

# Short-term quality of life in patients undergoing colonic surgery using enhanced recovery after surgery program versus conventional perioperative management

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## Abstract

**Objective** Enhanced recovery after surgery (ERAS) integrates evidence-based interventions to reduce surgical stress and accelerate rehabilitation. Our study was to compare the short-term quality of life (QOL) in patients undergoing open colonic surgery using ERAS program or conventional management.

**Methods** A prospective study of 57 patients using ERAS program and 60 patients using conventional management was conducted. The clinical characteristics of all patients were recorded. QOL was evaluated longitudinally using the questionnaires (EORTC QLQ-C30 and QLQ-CR29) pre- and postoperatively. Generalized estimating equation was used to do the analysis in order to determine the effective impact of correlative factors on the postoperative QOL, including age, sex, BMI, ASA grade, tumor location, tumor size, pTNM stage, recovery program and length of time after surgery.

**Results** The morbidity in ERAS and control group was 17.5 versus 26.7 % ( $p = 0.235$ ). The patients in ERAS group had much faster rehabilitation and less hospital stay. In the primary statistical analysis, the scores of global QOL (on POD3, POD6, POD10, POD14, POD21), physical

functioning (on POD3, POD6, POD10, POD14, POD21), role functioning (on POD6, POD10, POD14, POD21), emotional functioning (on POD3, POD6, POD10, POD14, POD21), cognitive functioning (on POD3, POD6) and social functioning (on POD3, POD6, POD10, POD14, POD21, POD28) were higher in ERAS group than in control group, which suggested that the patients in ERAS group had a better life status. However, the scores of pain (on POD10, POD14, POD21), appetite loss (on POD3, POD6), constipation (on POD3, POD6, POD10), diarrhea (on POD3, POD10), financial difficulties (on POD10, POD14, POD21), perspective of future health (on POD6, POD10, POD14), gastrointestinal tract problems (on POD3, POD6, POD10) and defecation problems (on POD6, POD10, POD14) were lower in ERAS group than in control group, which revealed that the patients in ERAS group suffered less symptoms. In the further generalized estimating equation analysis, the result showed that recovery program and length of time after surgery had independently positive impact on the patient's postoperative QOL.

**Conclusion** Short-term QOL in patients undergoing colonic cancer using ERAS program was better than that using conventional management.

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## Introduction

Enhanced recovery after surgery (ERAS) or fast track surgery, which combines a series of perioperative interventions, such as no mechanical bowel preparation, no preoperative fasting, and early postoperative feeding, to

facilitate early recovery after major surgery by reducing surgical stress and preserving physiological functions, has been popularized in the fields of colorectal surgery [1–4]. Accumulating evidence has validated the safety and effectiveness of the ERAS program in colorectal surgery, compared with the conventional management [5–8]. However, the majority of the available literatures presented the advantage of ERAS only by short-term clinical outcomes, such as morbidity, gastrointestinal recovery, stress responses and hospital stay, and long-term survival [9]. In addition, quality of life (QOL) has been advocated to assess cancer therapy [10]. Currently, the most widely used tool for the assessment of QOL in colonic cancer is established by European Organization for Research and Treatment of Cancer. It consists of QLQ-C30 (core module) and QLQ-CR29 (colonic cancer-specific module). Several clinical trials accomplished have proved the feasibility, reliability and validity to assess QOL of patients with colonic cancer pre- or postoperation [11–13]. However, there are few literatures on the influence of ERAS protocols and QOL, and no evidence that ERAS adversely affect QOL or patient satisfaction [14].

The aim of our prospective non-randomized controlled trial was to discover the difference between the short-term QOL of patients undergoing colonic surgery using ERAS program or conventional perioperative management, together with perioperative clinical outcomes.

## Patients and methods

### Study design

ERAS program has been introduced in our hospital from 2007. From 2012, we prospectively enrolled patients who underwent colonic surgery by the same surgical group and asked them to complete the QOL questionnaire. This prospective trial was approved by the Ethical Committee of Medicine, Zhongshan Hospital, Fudan University. All patients provided written informed consent. At last, a total of 117 patients were enrolled in this prospective study from July 2012 to October 2013.

### Perioperative treatment of the ERAS and control groups

All the patients underwent radical resection of colonic cancer via laparotomy by the same surgical group. The details of perioperative elements of ERAS program or conventional perioperative management have been published elsewhere [15]. The ERAS program consists of no mechanical bowel preparation, no preoperative fasting, early postoperative feeding, restrictive intravenous fluids,

early mobilization and other regimens. And the discharge criteria include good pain control with oral analgesia, ability to take solid food, no intravenous fluids, independently mobilization and be suitable for going home.

### The questionnaires and QOL assessment

QOL was the primary outcome of the planned study. The assessment of QOL was based on a previously validated cancer-specific core questionnaire, QLQ-C30 (version 3.0, in Chinese) and the colonic cancer-specific module QLQ-CR29 (in Chinese, translated from English version) both developed by EORTC. The QLQ-C30 module is composed of one global QOL scale, five functional scales (physical, role, emotional, cognitive and social), nine symptom scales (fatigue, nausea and vomiting, pain, dyspnea, insomnia, appetite loss, constipation, diarrhea and financial difficulties). Each scale contains one or several questions. And each question has four response alternatives: “not at all” (scored as 1), “a little” (scored as 2), “quite a bit” (scored as 3) and “very much” (scored as 4), except for the global QOL scale which ranges from “very poor” (scored as 1) to “excellent” (scored as 7) [16]. The QLQ-CR29 module includes two functional scales (body image and future health perspective) and five symptoms scales (micturition problem, gastrointestinal problem, defecation problems, sexual problems and chemotherapeutic-related problem). This module has the same four response alternatives as QLQ-C30 [17].

All patients filled out the questionnaires before operation and at the follow-up (postoperation day 3 (POD3), POD6, POD10, POD14, POD21 and POD28) by letter visit or outpatient consultant. Due to the observing time, the investigation of scales about chemotherapy or sexual problem in the CR-29 was not carried out.

### Statistic analysis

Demographic data were compared using *t* test, Mann-Whitney *U* test or *Chi-square* test as appropriate. Scores, derived from the questionnaires, were linearly transformed into a 0–100 scale according to the EORTC Scoring Manual [16, 17]. A higher score in the functional or global QOL scales represented a higher level of function and better global QOL, whereas a higher score in symptom scales or items indicated more severe symptoms. Then, the changed scores of QOL on POD3/6/10/14/21/28 (in comparison with pre-operation) were calculated, respectively. According to the EORTC guidelines document [18], a change of 5–10 points (on the 0–100 scale) for the score of QOL denotes a clinically significant change of “little better (or worse),” a change of 10–20 points as “moderate better (or worse)” and a change greater than 20 as “very much

better (or worse).” All data analyses were performed by using SPSS 22.0 software (SPSS, Chicago, IL, USA). Mean scores and standard deviations were calculated. The Mann–Whitney *U* test was used to examine statistical significance at the 5 % level for the difference of QOL scores between the two groups. *p* value of <0.05 was regarded as significance and <0.01 as prominent significance. Furthermore, we used generalized estimating equation to do the longitudinal data analysis in order to determine the effective impact of correlative factors on the postoperative QOL, including age, sex, BMI, ASA grade, tumor location, tumor size, pTNM stage, recovery program and length of time after surgery. The analysis was done using R 3.0.1.

## Results

### Demography of the patients

The two groups were comparable with respect to clinical characteristics. There was no significant difference between the two groups in age, gender, body mass index, ASA grade, tumor location, tumor size or TNM stage (Table 1).

### Perioperative outcomes

There was no mortality in the two groups. The morbidity was 17.5 % in ERAS group and 26.7 % in conventional group, with no significant difference (Table 2). However,

the patients in ERAS groups had faster rehabilitation: first time out of bed ( $15.3 \pm 3.64$  vs.  $42.5 \pm 14.7$  h,  $p < 0.001$ ), first time of flatus ( $60.9 \pm 11.1$  vs.  $74.2 \pm 16.3$  h,  $p < 0.001$ ) and first time of bowel movement ( $75.1 \pm 14.9$  vs.  $85.5 \pm 19.4$  h,  $p = 0.002$ ). In addition, the postoperative hospital stay was much shorter in ERAS group ( $6.1 \pm 1.7$  vs.  $8.7 \pm 2.8$  day,  $p < 0.001$ ).

### Comparison of QOL

The response of the QOL measure was about 96 % in total during the entire follow-up period (96.2 % [384/399] of questionnaires were fed back in the ERAS group and 95.2 % [400/420] in the control group). The missing data were two on POD3, two on POD6, three on POD10, one on POD14, two on POD21, five on POD28 in ERAS group, while three on POD3, four on POD6, two on POD10, five on POD14, two on POD21, four on POD28 in control group.

In the primary statistical analysis, the scores of global QOL (on POD3, POD6, POD10, POD14, POD21), physical functioning (on POD3, POD6, POD10, POD14, POD21), role functioning (on POD6, POD10, POD14, POD21), emotional functioning (on POD3, POD6, POD10, POD14, POD21), cognitive functioning (on POD3, POD6) and social functioning (on POD3, POD6, POD10, POD14, POD21, POD28) were higher in ERAS group than in control group, which suggested that the patients in ERAS group had a better life status (Table 3). However, the scores of pain (on POD10, POD14, POD21), appetite loss

**Table 1** Demographic and clinical data of the two group patients

	ERAS group ( <i>n</i> = 57)	Control group ( <i>n</i> = 60)	<i>p</i>
Age (mean, years)	59.4 ± 6.3	58.7 ± 6.7	0.551
Gender			0.655
Male	28	27	
Female	29	33	
Body mass index	23.7 ± 2.2	24.1 ± 2.0	0.352
ASA grade			
I	43	41	0.393
II	14	19	
Tumor location			0.711
Right sided	44	48	
Left sided	13	12	
Tumor size (cm)			0.580
<3	15	20	
3–5	26	22	
>5	16	18	
TNM stage			0.823
I	9	11	
II	23	26	
III	25	23	

**Table 2** Perioperative outcomes of the two group patients

	ERAS group	Control group	<i>p</i>
Convalescence			
First time out of bed (h)	15.3 ± 3.6	42.5 ± 14.7	0.000
First time of flatus (h)	60.9 ± 11.1	74.2 ± 16.3	0.000
First bowel movement (h)	75.1 ± 14.9	85.5 ± 19.4	0.002
Postoperative hospital stay (days)	6.1 ± 1.7	8.7 ± 2.8	0.000
Morbidity			
Total	10 (17.5 %)	16 (26.7 %)	0.235
Anastomotic leakage	1	2	
Ileus	3	5	
Gastric retention	1	2	
Wound infection	2	2	
Pulmonary infection	1	3	
Cardiovascular events	2	2	

(on POD3, POD6), constipation (on POD3, POD6, POD10), diarrhea (on POD3, POD10), financial difficulties (on POD10, POD14, POD21), perspective of future health (on POD6, POD10, POD14), gastrointestinal tract problems (on POD3, POD6, POD10) and defecation problems (on POD6, POD10, POD14) were lower in ERAS group than in control group, which revealed that the patients in ERAS group suffered less symptoms (Table 3).

In the further generalized estimating equation analysis, the result showed that recovery program and length of time after surgery had independently positive impact on the patients' postoperative QOL (in the items of global QOL, physical functioning, role functioning, emotional functioning, social functioning, gastrointestinal tract problems and defecation problems; Table 4).

## Discussion

The research focusing on QOL of ERAS program, especially in the early postoperative period, is required. This study shows that the ERAS group has faster rehabilitation, fewer hospital stay and no increased morbidity, which is in accordance with previous reports, and ERAS could improve the short-term QOL in patients undergoing colonic resection.

ERAS program could hasten recovery of the physical and mental function in the postoperative period compared with conventional management. Gatt et al. [19] measured the hand-grip strength preoperatively and postoperatively to assess the recovery of physical function in patients undergoing major colonic resection and found that the hand-grip strength was maintained throughout the observation period in the ERAS group, but was significantly reduced in conventional group. Besides, the mental function of patients is seldom used to evaluate the clinical outcome

because it is determined subjectively and usually difficult to reflect. However, it is actually important for patients, especially during the period of enduring a major surgery.

A few studies have examined the influence of ERAS protocols and QOL. Anderson et al. [20] observed that ERAS was associated with significantly lower pain scores at rest, on movement and on coughing, on POD1, and lower fatigue scores on POD7. Basse et al. [21] also demonstrated that patients with ERAS program were with less pain at rest on POD1 and POD2. Raue et al. [22] evaluated that visual analog scale scores for pain were similar for the two groups, but fatigue was increased in the standard-care group on POD1 and POD2. Jakobsen et al. [23] found that patients with ERAS program regained functional capabilities earlier with less fatigue and need for sleep compared with those having conventional care. Zargar-Shoshtari et al. [24] demonstrated that postoperative fatigue significantly increased in both groups, and peak fatigue score, the total fatigue experience and the total fatigue impact were significantly lower in the ERAS group. However, Delaney et al. [25] observed that the pain scores at the time of discharge were higher in ERAS patients, and the role emotional and mental health scores were significantly reduced in ERAS patients at discharge. In contrast, Gatt et al. [19] and Henriksen et al. [26] documented that there were no differences in pain or fatigue scores postoperatively between the groups, and King et al. [27] and Khan et al. [28] proved that there were no significant differences in QOL or health economic outcomes between the two groups. Our result showed that the patients in ERAS group had better status on role, emotional and social function in the early postoperative period than those in the control group. As patients generally have severe psychological burden of surgery, faster recovery to daily life is crucial to overcome the depression and return to a promising mental status.

**Table 3** QOL assessment (comparison of the changed scores)

	ERAS group	Control group	<i>p</i>
<i>QLQ-C30</i>			
Global quality of life <sup>a</sup>			
ΔPOD3	-10.9 ± 2.9	-18.7 ± 7.0	0.000
ΔPOD6	-6.1 ± 4.9	-16.7 ± 5.1	0.000
ΔPOD10	-3.0 ± 4.6	-11.5 ± 3.6	0.002
ΔPOD14	-1.8 ± 3.8	-8.2 ± 3.9	0.013
ΔPOD21	-0.5 ± 2.3	-5.3 ± 5.0	0.041
ΔPOD28	0.5 ± 2.3	-1.8 ± 3.9	0.106
Functioning scales			
Physical functioning <sup>a</sup>			
ΔPOD3	-11.9 ± 4.0	-24.8 ± 5.7	0.000
ΔPOD6	-7.5 ± 4.3	-22.7 ± 5.1	0.000
ΔPOD10	-4.9 ± 5.0	-14.3 ± 5.0	0.000
ΔPOD14	-3.5 ± 4.8	-10.3 ± 1.8	0.009
ΔPOD21	-2.6 ± 4.4	-7.8 ± 4.2	0.029
ΔPOD28	-2.3 ± 4.2	-4.8 ± 5.0	0.077
Role functioning <sup>a</sup>			
ΔPOD3	-45.8 ± 5.0	-53.7 ± 4.9	0.002
ΔPOD6	-36.0 ± 4.9	-48.2 ± 3.9	0.000
ΔPOD10	-26.5 ± 4.8	-40.3 ± 5.8	0.000
ΔPOD14	-20.7 ± 7.0	-31.5 ± 3.6	0.000
ΔPOD21	-17.9 ± 4.1	-26.3 ± 4.9	0.000
ΔPOD28	-16.8 ± 4.7	-21.3 ± 3.4	0.037
Emotional functioning <sup>a</sup>			
ΔPOD3	1.4 ± 3.5	-4.5 ± 5.0	0.015
ΔPOD6	10.5 ± 2.3	0.3 ± 5.5	0.000
ΔPOD10	14.2 ± 5.0	5.2 ± 5.0	0.001
ΔPOD14	16.7 ± 4.8	9.0 ± 3.0	0.002
ΔPOD21	18.1 ± 4.0	13.7 ± 4.9	0.035
ΔPOD28	19.5 ± 2.3	19.0 ± 3.0	0.819
Cognitive functioning <sup>a</sup>			
ΔPOD3	-11.1 ± 3.2	-15.8 ± 3.4	0.033
ΔPOD6	-7.6 ± 4.1	-11.9 ± 3.9	0.039
ΔPOD10	-4.3 ± 3.3	-7.4 ± 4.8	0.051
ΔPOD14	-2.1 ± 3.1	-3.4 ± 4.3	0.347
ΔPOD21	0.6 ± 2.8	-1.1 ± 3.2	0.161
ΔPOD28	1.8 ± 3.5	0.8 ± 4.1	0.410
Social functioning <sup>a</sup>			
ΔPOD3	-29.6 ± 7.1	-34.2 ± 5.0	0.033
ΔPOD6	-23.2 ± 4.7	-29.0 ± 3.0	0.019
ΔPOD10	-11.1 ± 3.1	-25.0 ± 5.0	0.000
ΔPOD14	-7.4 ± 4.4	-16.5 ± 4.8	0.000
ΔPOD21	-3.3 ± 4.8	-10.0 ± 5.2	0.012
ΔPOD28	-0.5 ± 2.3	-4.0 ± 4.9	0.047
Symptom scales			
Fatigue <sup>b</sup>			
ΔPOD3	40.1 ± 5.2	35.5 ± 2.5	0.051

**Table 3** continued

	ERAS group	Control group	<i>p</i>
ΔPOD6	27.1 ± 5.6	23.8 ± 3.1	0.054
ΔPOD10	18.1 ± 4.2	18.3 ± 4.6	0.829
ΔPOD14	15.7 ± 4.2	16.2 ± 4.3	0.727
ΔPOD21	15.0 ± 4.0	15.7 ± 4.6	0.614
ΔPOD28	13.8 ± 3.2	14.0 ± 3.8	0.841
Nausea and vomiting <sup>b</sup>			
ΔPOD3	10.5 ± 3.7	10.0 ± 3.2	0.703
ΔPOD6	1.6 ± 4.3	4.8 ± 3.7	0.050
ΔPOD10	-0.9 ± 4.2	-1.1 ± 4.1	0.799
ΔPOD14	-0.6 ± 5.2	0.2 ± 4.9	0.515
ΔPOD21	-1.0 ± 3.0	-1.2 ± 3.3	0.823
ΔPOD28	-1.7 ± 4.2	-1.4 ± 4.3	0.778
Pain <sup>b</sup>			
ΔPOD3	24.6 ± 4.3	22.2 ± 3.8	0.817
ΔPOD6	19.9 ± 4.0	20.0 ± 3.2	0.915
ΔPOD10	15.5 ± 5.2	18.8 ± 3.7	0.045
ΔPOD14	11.3 ± 5.4	15.6 ± 4.1	0.044
ΔPOD21	9.8 ± 5.2	14.0 ± 4.4	0.039
ΔPOD28	7.9 ± 4.9	11.1 ± 3.9	0.050
Dyspnea <sup>b</sup>			
ΔPOD3	10.5 ± 4.8	8.3 ± 4.3	0.083
ΔPOD6	5.8 ± 3.9	6.7 ± 4.2	0.464
ΔPOD10	3.5 ± 4.7	5.0 ± 3.8	0.254
ΔPOD14	1.7 ± 4.5	2.8 ± 4.7	0.385
ΔPOD21	1.2 ± 3.4	1.7 ± 4.1	0.715
ΔPOD28	0.6 ± 4.2	0.6 ± 4.0	0.931
Insomina <sup>b</sup>			
ΔPOD3	12.8 ± 4.7	14.5 ± 5.2	0.183
ΔPOD6	6.4 ± 4.4	9.4 ± 4.9	0.051
ΔPOD10	4.1 ± 4.4	6.7 ± 4.1	0.077
ΔPOD14	2.3 ± 5.2	2.8 ± 4.9	0.712
ΔPOD21	0.1 ± 4.8	0.1 ± 5.1	0.926
ΔPOD28	-1.2 ± 4.1	-1.7 ± 3.8	0.693
Appetite loss <sup>b</sup>			
ΔPOD3	6.5 ± 3.8	13.3 ± 4.5	0.008
ΔPOD6	2.5 ± 4.6	8.7 ± 5.1	0.014
ΔPOD10	1.3 ± 3.9	5.3 ± 4.3	0.050
ΔPOD14	1.3 ± 5.1	2.7 ± 4.2	0.276
ΔPOD21	0.6 ± 5.2	1.1 ± 4.0	0.718
ΔPOD28	-0.5 ± 3.6	-0.6 ± 4.1	0.845
Constipation <sup>b</sup>			
ΔPOD3	5.9 ± 3.9	12.1 ± 3.4	0.013
ΔPOD6	0.1 ± 4.4	7.5 ± 5.6	0.005
ΔPOD10	-1.1 ± 5.0	5.4 ± 5.2	0.011
ΔPOD14	-0.6 ± 3.5	2.7 ± 3.8	0.078
ΔPOD21	-1.9 ± 4.4	0.5 ± 3.7	0.080
ΔPOD28	-0.6 ± 4.3	-0.5 ± 5.1	0.873

**Table 3** continued

	ERAS group	Control group	<i>p</i>
<b>Diarrhea<sup>b</sup></b>			
ΔPOD3	4.1 ± 3.7	−4.4 ± 4.6	0.001
ΔPOD6	1.7 ± 4.2	3.9 ± 5.2	0.089
ΔPOD10	−0.6 ± 4.2	2.8 ± 5.1	0.046
ΔPOD14	−1.2 ± 4.1	−0.5 ± 4.5	0.535
ΔPOD21	−2.4 ± 5.3	−2.2 ± 4.5	0.837
ΔPOD28	−1.8 ± 4.5	−3.3 ± 5.1	0.248
<b>Financial difficulties<sup>b</sup></b>			
ΔPOD3	4.1 ± 4.2	3.3 ± 4.1	0.517
ΔPOD6	6.4 ± 5.2	6.1 ± 4.2	0.793
ΔPOD10	3.0 ± 5.3	8.1 ± 5.2	0.030
ΔPOD14	2.0 ± 4.3	6.5 ± 5.2	0.035
ΔPOD21	1.2 ± 3.5	5.3 ± 4.2	0.039
ΔPOD28	−0.6 ± 4.2	2.4 ± 5.1	0.053
<b>QLQ-CR29</b>			
<b>Functional scales</b>			
<b>Body image<sup>a</sup></b>			
ΔPOD3	−10.7 ± 3.5	−13.3 ± 4.9	0.072
ΔPOD6	−6.5 ± 4.3	−9.8 ± 5.1	0.055
ΔPOD10	−2.7 ± 5.3	−6.2 ± 3.7	0.059
ΔPOD14	0.3 ± 5.0	−3.2 ± 4.9	0.061
ΔPOD21	3.3 ± 2.9	0.9 ± 5.3	0.075
ΔPOD28	4.7 ± 3.9	3.2 ± 4.8	0.257
<b>Perspective of future health<sup>a</sup></b>			
ΔPOD3	0.2 ± 3.3	3.8 ± 2.8	0.053
ΔPOD6	5.1 ± 5.1	11.1 ± 4.5	0.015
ΔPOD10	12.3 ± 5.0	19.8 ± 3.4	0.003
ΔPOD14	18.5 ± 5.3	25.6 ± 5.3	0.006
ΔPOD21	23.2 ± 3.8	27.9 ± 4.5	0.050
ΔPOD28	26.8 ± 5.2	29.8 ± 4.9	0.054
<b>Symptom scales</b>			
<b>Micturition problems<sup>b</sup></b>			
ΔPOD3	3.0 ± 4.9	3.5 ± 5.0	0.704
ΔPOD6	1.4 ± 3.4	4.9 ± 5.3	0.050
ΔPOD10	0.9 ± 3.5	3.5 ± 2.9	0.078
ΔPOD14	0.5 ± 5.8	2.2 ± 4.9	0.204
ΔPOD21	0.6 ± 3.7	2.4 ± 5.2	0.193
ΔPOD28	0.9 ± 3.9	1.4 ± 5.0	0.683
<b>Gastrointestinal tract problems<sup>b</sup></b>			
ΔPOD3	−1.4 ± 3.5	−4.5 ± 5.0	0.049
ΔPOD6	−4.7 ± 5.0	0.7 ± 2.5	0.027
ΔPOD10	−6.3 ± 4.9	−1.8 ± 4.7	0.035
ΔPOD14	−6.5 ± 4.8	−4.7 ± 5.0	0.166
ΔPOD21	−6.8 ± 4.7	−5.2 ± 5.0	0.237
ΔPOD28	−7.4 ± 4.4	−6.3 ± 4.9	0.391

**Table 3** continued

	ERAS group	Control group	<i>p</i>
<b>Defecation problems<sup>b</sup></b>			
ΔPOD3	3.7 ± 4.9	2.2 ± 4.2	0.255
ΔPOD6	−0.5 ± 2.3	5.5 ± 5.0	0.013
ΔPOD10	−2.6 ± 4.4	3.5 ± 4.8	0.014
ΔPOD14	−4.0 ± 4.9	−0.3 ± 1.8	0.042
ΔPOD21	−4.4 ± 5.0	−1.5 ± 3.6	0.053
ΔPOD28	−4.7 ± 5.0	−2.8 ± 4.5	0.058

A change of 5–10 points for the score of QOL denotes a clinically significant change of “little better (or worse),” a change of 10–20 points as “moderate better (or worse)” and a change greater than 20 as “very much better (or worse)”

*POD* postoperative day, *ΔPOD3* score(POD3)-score(pre-operation)

<sup>a</sup> Higher score represents a better quality of life or a higher level of functioning

<sup>b</sup> Higher score represents more severe symptoms

In addition, this result showed that gastrointestinal tract problem and defecation problem meliorated to normal level much faster in the ERAS group than that in the conventional group. It can probably be attributed to perioperative nutrition support and early mobilization, which could reduce gastrointestinal stress response and accelerate the recovery of bowel movement.

In the present study, a faster recuperation after colonic surgery may bring the patients a better subjective feelings and satisfaction. Therefore, the score of global QOL scale in ERAS group was higher than control group (POD3, POD6, POD10, POD14, POD21). However, the scores of the two groups tended to closer in the follow-up (POD28), which might indicate that the difference between two perioperative management only manifest during a short term after surgery. And a recent systematic review often publications also concluded beyond 30 days after surgery; none of the QOL measures showed any differences [14]. Moreover, some patients in this study would receive adjuvantive chemotherapy which would add much more influence on the QOL. Therefore, the observation endpoint time of this study was set on just 1 month after surgery.

However, the differences of QOL scores usually lack a clinical interpretation until the advent of some evidence-based guidelines for interpreting change scores [29, 30]. With the help of those guidelines, we more accurately interpret QOL differences. In our study, the significant differences of physical functioning and social functioning are likely to be median improvements, the differences of global QOL in POD21 and POD28 are trivial improvements, and other differences are small improvements.

**Table 4** Analysis of QOL (generalized estimating equation)

	Estimate	SE	Wald statistics	<i>p</i>
<b>Global QOL</b>				
Intercept	-18.933	3.227	34.426	0.000
Age	-0.061	0.066	0.860	0.354
Sex	-0.462	0.422	1.197	0.274
BMI	0.119	0.150	0.629	0.428
ASA grade	0.876	0.514	2.904	0.088
Tumor location	-0.269	0.535	0.254	0.614
Tumor size	-0.265	0.714	0.137	0.711
pTNM stage	0.600	0.726	0.683	0.409
Recovery program	6.051	0.441	188.562	0.008
Length of time after surgery	0.576	0.026	505.655	0.000
<b>Physical functioning</b>				
Intercept	-29.219	4.034	52.467	0.000
Age	0.010	0.079	0.015	0.903
Sex	-0.203	0.525	0.150	0.698
BMI	0.247	0.161	2.358	0.125
ASA grade	0.394	0.607	0.421	0.516
Tumor location	-0.879	0.544	2.614	0.106
Tumor size	-0.732	0.883	0.686	0.407
pTNM stage	1.104	0.894	1.525	0.217
Recovery program	8.984	0.520	298.664	0.002
Length of time after surgery	0.478	0.029	265.559	0.000
<b>Role functioning</b>				
Intercept	-52.050	3.584	210.913	0.000
Age	0.111	0.080	1.931	0.165
Sex	0.154	0.643	0.058	0.810
BMI	-0.381	0.192	3.940	0.047
ASA grade	-0.532	0.749	0.505	0.477
Tumor location	0.545	0.812	0.450	0.502
Tumor size	0.173	1.018	0.029	0.865
pTNM stage	0.171	0.965	0.031	0.860
Recovery program	8.638	0.609	201.182	0.000
Length of time after surgery	1.240	0.023	3024.852	0.000
<b>Emotional functioning</b>				
Intercept	-1.384	7.668	0.033	0.857
Age	0.043	0.149	0.083	0.773
Sex	-0.123	1.164	0.011	0.916
BMI	-0.165	0.404	0.167	0.683
ASA grade	-1.961	1.342	2.134	0.144
Tumor location	0.611	1.389	0.194	0.660
Tumor size	1.361	1.692	0.647	0.421
pTNM stage	-1.039	1.575	0.435	0.509
Recovery program	5.270	1.088	23.472	0.003
Length of time after surgery	0.860	0.034	626.593	0.000
<b>Social functioning</b>				
Intercept	-35.993	3.667	96.348	0.000
Age	0.115	0.072	2.522	0.112
Sex	-0.149	0.470	0.100	0.752

**Table 4** continued

	Estimate	SE	Wald statistics	<i>p</i>
BMI	-0.247	0.157	2.460	0.117
ASA grade	-0.443	0.571	0.604	0.437
Tumor location	-0.996	0.608	2.684	0.101
Tumor size	-0.512	0.789	0.421	0.516
pTNM stage	0.540	0.761	0.504	0.478
Recovery program	7.314	0.485	227.369	0.000
Length of time after surgery	1.162	0.025	2194.624	0.000
<b>Gastrointestinal tract problems</b>				
Intercept	-5.320	4.223	1.587	0.208
Age	-0.136	0.079	2.978	0.084
Sex	-0.256	0.564	0.207	0.649
BMI	0.391	0.172	5.188	0.023
ASA grade	0.950	0.671	2.004	0.157
Tumor location	0.447	0.663	0.455	0.500
Tumor size	-0.683	0.964	0.502	0.479
pTNM stage	1.166	0.926	1.588	0.208
Recovery program	-1.158	0.563	4.232	0.040
Length of time after surgery	-0.135	0.017	62.317	0.000
<b>Defecation problems</b>				
Intercept	6.830	3.137	4.741	0.029
Age	0.013	0.068	0.037	0.847
Sex	-0.178	0.459	0.150	0.698
BMI	-0.153	0.158	0.945	0.331
ASA grade	-0.346	0.622	0.310	0.578
Tumor location	-0.337	0.552	0.373	0.541
Tumor size	0.279	0.739	0.142	0.706
pTNM stage	0.012	0.685	0.000	0.986
Recovery program	-2.322	0.478	23.564	0.001
Length of time after surgery	-0.219	0.021	112.879	0.000

Whether the ERAS could be universally applied is an important issue. As it is advocated and popularize mainly in Europe and North America, some researchers may doubt whether ERAS could be feasible in eastern countries. Our previous study has proved its feasibility [15]. In addition, in this series, 95 % of the patients fulfilled the entire ERAS program and presented a better perioperative outcome and QOL. Therefore, as to our experience, ERAS could also be suitable for Chinese patients, in despite of the diversity of race and custom.

In summary, this study showed that the short-term QOL in patients undergoing colonic resection using ERAS program was better than that using conventional management. These results may provide another descriptive dimension for the recommendation of ERAS in the surgery of colonic cancer. However, the main limitation of this study was the single institution participated and non-randomized.

Besides, the patient's self-reported components were subjective data, which may be inhomogeneous. And all these would lead to bias. Therefore, further randomized controlled studies from multiple centers are necessary to confirm these findings.

**Conflicts of interest** The authors have declared no conflicts of interest.

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