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RETROSPECTIVE STUDY

Enhanced recovery after surgery *vs* conventional care in emergency colorectal surgery

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Abstract

AIM: To investigate the feasibility and beneficial effects of enhanced recovery after surgery (ERAS) programme in the setting of emergency colorectal surgery.

METHODS: Between January 2011 and October 2013, patients undergoing emergency resection for obstructing colorectal cancer at the Faculty of Medicine Siriraj Hospital, Bangkok, Thailand using ERAS programme were compared with those using conventional care (1:2 ratio). They were matched for their age, gender, ColoRectal Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity score, and type of surgery. Primary outcomes were length of hospital stay and postoperative morbidity. Secondary outcomes included gastrointestinal recovery, 30-d readmission, and time interval from surgery to chemotherapy.

RESULTS: Twenty patients treated with ERAS programme were compared with 40 patients receiving conventional postoperative care. Median of hospital stay was shorter in the ERAS group: 5.5 d (range: 3-16) *vs* 7.5 d (range: 5-25), $P = 0.009$. The ERAS group had a non-significant reduction in the incidence of postoperative complication (25% *vs* 48%, $P = 0.094$). No 30-d mortality and readmission occurred. Patients with ERAS programme had a shorter time to first flatus (1.6 d *vs* 2.8 d, $P < 0.001$) and time to resumption of normal diet (3.5 d *vs* 5.5 d, $P = 0.002$). Time interval between operation and initiation of adjuvant chemotherapy was significantly shorter in the ERAS group (37 d *vs* 49 d, $P = 0.009$).

CONCLUSION: The ERAS programme in the setting of emergency colorectal surgery was safe and feasible. It achieved significantly shorter hospitalisation and faster recovery of bowel function.

Key words: Colorectal cancer; Obstruction; Emergency surgery; Enhanced recovery after surgery; Enhanced recovery programme; Outcome

Core tip: The present study is the first study examining the outcomes of enhanced recovery after surgery (ERAS) programme in the setting of emergency colorectal surgery. This study demonstrated that ERAS programme was also safe and beneficial in non-elective surgical setting. Comparing with a conventional postoperative care, ERAS programme in emergency tumour resection for obstructing colorectal cancer was associated with a significantly shorter length of hospital stay and faster recovery of bowel function, without an increase in 30-d mortality and readmission.

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INTRODUCTION

Up to 20% of patients with colorectal cancer present with acute colonic obstruction[1]. A variety of procedures have been used to treat this condition including colonic stenting, proximal diversion and tumour resection. Even in a modern surgical era, a high rate of postoperative complication and prolonged hospital stay have been consistently reported in emergency surgery for obstructing colorectal cancer[2-4]. A potential method of improving surgical outcomes after such an operation is by optimising perioperative care. Enhanced recovery after surgery (ERAS) programme is designed to reduce perioperative and intraoperative stress responses, and to support the recovery of organ function aiming to help patients getting better sooner after surgery. Two recent systematic reviews and meta-analyses have shown that ERAS programme is associated with a reduction in the length of hospital stay and postoperative complication after elective colorectal surgery without any significant change in mortality and readmission rate[5,6]. Lately, the ERAS® Society has published evidence-based guidelines for perioperative care in elective colon surgery and rectal/pelvic surgery[7,8].

Despite a large number of clinical studies confirming the benefit of ERAS programmes in elective surgery, the feasibility and effectiveness of ERAS programme in the setting of emergency colorectal surgery is unknown. The aim of the present study was therefore to compare the surgical outcomes of patients with obstructing colorectal cancer undergoing surgery with an ERAS programme and those with conventional postoperative care, in a matched case-control study.

MATERIALS AND METHODS

After obtaining approval from the Institutional Review Board, a prospectively collected database of patients undergoing emergency surgery for obstructing colorectal adenocarcinoma using an ERAS programme between January 2011 and October 2013 in the Division of General Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Bangkok, Thailand were reviewed. Patients with clinical peritonitis, those with obstructing recurrent tumour, those having non-resection operation, and those receiving neoadjuvant treatments were excluded. These patients (ERAS group) were compared with a group of patients who underwent emergency resection for obstructing colorectal cancer using a conventional postoperative care management during the same period (Non-ERAS group). They were matched for age, the American Society of Anesthesiologists (ASA) grade, the ColoRectal Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity (CR-POSSUM) score, duration of obstruction, location of tumour, and type of surgical procedure, with the ratio of 1 ERAS case to 2 non-ERAS cases.

In this context, emergency surgery was defined as an unplanned operation performed within 24 h after patients were admitted or consulted for acute colonic obstruction (the duration of obstruction was not longer than 1 wk). The evidence of complete or nearly complete colonic obstruction was confirmed by a computed tomography (CT) scan and/or limited contrast enema. Patients with ERAS programme were operated on by the author (who has experienced more than 100 cases with an ERAS programme in elective colorectal surgery) while non-ERAS cases were taken care of by other experienced surgical consultants in the same division (a total of 500-600 colorectal operations per annum). The choice and technique of operation were left to the discretion of each surgeon. The protocol of conventional care was previously described[9]. The summary of major differences between ERAS programme and conventional care management is shown in Table 1. In both pathways, patients were discharged from the hospital when they had no fever, adequate pain control with oral analgesic, good ambulation, good appetite and satisfactory recovery of gastrointestinal function. Of note, according to the institute's policy any form of bowel preparation, laparoscopic surgery and epidural analgesia were not applied in an emergency setting. Moreover, approach to left-sided colonic obstruction could be stenting, diversion or resection depended on clinical ground, patient's health coverage scheme, and surgeon's preference.

All data were recorded including patient demographic, operative details (tumour location, procedure type, operative time and blood loss), pathological staging and postoperative outcomes. The postoperative outcomes include postoperative complication (graded I -V according to the Clavien-Dindo classification system[10]), time to first flatus, time to first defaecation, time to resumption of normal diet, length of hospital stay, hospital readmission and death within 30 d, and time interval between operation and initiation of adjuvant chemotherapy (if appropriate). All patients were scheduled for follow-up at 30 d postoperatively. Notably, unless patients had the Eastern Cooperative Oncology Group (ECOG) performance status more than two[11], adjuvant chemotherapy is routinely recommended after curative resection of the obstructed colorectal cancer. However, the decision of whether and when to start adjuvant treatment was depended on the agreement of patients and medical oncologists. Time interval between operation and initiation of adjuvant chemotherapy was defined as the period from surgery to the day of the first chemotherapy session.

All data were prepared and compiled using SPSS computer software (version 15.0 for Windows). Mean and standard deviation, or median (range) are presented for continuous data. The Kolmogorov-Smirnov test was used to test for the pattern of data distribution. Student unpaired *t*-tests were used to compare data between the two groups when they showed normal distribution. The Mann-Whitney *U* tests were used when data were not normally distributed. The Pearson χ^2 tests or Fisher's exact tests were used for categorical data. A *P*-value of less than 0.05

Table 1 Summary of enhanced recovery after surgery programme and comparison with conventional care pathway

Primary component	ERAS programme	Conventional care pathway
Before surgery	Detailed information and education, including breathing exercise, mobilisation, dietary goal, and estimated length of hospital stay	Advice given by an on-call consultant surgeon
During surgery	Standard anaesthetic protocol (balanced general anaesthesia) and surgical management	Standard anaesthetic protocol (balanced general anaesthesia) and surgical management
	Transverse abdominal incision for right-sided colon cancer surgery	Midline incision with the application of Balfour self-retaining retractor
	Manual colonic decompression prior to primary anastomosis in obstructing left-sided colorectal cancer	Intra-abdominal or pelvic drainage at the surgeon's discretion
	No intra-abdominal or pelvic drainage	No standard protocol for prophylaxis of PONV
	Application of O-ring wound retractor (Alexis® Retractor)	
	Active warming (warm intravenous fluid, Bair Hugger®, warm saline-soaked swab around the intestine)	
	Infiltration of 0.5% bupivacaine into fascial layer and skin before wound closure	
	Prophylaxis of PONV based on risk factors	
After surgery	Fluid therapy to keep a urine output of 0.5-1 mL/kg per hour, with deliberate administration of colloid solution if needed	Care decided by consultant surgeon
	Early removal of NGT at 24-48 h postoperatively unless there was > 400 mL drainage in a 24-h period	Crystalloid fluid replacement
	Early ingestion of oral intake after NGT removal	NPO until patients passed flatus, had an active bowel sound and NGT content < 400 mL/d
	Multimodal analgesia with the preferential use of selective cyclo-oxygenese 2 inhibitors	Intravenous opioids as a primary modality for postoperative analgesia
	Scheduled removal of urinary catheter at 48-72 h postoperatively in a stable patient	
	Regular mobilisation with daily physiotherapy	
	Aim to discharge on postoperative d5	
After discharge	Telephone call 3 d and 1 wk after discharge 2 wk and 30 d follow-up in clinic	2 wk and 30 d follow-up in clinic

ERAS: Enhanced recovery after surgery; NGT: Nasogastric tube; NPO: Nil *per os*; PONV: Postoperative nausea and vomiting.

was considered statistically significant.

RESULTS

During the study period of 34 mo, 131 patients were hospitalised for acutely obstructed colorectal adenocarcinoma. Twenty-eight patients had colonic stent insertion (for palliative care or bridge-to-surgery purpose), 26 patients had diverting stoma, and the others (77 cases) underwent emergency tumour resection. Of 77 patients having tumour removal, 20 patients (26%) were taken care using the ERAS programme. For comparison purpose, 40 patients with conventional postoperative care treated during the study period were matched. The two groups were comparable with respect to their age, gender, body mass index, ASA grade, CR-POSSUM score, preoperative haematocrit level, preoperative serum albumin level, duration of obstruction, and type of procedure. Characteristics and operative details of ERAS patients and non-ERAS patients are shown in Table 2. Of note, no diverting stoma was performed in cases of tumour resection with primary anastomosis.

Median of hospital stay was significantly shorter in the ERAS group compared with non-ERAS group [5.5 d (range: 3-16) *vs* 7.5 d (range: 5-25), $P = 0.009$]. Incidence of overall postoperative complication tended to be reduced in the ERAS group (25% *vs* 48%) but this did not reach statistical significance ($P = 0.094$). There was no 30-d mortality and readmission in both groups. Patients with ERAS programme had a shorter time to first flatus (1.6 d *vs* 2.8 d, $P < 0.001$) and time to resumption of normal diet (3.5 d *vs* 5.5 d, $P = 0.002$), but not time to first defaecation (3.4 d *vs* 3.7 d, $P = 0.428$). 80% of patients in the ERAS group (16 of 20) and 68% of patients in the non-ERAS group (27 of 40) received adjuvant chemotherapy ($P = 0.375$). Time interval between operation and initiation of adjuvant chemotherapy was significantly shorter in the ERAS group (37 d *vs* 49 d, $P = 0.009$). Comparison of the primary and secondary outcomes between ERAS patients and non-ERAS patients are shown in Table 3.

DISCUSSION

This case-matched study has demonstrated the feasibility and effectiveness of ERAS programme in the setting of emergency colorectal surgery. Compared with those having a conventional care pathway, patients within an ERAS programme had a shorter length of hospital stay, faster bowel recovery and shorter time to start adjuvant therapy. The reduction in hospital stay did not lead to an increase in 30-d readmission, or a higher rate of postoperative complication. In fact, the incidence of postoperative complication tended to be reduced in the ERAS group.

In this study, ERAS programme shorten a median length of hospital stay by 2 d. The magnitude of reduction in hospital stay is fairly comparable to those

Table 2 Patient characteristics and operative details *n* (%)

	ERAS group (*n* = 20)	Non-ERAS group (*n* = 40)	*P* value
Age (yr)	57.6 ± 13.2	62.0 ± 13.2	0.22
Male	14 (70)	24 (60)	0.45
BMI (kg/m^2)	21.7 ± 3.3	22.8 ± 3.4	0.22
ASA grade ⩾ 3	4 (20)	4 (10)	0.42
CR-POSSUM predicted mortality rate	3.34 ± 2.83	3.56 ± 2.47	0.76
Preoperative haematocrit (%)	36.1 ± 6.4	36.1 ± 5.8	0.98
Preoperative serum albumin (g/dL)	3.6 ± 0.6	3.7 ± 0.6	0.63
Duration of obstruction (d)	3.5 ± 1.6	3.3 ± 1.6	0.69
Left-sided colonic obstruction[1]	10 (50)	21 (53)	0.71
Obstructing rectal cancer[2]	2 (10)	5 (13)	1.00
Detailed procedure type			0.93
(Extended) right hemicolectomy	10 (50)	19 (48)	
Left hemicolectomy/sigmoidectomy	3 (15)	5 (13)	
Hartmann's procedure	4 (20)	7 (18)	
Anterior resection	2 (10)	4 (10)	
Subtotal colectomy	1 (5)	5 (13)	
Tumor removal with primary anastomosis	16 (80)	33 (83)	1.00
Multi-visceral organ resection	3 (15)	5 (13)	1.00
Operative time (min)	216 ± 85	190 ± 59	0.17
Estimated blood loss (mL)	233 ± 200	192 ± 166	0.42
Maximal tumour size (cm)	6.3 ± 2.5	5.6 ± 2.2	0.34
Pathological staging 3 or 4	14 (70)	26 (65)	0.70

[1]Left-sided colonic obstruction is defined as an obstruction caused by tumor distal to the splenic flexure (including rectal cancer); [2]Rectal cancer is defined as a cancer located within 12 cm of the anal verge. ASA: American Society of Anesthesiologists; BMI: Body mass index; CR-POSSUM: ColoRectal Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity; ERAS: Enhanced recovery after surgery.

Table 3 Surgical outcomes *n* (%)

	ERAS group (*n* = 20)	Non-ERAS group (*n* = 40)	*P* value
Median length of hospital stay (d)	5.5 (3-16)	7.5 (5-25)	0.009
Average length of hospital stay (d)	6.0 ± 2.9	9.4 ± 5.1	0.002
Overall complications	5 (25)	19 (48)	0.090
Complications excluding Grade I[1]	2 (10)	8 (20)	0.470
Time to first flatus (d)	1.6 ± 0.7	2.8 ± 1.3	< 0.001
Time to first defaecation (d)	3.4 ± 1.2	3.7 ± 1.4	0.430
Time to resumption of normal diet (d)	3.4 ± 1.7	5.5 ± 2.4	0.002
Unplanned 30-d readmission	0	0	NA
Patients receiving adjuvant chemotherapy	16 (80)	27 (68)	0.380
Interval between operation and initiation of adjuvant chemotherapy (d)	37.0 ± 8.9	49.4 ± 20.4	0.009

[1]According to the Clavien-Dindo classification of surgical complication. ERAS: Enhanced recovery after surgery; NA: Not applicable.

reported from the ERAS pathway for elective colorectal surgery[5,6]. A recent meta-analysis of 13 randomised trials including 1910 patients has shown that ERAS programmes in an elective setting were associated with a significant reduction in primary and total hospital stay with a weighted mean difference of 2.44 d and 2.39 d, respectively[6]. This meta-analysis also demonstrated a significant 30% reduction in postoperative complications within the ERAS setting. Likewise, the present study revealed a tendency towards a lower incidence of both major and minor postoperative complications in the ERAS group. The reduction of postoperative complication in ERAS programme for patient undergoing emergency resection for obstructing colorectal cancer is likely to result from a combination of multimodal perioperative interventions, rather than single manoeuvre alone, aiming to attenuate metabolic response to surgery, to support the recovery of organ function, and to preserve postoperative immune system[7,8,12].

Postoperative gastrointestinal recovery seems to be quicker in patients with ERAS programme as they had a shorter period to pass the first flatus and they were able to resume normal diet in less than 4 d postoperatively. These results might be partly due to the combination of the administration of postoperative nausea/vomiting prophylaxis, judicious fluid therapy, and the preferential use of non-opioid analgesia in the ERAS pathway. It remains unclear why patients with ERAS programme passed flatus sooner than the controls, but there was no difference in time to first defaecation.

So far, most studies of ERAS programme in colorectal surgery have focused on short-term benefits[5,6]. Nev-

ertheless, longer-term measures of recovery are also of great importance. Time to initiation of adjuvant chemotherapy is potentially a mid-term outcome measure because it could reflect patient's overall postoperative recovery and performance[13]. In the present study, patients with ERAS programme received postoperative chemotherapy 12 d earlier than patients with conventional care pathway. A reduction in convalescence between surgery and chemotherapy in the ERAS group could be partly explained by a fewer incidence of postoperative complication and quicker overall recovery with ERAS programme. Knowingly various factors have contributed to determine whether and when to start adjuvant treatment including physician's opinion and social support, but patient's postoperative condition is a significant determinant[14,15]. Interestingly, a recent systematic review and meta-analysis has demonstrated that colorectal cancer patients with shorter convalescence between surgery and chemotherapy had a better overall survival and disease-free survival[16].

Some limitations of this study included a relatively small sample size with a selected group of patients. Low-risk patients (*i.e.*, low ASA grade and CR-POSSUM score) were likely to be included, while high-risk patients with obstructed colorectal cancer were subjected to other less invasive management such as colonic stenting or diverting colostomy. Consequently, based on this study, ERAS protocol might be safely applied in only low-risk patients. However, it is of great interest to investigate the effect of ERAS program on emergency colorectal surgery in high-risk individuals; in which optimal perioperative care is fundamentally required.

Another limitation of this study was the fact that a performance bias may occur since patients with ERAS programme were taken care of by single surgeon while non-ERAS cases were treated by other experienced surgeons. However, the performance and quality of care in both studied groups are likely to be invariable, except the different protocols, because all patients were treated by highly-experienced academic surgeons and nursing staffs in the same surgical unit of a tertiary referral center. Additionally, the patients included in this comparative study were carefully matched with well-known confounders such as age, ASA grade, CR-POSSUM score, tumour location and type of procedure.

Considering the fact that protocols of conventional care might be not uniform and some ERAS components could be applied within the conventional care pathway, it is possible that the different outcomes in this study were due to the application of more ERAS items in the ERAS group than the conventional care group. Interestingly, it was evident that the optimal outcomes of ERAS pathway were dependent on the number of ERAS components and adherence to the protocol, like a dose-response relationship[17,18]. Therefore, in order to make a definite conclusion on ERAS programme in the setting of emergency colorectal surgery, larger studies and randomised trials are required.

Since there is little information on ERAS programme in an emergency setting[19,20] and the randomised trials on ERAS pathway in the setting of emergency colorectal surgery are lacking (http://www.clinicaltrials.gov/ClinicalTrials.gov; accessed on 30 March 2014), the present study has provided encouraging results. This case-matched study suggests that ERAS programme could be applied safely and effectively in the setting of emergency colorectal surgery. It led to better outcomes, such as a shorter length of hospital stay and faster recovery of bowel function, without an increased in 30-d readmission or a higher rate of postoperative complication. In fact, the incidence of postoperative complication tended to be reduced in the ERAS group.

COMMENTS

Background

Enhanced recovery after surgery (ERAS) programme is a modern pathway for perioperative care. It is a multidisciplinary and multimodal approach which is designed to reduce surgical stress responses and to support function of vital organs - aiming to achieve early recovery of patients undergoing major surgery. The strategies of ERAS has been developed and applied into elective colorectal surgery since 2000.

Research frontiers

Several studies and systematic reviews have shown that, when compared with a conventional perioperative care, ERAS programme was associated with a reduction in the length of hospital stay and rates of complication following elective colorectal surgery. Whether such a programme is feasible and beneficial in the setting of emergency colorectal surgery remains unknown.

Innovations and breakthroughs

The present study demonstrates, for the first time, that ERAS programme could be applied safely and effectively in the setting of emergency colorectal surgery. It led to better outcomes, such as a shorter length of hospital stay and faster recovery of bowel function, without an increased in 30-d readmission or a higher rate of postoperative complication. In fact, ERAS programme tended to have a fewer rate of overall complication. Time interval between operation and initiation of adjuvant chemotherapy (which could be a potential mid-term measure of patient's recovery) was also significantly shorter with an ERAS programme.

Applications

The study results suggest that ERAS programme was a safe and effective perioperative care pathway which could be used in the setting of emergency colorectal surgery.

Peer review

The author showed the usefulness of ERAS programme for patients undergoing emergency surgery for obstructive colorectal cancer, compared to conventional postoperative care. Although this is a retrospective case-matched study performed by a limited number of doctors in a single centre, this is the first study performed in the set of emergency surgery for obstructive colorectal cancer. The manuscript was well written. The results were reliable and encouraging. This work provided convincing evidence of the advantages of ERAS programme.

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