were observed in this series. One patient developed an internal hernia treated surgically after more than 90 days from the operation. Moreover, one patient with ileostomy experienced severe hypokalemia around 4 months from the operation; this was treated with in-hospital 2-day intravenous potassium administration.

At the univariate analysis, the presence of complications was the only predictive factor for prolonged hospital stay ($p < 0.001$; Table 5).

The differences observed between Period 1 (first 60 cases) and Period 2 (last 60 cases) are depicted in Table 6. During Period 2, a significant increase of the use of TAP-block and epidural anaesthesia was observed ($p = 0.03$ and 0.05, respectively) with a reduction of infiltration of surgical incision ($p < 0.01$) resulting in a lower VAS scale in recovery room ($p = 0.001$) and paracetamol grams per day ($p = 0.001$).

Discussion

Since first described by Kehlet [1], the application of ERAS protocols in patients undergoing colorectal surgery, whether open or laparoscopic, increased worldwide showing significant positive effects on postoperative surgical and medical outcomes [11, 17, 18]. Certainly, this perioperative management was originally described for open surgery, with the aims of a reduction of hospital stay and postoperative pain. However, nowadays, laparoscopic approach for colorectal disease has to be considered the gold-standard for colonic resection and the optimal approach for rectal surgery.

Several studies demonstrated that laparoscopy itself leads to a reduction of the HS presenting better postoperative outcomes compared to open; for this reason, the association of ERAS protocols and laparoscopy has to be considered the best perioperative approach for patients suffering from colorectal disease, whether benign or malignant [13, 17].

In our department, laparoscopic approach for colorectal surgery is performed since 10 years and we decided to move through ERAS to optimize our perioperative

Table 5 Logistic regression analysis of the predictive variables of prolonged HS

Covariates			Univariate analysis		
	n	%	*p*	OR	95% CI
Age (years)			0.4	−0.8	−1.7 to 0.7
<65	66/120	55			
>65	54/120	45			
Gender			0.6	−0.4	−1.5 to 0.9
Male	62/120	51.6			
Female	58/120	48.3			
BMI (kg/m^2)			0.2	1.1	−0.5 to 1.9
<25	59/120	49.1			
>25	61/120	50.8			
ASA			0.5	−0.6	−1.5 to 0.8
1/2	52/120	43.3			
3	68/120	56.7			
Complications			**<0.001**	4.6	2.6 to 6.5
Yes	12/120	10			
No	108/120	90			
Indications			0.5	−0.6	−2.1 to 1
Benign	19/120	15.8			
Malignant	101/120	84.2			
Intra-op infusions (ml)			0.6	−0.5	−1.6 to 0.9
<1600	76/120	63.3			
>1600	44/120	36.6			
Surgical approach			0.6	0.5	−1.8 to 3.4
Laparoscopy	115/120	95.8			
Open	5/120	4.2			

$p < 0.05$ are in bold

Table 6 Analysis of the changes during the two different time periods

Outcomes	Period 1 (first 60 cases)	Period 2 (last 60 cases)	*p*
Anaesthesiologic techniques			
Infiltration of incision	55% (33/60)	13.3% (8/60)	**<0.001**
Epidural	30% (18/60)	51.7% (31/60)	**0.02**
Tap-Block	15% (9/60)	35% (21/60)	**0.01**
VAS recovery room	2.7 ± 0.6	2.2 ± 0.5	**0.001**
VAS on 1st POD	2.7 ± 0.9	2.4 ± 0.7	0.06
Paracetamol per day (g)	1 ± 0.7	0.5 ± 0.4	**0.001**
Intra-op infusions (ml)	1752.9 ± 779.3	1508.2 ± 541.4	0.07
Hospital Stay (days)	4 (3–34)	4 (3–8)	0.3

$p < 0.05$ are in bold

management improving our outcomes [23–28]. When we decided to start our ERAS protocol for colorectal surgery, we strongly believed in the application of these care elements. After our first 120 cases, we observed a median HS in the whole series was of 4 POD with a maximum of 5 days for rectal resection or Miles procedure.

Associating loco regional anaesthesia, whether epidural or Tap-block, an optimal postoperative pain control was obtained. Moreover, no pulmonary complications were observed in all the series, probably thanks to the immediate mobilization and the avoided perioperative over-hydration obtained in all patients.

No 30-day rehospitalisation was observed with a morbidity rate of 10%. Only four patients experienced severe complications and only one anastomotic leak was observed requiring ileostomy. Moreover, in one case, an anastomotic leak after anterior rectal resection with ileostomy was observed; in this patient, the presence of ileostomy leads to

a conservative treatment without any reoperation needed, and discharge after 8 POD. The possible reduction of morbidity rate with the application of an ERAS protocol is already described in literature even if under debate [11, 13, 29–32]. In this setting, it is certainly not easy to analyse and explain our optimal results; we strongly believed that a dedicated multidisciplinary team and a strict application of the majority of the ERAS guidelines are the key points to achieve good postoperative medical and surgical outcomes. Obtaining these results, a cost reduction could be speculated, as already described in literature [33–36], with an additional improvement of perioperative treatment quality whether for patients, doctors, and nursing staff involved. Our future aim is to clearly define the real cost-effectiveness of the application of an accurate ERAS protocol for colorectal surgery in a University Hospital.

Regarding the analysis of our learning curve, after the first cases, we decided to move toward a major use of the locoregional anaesthesia. This decision was related to a better knowledge of the protocol with an improvement of the collaboration between surgeons and anaesthesiologists involved in the dedicated ERAS team. The results showed a reduction of the VAS scale related to these changes. We believed that a continuous audit and monitoring of the results during the application of the protocol is a crucial aspect to create a continuous evolving process for the ERAS application and accuracy.

Several studies have already demonstrated that maximizing patients adherence to the ERAS guidelines is directly related to postoperative results. A cutoff of 70% was set to obtain a significant improvement of morbidity rate with a reduction of HS [12]. We cannot complete all the ERAS items due to the unavailability of carbohydrates fluid solution in our hospital. The benefits of this item are described and demonstrated in literature. However, it has to be considered one of the numerous ERAS items described for colorectal surgery and its importance is still under debate [37]. Final conclusions cannot be drawn regarding the possible influence of the presence/absence of the carbohydrates fluid solution, but our aim is to start to use it to maximize our adherence to the ERAS society guidelines. Another controversial item is represented by the use of the abdominal drainage for colonic resection. Differently from the ERAS guidelines [9], we prefer to place an abdominal drainage for 48 h after left hemicolectomy for malignancy. We believed that it has to be considered still a valid tool during the first 2 POD and in our experience the presence of the drainage did not procured any additional pain and did not prolonged the hospital stay.

It is still unclear which has to be considered the most important item of the ERAS protocol for colorectal surgery [38]; we believe that an accurate and multidisciplinary counselling, an adequate anaesthesia with optimal pain management, an immediate mobilization and food administration with the additional use of laparoscopy represent the fundamental steps to follow to achieve the best postoperative results. Moreover, it is important to create a dedicated multidisciplinary team with a perfect knowledge of the scientific basis of the protocol and a strong belief in its application. Future studies are certainly necessary to establish the importance of each single ERAS care elements.

Certainly, our small sample size and the retrospective fashion of the study represent possible limitations. However, we strongly believe that our results show the possible advantages of the creation and implementation of an ERAS protocol in colorectal surgery in a dedicated department of a University Hospital.

In conclusion, in our experience, the adoption and the implementation of ERAS protocol for colorectal surgery allow an immediate significant reduction of HS improving perioperative management and postoperative outcomes. Dedicated multidisciplinary team and strict application of ERAS items are crucial to obtain an unequivocally outcomes improvement compared to the conventional traditional care pathways, reflecting the absolutely benefits of ERAS protocol.

Compliance with ethical standards

Conflict of interest All the authors declare that they have no conflict of interest.

Research involving human participants and/or animals This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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