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ORIGINAL ARTICLE

Is an enhanced recovery program (ERP) after rectal surgery as feasible as after colonic surgery? A multicentre Francophone study of 870 rectal resections

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Abstract

Background Enhanced recovery program (ERP) is well-established in colorectal surgery. Rectal surgery (RS) is known to be associated with high morbidity and prolonged hospital stay, which might explain why ERPs are less applied in this specific group of patients. The aim of this large-scale study was to assess the feasibility of an ERP in RS compared with colonic surgery.

Methods This study was a retrospective analysis of a prospective database including 3740 patients eligible for colorectal resection from February 2014 to January 2017 in 75 European Francophone centres. Patients were divided into two groups (colon group C vs. rectum group R). The main endpoint was compliance with ERP components. A subgroup analysis was performed in patients for whom a defunctioning stoma (DS) was required after RS.

Results A total of 3740 patients were included. There were 2870 patients in group C and 870 patients in group R. The overall compliance rate for ERPs was 81.71% in group C and 79.09% in group R. Patients were significantly less mobilized within 24 h in group R. Specific recommendations for RS concerning bowel preparation and abdominal drainage were significantly less implemented. Overall morbidity was significantly higher in group R. Mean length of stay (LOS) was significantly shorter in group C. In the sub-group analysis, a DS was significantly associated with fewer compliance with early mobilization and early feeding, leading to significantly longer LOS (group R).

Conclusion ERP is safe and effective in RS, despite the well-known higher morbidity and LOS compared with colonic surgery. DS could be a limiting factor in ERP implementation after RS.

Keywords Enhanced recovery program · Compliance · Rectal surgery · Colonic surgery

Introduction

Enhanced recovery program (ERP) is now a well-established care protocol in colorectal surgery [1]. Major rectal surgery, involving rectal resections with infra-peritoneal anastomosis, is known to be associated with high morbidity and prolonged hospital stay compared with colonic resection, which may explain why ERPs are less fully applied [2, 3]. Some ERP components recommended for colonic surgery have been successfully applied to rectal resections. Rectal/pelvic resections are often included in overall analysis or set aside or discounted as a group for "special consideration" [4, 5]. In the present work, we have specifically considered the application of ERP principles to this special population of rectal resection patients. The aim of this large-scale study was to assess the feasibility of ERP in rectal resections compared with colonic surgery.

Methods

Type of study

This study was a retrospective analysis of a prospective large database from the Francophone Group for Enhanced Recovery

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after Surgery (Groupe Francophone de Réhabilitation Améliorée après Chirurgie - GRACE). Seventy-five centres, registered from the GRACE-AUDIT database, took part in this study. This analysis included consecutive patients who underwent elective colorectal resection for benign or malignant disease between February 2014 and January 2017. All the patients were managed within the ERP established by the GRACE working group (www.grace-asso.fr), based on the published national and international recommendations. The participant teams were trained for ERP whether owing to on-site visit of a member of GRACE or less frequently by visiting the GRACE website and downloading the documents and procedures for an optimal implementation of ERP. Patients were divided into two groups, depending on the location of resection. The control group (group C) included patients undergoing colonic resection or colorectal resection with intraperitoneal anastomosis. Group R consisted of patients with rectal surgery, where low anterior resection of the rectum (LAR) with or without defunctioning stoma was performed. Converted laparoscopic procedures were included in laparoscopy group, according to intention to treat basis.

Data collection

Data was stored anonymously to ensure confidentiality. Collected information comprised patient demographics, comorbidities, type of surgical resection (colon vs. rectum), postoperative course (length of hospital stay, overall morbidity, and 30-day mortality), and which different components of the colon or rectum ERP were or were not applied. Exclusion criteria included emergency surgery, pregnancy, patient refusal to take part, and inability to contact the patient after discharge.

Data collection was registered at the French data protection agency (CNIL) as required by the modified Data Protection Act of Jan 6, 1978. CNIL authorization was acquired on December 8, 2014 (No. 1817711).

Compliance with each ERP component was assessed and compared between group C and group R.

ERP components

The protocol for colonic and rectal surgery has been published in detail elsewhere and is specified by the GRACE group (www.grace-asso.fr/espace-membre) according to national and international recommendations. The details of each component by surgical specialty (colonic or rectal) are presented in Table 1.

Endpoints

Compliance with ERP components was the main endpoint. Secondary endpoints were length of stay, readmissions, overall morbidity and 30-day mortality, rate of anastomotic leak, and unplanned surgical procedures (reinterventions).

A subgroup analysis was performed in patients where a defunctioning stoma was required after rectal surgery.

Statistical analysis

The data were analysed with Stata 15 software (StataCorp LP, College Station, USA). Categorical parameters were presented as frequencies and associated percentages, and quantitative data (i.e. length of stay) as mean ± standard deviation. The comparisons concerning categorical data between groups were performed using Chi-squared and Fisher's exact test. Length of stay was compared by Student *t* test. The type I error was two-sided at 0.05. A sub-group analysis was carried out according need or not for defunctioning stoma in rectal procedure.

Results

A total of 3740 patients were included in this study between February 2014 and January 2017 in 75 GRACE expert centres. Group C involved 2870 patients and group R (infraperitoneal rectal resection) 870 patients. Demographic data and characteristics of patients were comparable between the two groups except for age and sex (Tables 2 and 3). Briefly, the patients in group R were significantly older, but had fewer malignant diseases (61.2% vs. 41.5% $p < 0.001$) but more neoadjuvant therapy than in group C. Beside malignant diseases, the remaining indications for rectal resections were endoscopically unresectable polyps with high-grade dysplasia, endometriosis, inflammatory bowel diseases, and rectovesical or colorectal fistula.

A total of 225 laparoscopic procedures had to be converted in group C (7.8%) and 70 in group R (8.05%) (p = NS).

The compliance rates for each ERP component for the other endpoints in each group are presented in Table 4.

The overall compliance rate for all components of the ERP was 81.71% in group C and 79.09% in group R ($p = 0.083$). No components were implemented at a rate of less than 50%. The least often implemented component for both groups was intraoperative adequate vascular filling. A total of 13/19 components were implemented in more than 80% of instances in group C and 8/19 in group R. Among the "surgical" components, compliance with the specific recommendations regarding bowel preparation and abdominal drainage in rectal surgery was fewer in group R, than in group C. Similarly, patients were significantly less often mobilized within 24 h after rectal surgery than they were after colonic surgery (79.54% vs. 84.22%). On the other hand, postoperative multimodal analgesia, preoperative immunonutrition, and compliance with preoperative fasting conditions (6 h solids and 2 h clear liquids) were better applied in rectal surgery.

Table 1 ERP component features by surgical procedure (colon or rectum)

	ERP component	Colon	Rectum	References
Preoperative period	Information	Systematic patient information, "education" and counselling recommended.		[6]
	Immunonutrition	- Recommended as a preoperative adjunct to elective colorectal surgery for cancer - Not recommended in elective non-carcinologic colorectal surgery		[7–9]
	Premedication	Not recommended (only if necessary)		[10]
	Bowel preparation	Not recommended	Recommended The literature does not permit any recommendation with a high level of evidence.	[11]
	Preoperative fasting	< 6 h for solids and 2 h for clear fluids (water, coffee or clear juice)		[12]
	Preoperative carbohydrate loading	Recommended before elective colorectal surgery except for patients with diabetes or gastric emptying disorders		[13]
Intra-operative period	Laparoscopy	Recommended Laparoscopy approach should be preferred whenever possible		[14–16]
	Abdominal drainage	Not recommended	For infra-peritoneal rectal anastomosis, suction drainage should probably be recommended	[17, 18]
	Prophylactic antibiotic	Recommended: against aerobic and anaerobic bacteria		[19]
	Hypothermia prevention	Recommended		[20]
	Adequate fluid management	Recommended: monitoring intra-operative fluid administration, based on parameters reflecting volume replacement		[21]
	Prevention of nausea	Recommended: according to level of risk (Apfel score)		[22]
	Administration of corticosteroid	Recommended: a single injection at the time of induction		[23]
Postoperative period	Early mobilization (< 24 h)	Recommended		[24]
	Early food intake (< 24 h)	Recommended		[25]
	Short urinary drainage (no or less than 24 h)	Recommended	Recommended or alternatively suprapublic catheter	[26, 27]
	Multimodal analgesia	Recommended: preference for non-opioid drugs and/or locoregional technique		[28]
	Epidural analgesia	After laparoscopic surgery, epidural analgesia should probably not be recommended (grade 2−), recommended after laparotomy		[29, 30]
	Nonsteroidal anti-inflammatory drugs	Probably recommended (≤ 48 h)		[31]
	Venous thromboembolism prophylaxis	Recommended		[32]

The secondary endpoints are summarized in Table 4. Overall morbidity was significantly higher in group R than in group C (29.47% vs. 20.83%; $p < 0.001$). Mean length of stay was significantly shorter in the colonic resection group, with 7.09 ± 13.79 days vs. 9.59 ± 17.41 days in the rectal resection group ($p < 0.001$). Reintervention rate was significantly higher after rectal resection at 7.68% compared with 4.34% after colonic resection ($p < 0.001$).

Defunctioning stoma was very scarce in group C ($n = 87$, 3%). The subgroup analysis of rectal surgery with or without defunctioning stoma is reported in Table 5. Of the 870 patients in group R, 41% ($n = 357$) required a defunctioning stoma. The presence of stoma after major rectal surgery was significantly associated with less early mobilization (73.11% vs. 85.93%, $p < 0.01$) and less early refeeding (71.99% vs. 87.13%, $p < 0.01$). Early feeding was also less tolerated in

Table 2 Patient characteristics: colon vs. rectum

	Group C ($n = 2870$)	Group R ($n = 870$)	p value
Male sex (%)	1485 (52)	488 (56)	0.028
Mean age, years	48.9	60.35	< 0.001
Body mass index > 30 kg/m^2 (%)	476 (16.6)	132 (15.2)	0.130
Diabetes (%)	265 (9.2)	87 (10)	0.516
Immunosuppression (%)	63 (2.2)	17 (2)	0.652
Active smoking (%)	322 (11.2)	102 (12)	0.103
Coronaropathy (%)	188 (65.5)	59 (6.8)	0.837
BPCO (%)	172 (6)	40 (4.6)	0.109
Cancer (%)	1782 (62.1)	361 (41.5)	< 0.001
Neoadjuvant treatment (%)	78 (2.7)	300 (34.5)	< 0.001

Table 3 Patient characteristics: stoma vs. no stoma (Group R)

	Stoma (n = 357)	No stoma (n = 334)	p value
Male sex (%)	198 (55.46)	184 (55.09)	0.922
Diabetes (%)	47 (13.17)	39 (11.68)	0.554
Immunosuppression (%)	11 (3.08)	6 (1.80)	0.276
Coronaropathy (%)	27 (7.56)	31 (9.28)	0.416
BPCO (%)	20 (5.6)	20 (5.99)	0.828
Cancer (%)	284 (79.5)	223 (66.77)	< 0.001
Neoadjuvant treatment (%)	197 (69.37)	42 (18.83)	< 0.001

this subgroup: poor tolerance of feeding or nausea or vomiting was reported in 13.7% of cases (n = 49) significantly more than in case of no-stoma (n = 29, 8.7%) (p < 0.001). There was also a significant increase in mean length of hospital stay (11.04 days vs. 7.12 p < 0.01), postoperative morbidity (40.06% vs. 18.54%, p < 0.01), and reintervention rate (10.66% vs. 4.26%, p < 0.01) in the stoma group.

Discussion

The present study analysed the feasibility of an ERP in rectal surgery by comparison of the compliance with ERP components in this population with that in colon surgery. We also investigated the impact of a defunctioning stoma on ERP compliance and results after rectal surgery. Our findings suggest that despite the well-known higher morbidity and prolonged hospital stay in major elective rectal surgery, ERP is feasible and effective. Overall adherence to the protocol did not differ significantly between patients with rectal and colonic resection, at about 80% (79.09% in group R vs. 81.71% in group C, p = 0.083). This observation is similar to that of Pedziwiatr et al. [33] with a smaller sample size (n = 82).

Table 4 ERP implementation (compliance rate for each component) between colon (group C) and rectal (group R) surgery

		Group C (n = 2870)	Group R (n = 870)	p value
Preoperative period	Patient information (%)	88.71	88.74	1
	Immunonutrition (%)	70.77	76.78	< 0.001
	No routine premedication (%)	68.68	67.47	< 0.001
	Bowel preparation (no for C, yes for R) (%)	71.81	66.44	0.002
	Short preoperative fasting (%)	83.94	88.05	0.004
	Preoperative carbohydrate loading (%)	85.05	70.11	< 0.001
Intra-operative period	Prophylactic antibiotics (%)	97.67	97.36	0.797
	Hypothermia prevention (%)	96.79	95.4	0.422
	Laparoscopy (%)	83.52	83.68	0.718
	Adequate fluid management (%)	52.47	51.38	0.705
	Prevention of nausea (%)	88.89	87.01	0.298
	Abdominal drainage (no for C, yes for R) (%)	81.53	58.85	< 0.001
	Administration of corticosteroids (%)	74.11	76.44	0.087
Postoperative period	Multimodal analgesia (%)	85.85	87.59	0.038
	Epidural analgesia (%)	82.3	75.4	0.396
	Nonsteroidal anti-inflammatory drugs (%)	76.2	77.13	0.415
	Venous thromboembolism prophylaxis (%)	97.53	95.98	0.698
	Early mobilization < 24 h (%)	84.22	79.54	0.019
	Early food intake < 24 h (%	82.44	79.31	0.353
	Short urinary drainage for C & short indwelling catheter or suprapubic catheter for R (%)	73.7	47.7	< 0.001
Endpoints	Mean length of stay (days)	7.09 ± 13.79	9.59 ± 17.41	< 0.001
	Overall morbidity (%)	20.83	29.47	< 0.001
	Reintervention (%)	4.34	7.68	< 0.001
	Mortality (%)	0.25	0.35	< 0.001
	Readmission (%)	5.79	7.63	0.113
	Anastomotic leak (%)	2.4	2.76	0.556

Table 5 Subgroup analysis of ERP implementation (% compliance rate for each component) according need or not for defunctioning stoma in rectal procedure

		Stoma (n = 357)	No stoma (n = 334)	p value
Preoperative period	Patient information (%)	82.91	94.01	< 0.01
	Immunonutrition (%)	74.51	79.34	0.006
	No routine premedication (%)	37.53	31.44	0.052
	Bowel preparation (no for C, yes for R) (%)	63.03	69.16	0.089
	Preoperative fasting (%)	95.43	93.71	< 0.01
	Preoperative carbohydrate loading (%)	73.11	69.46	0.289
Intra-operative period	Prophylactic antibiotic (%)	95.24	99.1	0.04
	Hypothermia prevention (%)	96.92	97.01	0.067
	Laparoscopy (%)	78.71	86.83	0.02
	Adequate fluid management (%)	49.3	51.2	0.81
	Prevention of nausea (%)	88.52	88.62	0.48
	Abdominal drainage (no for C, yes for R) (%)	79.27	43.71	< 0.01
	Administration of corticosteroids (%)	77.31	73.65	0.109
Postoperative period	Multimodal analgesia (%)	89.92	93.11	0.23
	Epidural analgesia (%)	79.27	84.43	0.001
	Nonsteroidal anti-inflammatory drugs (%)	82.91	85.53	0.483
	Venous thromboembolism prophylaxis (%)	96.08	96.41	0.5
	Early mobilization < 24 h (%)	73.11	85.93	< 0.01
	Early food intake < 24 h (%)	71.99	87.13	< 0.01
Endpoints	Mean length of stay (days)	11.04	7.12	< 0.01
	Overall morbidity (%)	40.06	18.54	< 0.01
	Reintervention (%)	10.66	4.26	< 0.001
	Mortality (%)	0.29	0.3	0.518
	Readmission (%)	10.5	6.44	0.06
	Anastomotic leak (%)	3.36	2.4	0.449

On the other hand, we found few reports with a similar number of rectal resections within ERP (n = 705 anterior resections) and analysing separately the compliance with the ERP in rectal surgery [34]. In this ERAS Society study, the compliance rate in rectal surgery was 75%, significantly lower than that in colon surgery (77.5%, p = 0.04). Most studies on ERP in colorectal surgery are series with both colonic or rectal procedures, thus ruling out a formal analysis of feasibility of ERP in rectal surgery [5, 35]. Furthermore, our overall implementation rate of our multicentre study compares favourably with that of an earlier multicentre study, whereas we also noticed that there is room for improvement for some components [36].

Beside the overall implementation rates, the individual implementation rate differed depending on the ERP element. Some components of ERP after major elective rectal surgery were not so frequently applied as with colonic surgery. Mechanical bowel preparation (MBP) (66.44% vs. 71.81%), preoperative premedication (67.47% vs. 68.68%), carbohydrate loading (70.11% vs. 85.05%), postoperative drainage (58.85% vs. 81.83%), and early mobilization within 24 h (79.54% vs. 84.22%) were poorly applied in the rectum group. For two elements of the protocol, namely MBP and postoperative drainage, Pedziwiatr et al. [33] reached similar conclusions and pointed out that for a long time these two elements were unquestioned in perioperative care for colorectal surgery. In our study, according to French guidelines, MBP was recommended in cases of low rectal resections, and abdominal drainage was also recommended.

Our study shows that nearly one-third of patients had no bowel preparation or abdominal drainage in rectal surgery, which goes against the French guidelines. This situation is related to the discrepancy between the guidelines and routine practice [37]. The reasons for non-compliance with the guidelines are multiple: unawareness, disagreement, accessibility, habits, etc. [38]. Similarly, there was significantly less adherence to the recommendations for short urinary drainage or at least a suprapubic catheter, in RS. This is probably due to the same reasons.

Concerning early mobilization (< 24 h), observational and historical studies [4, 39] have reported a compliance in the range 28–69%, and it has been suggested that this component

is a significant predictor of earlier hospital discharge and potentially related to the presence of a stoma [40–43]. Additionally, patients in group R were significantly older, which could potentially explain lower compliance with early mobilization.

In this study, 41% (n = 370) of patients in group R had a stoma. According to Faiz et al. [44], a defunctioning stoma prolongs hospital stay, but a more recent study [33] did not confirm these results in a multivariate analysis, suggesting that there are other stronger factors influencing length of stay that require further investigation. In our subgroup analysis of rectum surgery, we reported a significantly longer mean length of stay in the stoma group than in the no-stoma group. This may potentially be related to the fact that patients with a stoma had significantly more abdominal drainage. Another explanation for late mobilization could be the fear of stoma pouch detachment, from some patients. Both abdominal drainage and the aforementioned fear may be a constraint to early mobilization and therefore increase the length of stay. It has been showed that a defunctioning stoma is not always associated with a longer hospital stay if adequate and intensive preoperative stoma education and stoma self-care management is offered to patients [43, 45]. Our study showed well that there is room for improvement in the subgroup of patients with defunctioning stoma. Currently, a key aspect of the ERP has been to fully involve patients in their own healthcare and so empower them in the decision-making process to become actors in their personal care. On the other hand, early feeding was also less tolerated in patients with stoma since nausea or vomiting was more frequent in this subgroup of patients (13.7% vs. 8.7%, $p < 0.001$). Indeed, poor tolerance to early feeding could be a red flag for a possible postoperative complication in this subgroup of patients [46], which was the case in this series.

Our results suggest that patients undergoing rectal resections may benefit from ERP, with a reduction in hospital stay compared with results of historical series with conventional pathways [3, 47]. Although it is not the main topic of the present study, several authors have shown that ERPs reduce length of stay without an increased rate of postoperative complication after rectal resection compared with conventional care [48, 49].

Our study did not involve a subgroup analysis of the implementation of ERP in cancer vs. no-cancer patients. A previous and recent study from the same GRACE-AUDIT database has shown that the indication for did not significantly influence peri-operative management and postoperative major complications, in patients managed within an ERP [50].

There are several limitations in our report. A selection bias is possible with the exclusion of patients sustaining postoperative complications. There may be a selection of rectal procedures more amenable to an ERP, and there was also a relative low rate of cancer. However, we found the same morbidity rates as in the literature [49, 51, 52]. This type of comparative study cannot be randomized. Even so, this is the largest series published on this subject with more 870 major elective rectal procedures. It is also a multicentric study in which 75 healthcare centres took part. These features lend the study good external validity.

Conclusion

At variance with some beliefs, this study demonstrates that an ERP after major elective rectal surgery is safe and effective, with results comparable to colon surgery, even if some specific components were less often implemented in rectal surgery, namely MBP, postoperative drainage, and early mobilization (> 24 h). Our study also suggests that the placement of a defunctioning stoma could be a limiting factor for ERP implementation in rectal surgery. A strengthening of pre-operative measures such as patient information, education, and teaching would be beneficial in improving ERP compliance after rectal surgery.

Compliance with ethical standards

Conflict of interest KS declares an interest in the companies Sanofi, MSD, FSK, B-Braun, and Baxter. The other authors declare that they have no conflict of interest

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent All individual participants were informed about the inclusion of their (anonymous) data in the GRACE-AUDIT database.

References

1. Ni X, Jia D, Chen Y, Wang L, Suo J (2019) Is the Enhanced Recovery After Surgery (ERAS) program effective and safe in laparoscopic colorectal cancer surgery? A meta-analysis of randomized controlled trials. J Gastrointest Surg 23:1502–1512. https://doi.org/10.1007/s11605-019-04170-8
2. Nygren J, Thacker J, Carli F, Fearon KCH, Norderval S, Lobo DN, Ljungqvist O, Soop M, Ramirez J, Enhanced Recovery After Surgery (ERAS) Society, for Perioperative Care, European Society for Clinical Nutrition and Metabolism (ESPEN), International Association for Surgical Metabolism and Nutrition (IASMEN) (2013) Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS(®)) Society recommendations. World J Surg 37:285–305. https://doi.org/10.1007/s00268-012-1787-6
3. Stottmeier S, Harling H, Wille-Jørgensen P, Balleby L, Kehlet H (2012) Postoperative morbidity after fast-track laparoscopic resection of rectal cancer. Colorectal Dis 14:769–775. https://doi.org/10.1111/j.1463-1318.2011.02767.x

4. Gustafsson UO, Hausel J, Thorell A, Ljungqvist O, Soop M, Nygren J, Enhanced Recovery After Surgery Study Group (2011) Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. Arch Surg 146:571–577. https://doi.org/10.1001/archsurg.2010.309
5. Greco M, Capretti G, Beretta L, Gemma M, Pecorelli N, Braga M (2014) Enhanced recovery program in colorectal surgery: a meta-analysis of randomized controlled trials. World J Surg 38:1531–1541. https://doi.org/10.1007/s00268-013-2416-8
6. Maessen J, Dejong CHC, Hausel J, Nygren J, Lassen K, Andersen J, Kessels AGH, Revhaug A, Kehlet H, Ljungqvist O, Fearon KCH, von Meyenfeldt MF (2007) A protocol is not enough to implement an enhanced recovery programme for colorectal resection. Br J Surg 94:224–231. https://doi.org/10.1002/bjs.5468
7. Braga M, Gianotti L, Radaelli G, Vignali A, Mari G, Gentilini O, di Carlo V (1999) Perioperative immunonutrition in patients undergoing cancer surgery: results of a randomized double-blind phase 3 trial. Arch Surg 134:428–433. https://doi.org/10.1001/archsurg.134.4.428
8. Smedley F, Bowling T, James M, Stokes E, Goodger C, O'Connor O et al (2004) Randomized clinical trial of the effects of preoperative and postoperative oral nutritional supplements on clinical course and cost of care. Br J Surg 91:983–990. https://doi.org/10.1002/bjs.4578
9. Finco C, Magnanini P, Sarzo G, Vecchiato M, Luongo B, Savastano S, Bortoliero M, Barison P, Merigliano S (2007) Prospective randomized study on perioperative enteral immunonutrition in laparoscopic colorectal surgery. Surg Endosc 21:1175–1179. https://doi.org/10.1007/s00464-007-9238-4
10. Maurice-Szamburski A, Auquier P, Viarre-Oreal V, Cuvillon P, Carles M, Ripart J, Honore S, Triglia T, Loundou A, Leone M, Bruder N, PremedX Study Investigators (2015) Effect of sedative premedication on patient experience after general anesthesia: a randomized clinical trial. JAMA 313:916–925. https://doi.org/10.1001/jama.2015.1108
11. Blanc M-C, Slim K, Beyer-Berjot L (2020) Best practices in bowel preparation for colorectal surgery: a 2020 overview. Expert Rev Gastroenterol Hepatol 14:681–688. https://doi.org/10.1080/17474124.2020.1775581
12. Smith I, Kranke P, Murat I, Smith A, O'Sullivan G, Søreide E et al (2011) Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. Eur J Anaesthesiol 28:556–569. https://doi.org/10.1097/EJA.0b013e3283495ba1
13. Awad S, Varadhan KK, Ljungqvist O, Lobo DN (2013) A meta-analysis of randomised controlled trials on preoperative oral carbohydrate treatment in elective surgery. Clin Nutr 32:34–44. https://doi.org/10.1016/j.clnu.2012.10.011
14. Deijen CL, Vasmel JE, de Lange-de Klerk ESM, Cuesta MA, Coene P-PLO, Lange JF et al (2017) Ten-year outcomes of a randomised trial of laparoscopic versus open surgery for colon cancer. Surg Endosc 31:2607–2615. https://doi.org/10.1007/s00464-016-5270-6
15. Vlug MS, Wind J, Hollmann MW, Ubbink DT, Cense HA, Engel AF, Gerhards MF, van Wagensveld B, van der Zaag E, van Geloven A, Sprangers MA, Cuesta MA, Bemelman WA, LAFA study group (2011) Laparoscopy in combination with fast track multimodal management is the best perioperative strategy in patients undergoing colonic surgery: a randomized clinical trial (LAFA-study). Ann Surg 254:868–875. https://doi.org/10.1097/SLA.0b013e31821fd1ce
16. Breukink S, Pierie J, Wiggers T Laparoscopic versus open total mesorectal excision for rectal cancer. Cochrane Database Syst Rev 2006:CD005200. https://doi.org/10.1002/14651858.CD005200.pub2
17. Messager M, Sabbagh C, Denost Q, Regimbeau JM, Laurent C, Rullier E, Sa Cunha A, Mariette C (2015) Is there still a need for prophylactic intra-abdominal drainage in elective major gastrointestinal surgery? J Visc Surg 152:305–313. https://doi.org/10.1016/j.jviscsurg.2015.09.008
18. Peeters KCMJ, Tollenaar RAEM, Marijnen CAM, Klein Kranenbarg E, Steup WH, Wiggers T et al (2005) Risk factors for anastomotic failure after total mesorectal excision of rectal cancer. Br J Surg 92:211–216. https://doi.org/10.1002/bjs.4806
19. Nelson RL, Gladman E, Barbateskovic M Antimicrobial prophylaxis for colorectal surgery. Cochrane Database Syst Rev 2014:CD001181. https://doi.org/10.1002/14651858.CD001181.pub4.
20. Sessler DI (2016) Perioperative thermoregulation and heat balance. Lancet 387:2655–2664. https://doi.org/10.1016/S0140-6736(15)00981-2
21. Corcoran T, Rhodes JEJ, Clarke S, Myles PS, Ho KM (2012) Perioperative fluid management strategies in major surgery: a stratified meta-analysis. Anesth Analg 114:640–651. https://doi.org/10.1213/ANE.0b013e318240d6eb
22. Kranke P, Eberhart LHJ (2011) Possibilities and limitations in the pharmacological management of postoperative nausea and vomiting. Eur J Anaesthesiol 28:758–765. https://doi.org/10.1097/EJA.0b013e32834a4e1e
23. Srinivasa S, Kahokehr AA, Yu T-C, Hill AG (2011) Preoperative glucocorticoid use in major abdominal surgery: systematic review and meta-analysis of randomized trials. Ann Surg 254:183–191. https://doi.org/10.1097/SLA.0b013e3182261118
24. Castelino T, Fiore JF, Niculiseanu P, Landry T, Augustin B, Feldman LS (2016) The effect of early mobilization protocols on postoperative outcomes following abdominal and thoracic surgery: a systematic review. Surgery 159:991–1003. https://doi.org/10.1016/j.surg.2015.11.029
25. Andersen HK, Lewis SJ, Thomas S Early enteral nutrition within 24h of colorectal surgery versus later commencement of feeding for postoperative complications. Cochrane Database Syst Rev 2006:CD004080. https://doi.org/10.1002/14651858.CD004080.pub2.
26. Grass F, Slieker J, Frauche P, Solà J, Blanc C, Demartines N, Hübner M (2017) Postoperative urinary retention in colorectal surgery within an enhanced recovery pathway. J Surg Res 207:70–76. https://doi.org/10.1016/j.jss.2016.08.089
27. Schreiber A, Aydil E, Walschus U, Glitsch A, Patrzyk M, Heidecke C-D, Schulze T (2019) Early removal of urinary drainage in patients receiving epidural analgesia after colorectal surgery within an ERAS protocol is feasible. Langenbecks Arch Surg 404:853–863. https://doi.org/10.1007/s00423-019-01834-6
28. Alfonsi P, Slim K, Chauvin M, Mariani P, Faucheron JL, Fletcher D, Working Group of Société française d'anesthésie et réanimation (SFAR), Société française de chirurgie digestive (SFCD) (2014) French guidelines for enhanced recovery after elective colorectal surgery. J Visc Surg 151:65–79. https://doi.org/10.1016/j.jviscsurg.2013.10.006
29. Jouve P, Bazin J-E, Petit A, Minville V, Gerard A, Buc E, Dupre A, Kwiatkowski F, Constantin JM, Futier E (2013) Epidural versus continuous preperitoneal analgesia during fast-track open colorectal surgery: a randomized controlled trial. Anesthesiology 118:622–630. https://doi.org/10.1097/ALN.0b013e3182800d94
30. Marret E, Remy C, Bonnet F, Postoperative Pain Forum Group (2007) Meta-analysis of epidural analgesia versus parenteral opioid analgesia after colorectal surgery. Br J Surg 94:665–673. https://doi.org/10.1002/bjs.5825
31. Gorissen KJ, Benning D, Berghmans T, Snoeijs MG, Sosef MN, Hulsewe KWE, Luyer MDP (2012) Risk of anastomotic leakage with non-steroidal anti-inflammatory drugs in colorectal surgery. Br J Surg 99:721–727. https://doi.org/10.1002/bjs.8691
32. Sammour T, Chandra R, Moore JW (2016) Extended venous thromboembolism prophylaxis after colorectal cancer surgery: the current state of the evidence. J Thromb Thrombolysis 42:27–32. https://doi.org/10.1007/s11239-015-1300-9

33. Pędziwiatr M, Pisarska M, Kisielewski M, Major P, Mydlowska A, Rubinkiewicz M, Winiarski M, Budzyński A (2016) ERAS protocol in laparoscopic surgery for colonic versus rectal carcinoma: are there differences in short-term outcomes? Med Oncol 33:56. https://doi.org/10.1007/s12032-016-0772-6
34. ERAS Compliance Group (2015) The impact of enhanced recovery protocol compliance on elective colorectal cancer resection: results from an international registry. Ann Surg 261:1153–1159. https://doi.org/10.1097/SLA.0000000000001029
35. Kennedy RH, Francis EA, Wharton R, Blazeby JM, Quirke P, West NP, Dutton SJ (2014) Multicenter randomized controlled trial of conventional versus laparoscopic surgery for colorectal cancer within an enhanced recovery programme: EnROL. J Clin Oncol 32:1804–1811. https://doi.org/10.1200/JCO.2013.54.3694
36. van Zelm R, Coeckelberghs E, Sermeus W, De Buck van Overstraeten A, Weimann A, Seys D et al (2017) Variation in care for surgical patients with colorectal cancer: protocol adherence in 12 European hospitals. Int J Colorectal Dis 32:1471–1478. https://doi.org/10.1007/s00384-017-2863-z
37. Slim K (2010) Gaps between evidence-based guidelines and the daily surgical practices. J Visc Surg 147:e337–e339. https://doi.org/10.1016/j.jviscsurg.2010.10.007
38. Carthey J, Walker S, Deelchand V, Vincent C, Griffiths WH (2011) Breaking the rules: understanding non-compliance with policies and guidelines. BMJ 343:d5283. https://doi.org/10.1136/bmj.d5283
39. Feroci F, Lenzi E, Baraghini M, Garzi A, Vannucchi A, Cantafio S, Scatizzi M (2013) Fast-track colorectal surgery: protocol adherence influences postoperative outcomes. Int J Colorectal Dis 28:103–109. https://doi.org/10.1007/s00384-012-1569-5
40. Gumbau V, García-Armengol J, Salvador-Martínez A, Ivorra P, García-Coret MJ, García-Rodríguez V, Roig JV (2015) Impact of a diverting stoma in an enhanced recovery programme for rectal cancer. Cir Esp 93:18–22. https://doi.org/10.1016/j.ciresp.2014.03.016
41. Fiore JF, Castelino T, Pecorelli N, Niculiseanu P, Balvardi S, Hershorn O et al (2017) Ensuring early mobilization within an enhanced recovery program for colorectal surgery: a randomized controlled trial. Ann Surg 266:223–231. https://doi.org/10.1097/SLA.0000000000002114
42. Hughes MJ, Cunningham W, Yalamarthi S (2020) The effect of preoperative stoma training for patients undergoing colorectal surgery in an enhanced recovery programme. Ann R Coll Surg Engl 102:180–184. https://doi.org/10.1308/rcsann.2019.0145
43. Younis J, Salerno G, Fanto D, Hadjipavlou M, Chellar D, Trickett JP (2012) Focused preoperative patient stoma education, prior to ileostomy formation after anterior resection, contributes to a reduction in delayed discharge within the enhanced recovery programme. Int J Colorectal Dis 27:43–47. https://doi.org/10.1007/s00384-011-1252-2
44. Faiz O, Haji A, Burns E, Bottle A, Kennedy R, Aylin P (2011) Hospital stay amongst patients undergoing major elective colorectal surgery: predicting prolonged stay and readmissions in NHS hospitals. Colorectal Dis 13:816–822. https://doi.org/10.1111/j.1463-1318.2010.02277.x
45. Hignett S, Parmar CD, Lewis W, Makin CA, Walsh CJ (2011) Ileostomy formation does not prolong hospital length of stay after open anterior resection when performed within an enhanced recovery programme. Colorectal Dis 13:1180–1183. https://doi.org/10.1111/j.1463-1318.2010.02381.x
46. Slim K, Reymond T, Joris J, Paul S, Pereira B, Cotte E (2020) Intolerance to early oral feeding in enhanced recovery after colorectal surgery: an early red flag? Colorectal Dis 22:95–101. https://doi.org/10.1111/codi.14785
47. Keane C, Savage S, McFarlane K, Seigne R, Robertson G, Eglinton T (2012) Enhanced recovery after surgery versus conventional care in colonic and rectal surgery. ANZ J Surg 82:697–703. https://doi.org/10.1111/j.1445-2197.2012.06139.x
48. Cintorino D, Ricotta C, Bonsignore P, Di Francesco F, Li Petri S, Pagano D et al (2018) Preliminary report on introduction of enhanced recovery after surgery protocol for laparoscopic rectal resection: a single-center experience. J Laparoendosc Adv Surg Tech A 28:1437–1442. https://doi.org/10.1089/lap.2018.0234
49. Vignali A, Elmore U, Cossu A, Lemma M, Calì B, de Nardi P, Rosati R (2016) Enhanced recovery after surgery (ERAS) pathway vs traditional care in laparoscopic rectal resection: a single-center experience. Tech Coloproctol 20:559–566. https://doi.org/10.1007/s10151-016-1497-4
50. De Crignis L, Slim K, Cotte E, Meillat H, Dupré A (2020) Impact of surgical indication on patient outcomes and compliance with enhanced recovery program for colorectal surgery: A Francophone multicenter retrospective analysis. J Surg Oncol. https://doi.org/10.1002/jso.26097
51. Schwenk W, Neudecker J, Raue W, Haase O, Müller JM (2006) "Fast-track" rehabilitation after rectal cancer resection. Int J Colorectal Dis 21:547–553. https://doi.org/10.1007/s00384-005-0056-7
52. Branagan G, Richardson L, Shetty A, Chave HS (2010) An enhanced recovery programme reduces length of stay after rectal surgery. Int J Colorectal Dis 25:1359–1362. https://doi.org/10.1007/s00384-010-1032-4