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SCIENTIFIC REVIEW

Enhanced Recovery After Surgery Programs for Laparoscopic Abdominal Surgery: A Systematic Review and Meta-analysis

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Abstract

Background Enhanced recovery after surgery (ERAS) protocols or laparoscopic technique has been applied in various surgical procedures. However, the clinical efficacy of combination of the two methods still remains unclear. Thus, our aim was to assess the role of ERAS protocols in laparoscopic abdominal surgery.

Methods We performed a systematic literature search in various databases from January 1990 to October 2017. The results were analyzed according to predefined criteria.

Results In the present meta-analysis, the outcomes of 34 comparative studies (15 randomized controlled studies and 19 non-randomized controlled studies) enrolling 3615 patients (1749 in the ERAS group and 1866 in the control group) were pooled. ERAS group was associated with shorter hospital stay (WMD − 2.37 days; 95% CI − 3.00 to − 1.73; *P* 0.000) and earlier time to first flatus (WMD − 0.63 days; 95% CI − 0.90 to − 0.36; *P* 0.000). Meanwhile, lower overall postoperative complication rate (OR 0.62; 95% CI 0.51–0.76; *P* 0.000) and less hospital cost (WMD 801.52 US dollar; 95% CI − 918.15 to − 684.89; *P* 0.000) were observed in ERAS group. Similar readmission rate (OR 0.73, 95% CI 0.52–1.03, *P* 0.070) and perioperative mortality (OR 1.33; 95% CI 0.53–3.34; *P* 0.549) were found between the two groups.

Conclusions ERAS protocol for laparoscopic abdominal surgery is safe and effective. ERAS combined with laparoscopic technique is associated with faster postoperative recovery without increasing readmission rate and perioperative mortality.

Introduction

The concept of enhanced recovery after surgery (ERAS) was first introduced by Kehlet in the 1990s and has been widely used in various surgeries in past decade [1–5]. The application of ERAS protocols is expected to reduce surgical stress and complication rate by the combination of various interventions in the preoperative period. The key components of ERAS guidelines include preoperative education, epidural or regional anesthesia, no routine use of drains or nasogastric tubes, preventing postoperative vomiting, optimal pain control, early enteral nutrition, and ambulation. Extensive researches have shown that the ERAS protocol is superior to the conventional protocol in

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the field of many types of surgery [6–8]. Nowadays, laparoscopic technique has been applied widely because of the superior surgical and short-term outcomes as compared with open surgery. Accumulating researches have shown that patients undergoing major abdominal surgery could benefit from both ERAS programs and laparoscopic technique [9–11]. However, some surgeons still ignore the benefits of ERAS when performing laparoscopic surgery. The aim of this meta-analysis was to assess the role of ERAS protocols in laparoscopic abdominal surgery.

Search strategy

Materials and methods

A systematic literature search of PubMed, EMBASE, the Cochrane Library, and Web of Science from January 1990 to October 2017 was undertaken with restriction to English. Search terms "ERAS" (enhanced recovery, fast track) and "laparoscopy" (laparoscopic, laparoscopy-assisted) were used in combination with the Boolean operators AND or OR. The reference lists of articles obtained were also reviewed to find the relevant literature. Two investigators (ZYL and BB) performed the literature search independently.

Study selection

Included criteria for this meta-analysis were as follows: (1) randomized controlled trials (RCTs) or non-randomized controlled trials (nRCTs) that compared ERAS with traditional care in laparoscopic surgery; (2) studies that focus on major abdominal surgery, including gastrectomy, hepatectomy, cystectomy, pancreatectomy, prostatectomy, nephrectomy, and colorectal surgery; (3) studies that reported at least one outcome of interest, including length of hospital stay, postoperative complication, readmission rate, time to first flatus, hospital costs, and perioperative mortality; and (4) the ERAS group should include at least five intervention items of ERAS protocol that distinct from the control group. The excluded criteria were: (1) studies such as reviews, comments, letters, case reports, or cohort studies including fewer than ten patients; (2) study included vascular or emergency operation cases; and (3) studies published in a language other than English.

Data extraction, outcome measures, and bias assessment

Data were extracted independently by two reviewers (ZYL and BB), and discrepancies were adjudicated by a third reviewer (QCZ).Primary outcomes were length of hospital stay, postoperative complication, and readmission rate. Secondary outcomes were time to first flatus, hospital costs, and perioperative mortality. Hospital costs were converted into US dollar according to the exchange rate of October 2017.

Risk of bias of RCTs was assessed independently using the Cochrane risk of bias method [12]. Other studies were methodologically assessed by the same reviewers using the Newcastle–Ottawa scale (NOS), which has been widely used for the assessment of the quality of non-randomized studies in meta-analyses [13].

Statistical analysis

The data of primary and secondary outcomes were calculated using a random effects model and reported with 95% confidence interval (CI). Odds ratio (OR) was used to calculated categorical outcomes (postoperative complication, readmission rate, and perioperative mortality). Weighted mean difference (WMD) was used to calculate continuous outcomes (length of hospital stay, time to first flatus, and hospital costs). I^2 statistics were used to quantify the heterogeneity among studies. Heterogeneity was graded as low ($I^2 < 25\%$), moderate ($I^2 = 25\%$ to 75%), or high ($I^2 > 75\%$). Potential publication bias was tested by Begg test with visual inspection of the funnel plot (Supplemental Figure 1).

We performed sensitivity analysis to assess the stability of primary outcomes. The results were regarded as statistically significant at two-sided $P < 0.05$. All statistical analyses for meta-analyses were performed using Stata, version 14.1 (Stata Corp, College Station, TX). Risk of bias was assessed using the dedicated Cochrane tool of Review Manager software (RevMan version 5.3; Cochrane Collaboration).

Results

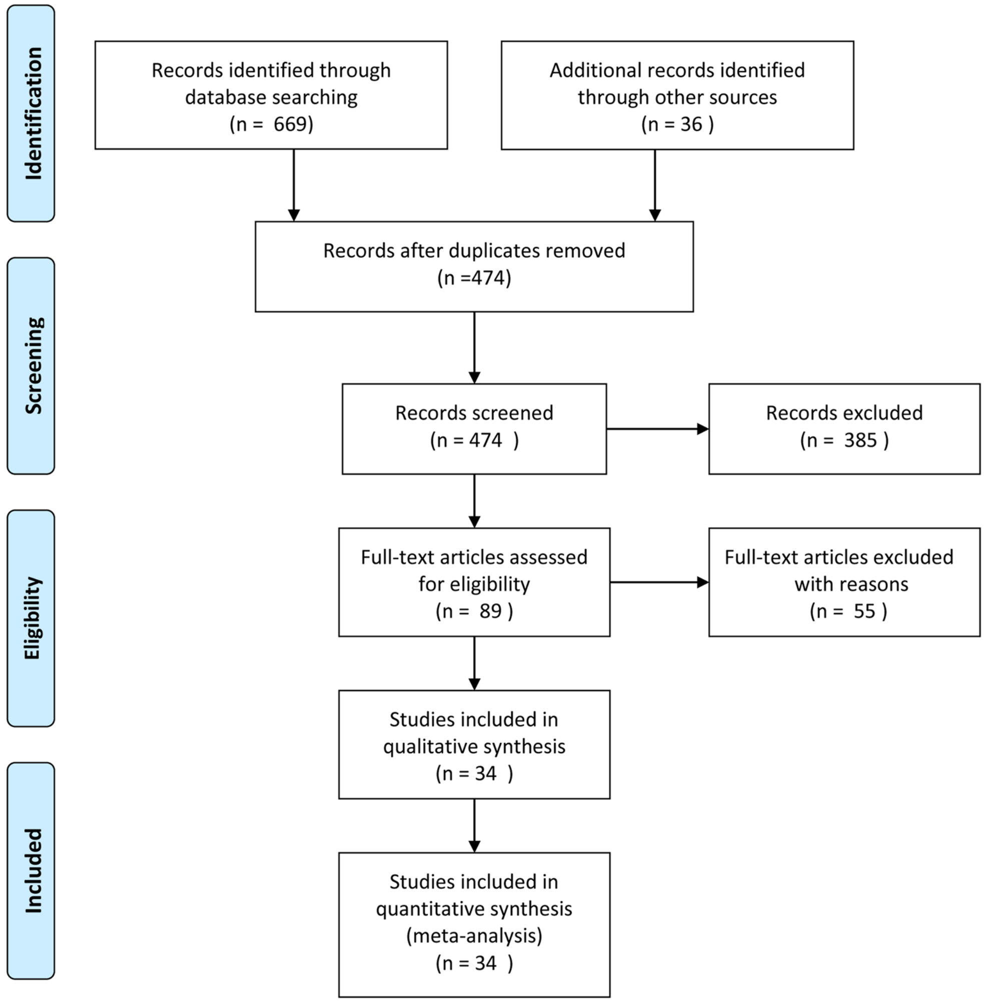
Study selection

We conduct this systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Finally, 34 studies [14–47] were eligibly included in the pooled analysis, which contained 15 randomized controlled studies [14–28] and 19 non-randomized controlled studies [29–47]. The detailed search steps are illustrated in Fig. 1.

Study characteristics and quality assessment

Table 1 presents the characteristics of the final included studies. These studies were published from 2005 to 2017. A

Fig. 1 PRISMA flow diagram of the meta-analysis



total of 3615 patients were included in 34 studies with 1749 in ERAS group and 1866 in control group. The 15 randomized controlled studies included 1247 patients: 606 in the ERAS group and 641 in the control group. The non-randomized controlled studies included 2368 patients: 1143 in the ERAS group and 1225 in the control group. The numbers of intervention items were ranged from 5 to 16. Risk of bias for randomized controlled studies is shown in Fig. 2. All these studies presented low to moderate risks. The quality assessment of non-randomized studies the NOS is presented in Table 2. Most of them had a score of 6–8, and only 2 studies had a score of 9.

Primary outcomes measures

Length of hospital stay

Twenty-one studies with appropriate data reported the length of hospital stay. This meta-analysis indicated that ERAS group was associated with a shorter hospital stay as compared with the control group (WMD − 2.37 days; 95% CI − 3.25 to − 1.73; P 0.000). This result showed a significant heterogeneity among the studies (I^2 = 94.2, P = 0.000) (Fig. 3a). There were 12 randomized trials reported postoperative hospital stay. Our results illustrate that the ERAS group is associated with a shorter hospital stay based on analysis of RCTs (WMD − 1.89 days; 95% CI − 2.46 to − 1.32; P 0.000). The result also showed a significant heterogeneity among these studies (I^2 = 88.1, P = 0.000) (Fig. 3b).

Postoperative complication rate

Thirty-one studies reported the postoperative complication. A lower postoperative complication rate was observed in the ERAS group (OR 0.61, 95% CI 0.49–0.75, P 0.000). This result showed a moderate heterogeneity (I^2 26.6, P 0.089) (Fig. 3c). Analysis of the RCTs also revealed a lower postoperative complication rate favoring ERAS group (OR 0.57, 95% CI 0.37–0.86, P 0.000). This result

Table 1 Characteristics of included studies

Study	Year	Study design	Surgical procedure	ERAS (*n*)	Control (*n*)	Interventions (*n*)
Recart et al.	2005	RCT	Laparoscopic nephrectomy	13	12	5
Gralla et al.	2007	RCT	Laparoscopic radical prostatectomy	25	25	10
Magheli et al.	2011	RCT	Laparoscopic radical prostatectomy	25	25	10
Vlug et al.	2011	RCT	Laparoscopic colectomy	100	109	16
Lee et al.	2011	RCT	Laparoscopic colectomy	46	54	7
Kim et al.	2012	RCT	Laparoscopic gastrectomy	22	22	11
Hu et al.	2012	RCT	Laparoscopic gastrectomy	19	22	10
Wang et al.	2012	RCT	Laparoscopic colorectal surgery	40	38	10
Wang et al.	2012	RCT	Laparoscopic colectomy	40	40	10
Lemanu et al.	2013	RCT	Laparoscopic sleeve gastrectomy	40	38	8
Feng et al.	2014	RCT	Laparoscopic rectal surgery	57	59	9
He et al.	2015	RCT	Laparoscopic hepatectomy	48	38	10
Abdikarim et al.	2015	RCT	Laparoscopic gastrectomy	30	31	12
Liang et al.	2016	RCT	Laparoscopic hepatectomy	80	107	11
Liu et al.	2016	RCT	Laparoscopic gastrectomy	21	21	11
Stoot et al.	2009	nRCT	Laparoscopic hepatectomy	13	13	14
Vassiliki et al.	2009	nRCT	Laparoscopic colectomy	82	115	6
Poon et al.	2010	nRCT	Laparoscopic colectomy	96	84	8
Gouvas et al.	2012	nRCT	Laparoscopic rectal surgery	42	33	9
Sanchez-Perez et al.	2012	nRCT	Laparoscopic hepatectomy	26	17	13
Huibers et al.	2012	nRCT	Laparoscopic colorectal surgery	43	33	14
Saar et al.	2013	nRCT	Robot-assisted laparoscopic cystectomy	31	31	15
Guan et al.	2014	nRCT	Laparoscopic radical cystectomy	60	55	7
Sahoo et al.	2014	nRCT	Laparoscopic gastrectomy	22	25	12
Taupyk et al.	2014	nRCT	Laparoscopic colorectal surgery	31	39	11
Esteban et al.	2014	nRCT	Laparoscopic colorectal surgery	150	56	13
Richardson et al.	2015	nRCT	Laparoscopic distal pancreatectomy	22	44	8
Alvarez et al.	2015	nRCT	Laparoscopic colectomy	89	162	7
Vignal et al.	2016	nRCT	Laparoscopic rectal surgery	162	135	11
Rege et al.	2016	nRCT	Laparoscopic nephrectomy	39	40	5
Fang et al.	2016	nRCT	Laparoscopic gastrectomy	33	30	6
Pedziwiatr et al.	2016	nRCT	Laparoscopic colorectal surgery	33	33	13
Sugi et al.	2017	nRCT	Laparoscopic radical prostatectomy	75	123	9
Zeng et al.	2017	nRCT	Laparoscopic colorectal surgery	94	157	10

RCT randomized controlled trial*, nRCT* non-randomized controlled trial

also showed a moderate heterogeneity (I^2 41.6, P 0.008) (Fig. 3d).

Readmission rate

Twenty-two studies reported the readmission rate, whereas nine of them had no readmission. The pooled data based on 13 studies identified no significant difference in readmission rate between the ERAS group and control group (OR 0.73, 95% CI 0.52–1.03, *P* 0.070) (Fig. 3e). Analysis of the RCTs also indicates that the readmission rate was similar between the two groups (OR 0.88; 95% CI 0.48–1.62, *P* 0.688) (Fig. 3f).

Subgroup analysis of primary outcomes measures

For the subgroup analysis based on study types (RCTs or nRCTs), number of intervention items (intervention items $\geq$ 10 or intervention items $<$ 10), and surgery types (laparoscopic non-colorectal surgery or laparoscopic colorectal surgery), the ERAS group still had the advantage of shorter hospital stay and lower postoperative complication

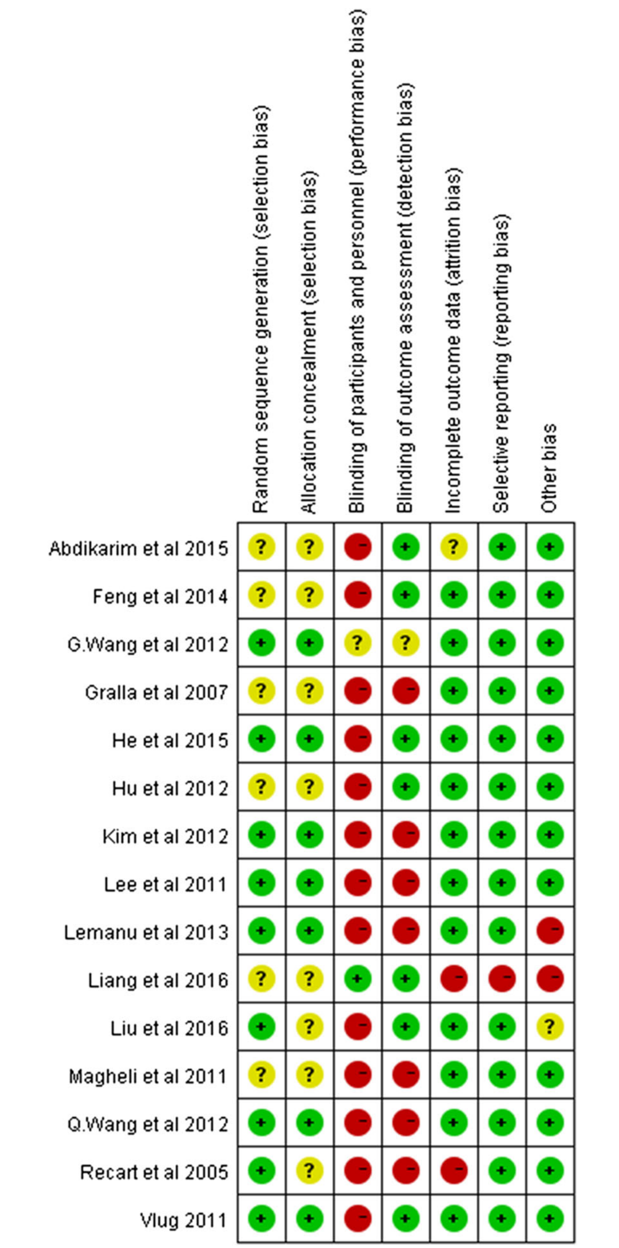


Fig. 2 Risk of bias for randomized controlled studies. +: low risk of bias; −: high risk of bias;?: unclear risk of bias

rate. The subgroup analysis also revealed that ERAS and control groups had similar readmission rate. Table 3 shows the results of subgroup analysis.

Secondary outcomes

Nine studies with the appropriate data reported the time to first flatus. The pooled result indicated that ERAS group is associated with earlier time to first flatus than control group (WMD − 0.63 days; 95% CI − 0.90 to − 0.36; *P* 0.000). The statistical outcome showed a significant heterogeneity among these studies (I^2 89.8, *P* 0.000) (Fig. 4a). Hospital cost with appropriate data was reported in seven of the included studies. Our result indicated that the ERAS group had less hospital cost (WMD − 801.52 US dollar; 95% CI − 918.15 to − 684.89; *P* 0.000) (Fig. 4b). Twenty-one studies reported perioperative mortality outcome, whereas 13 of them had no perioperative mortality. No significant difference was observed in perioperative mortality between the two groups (OR 1.33; 95% CI 0.53–3.34; *P* 0.549). This result showed no significant heterogeneity ($I^2 = 0$, $P = 0.983$) (Fig. 4c).

Publication bias and sensitivity analysis

Begg test with funnel plot for primary and secondary outcomes revealed no significant publication bias except for time to first flatus (Supplemental Figure 1). Sensitivity analysis was conducted by subgroup analysis on primary outcomes. Table 3 shows the result of subgroup analysis of primary outcomes. The result indicated that the primary outcomes are stable.

Discussion

Over the past decades, laparoscopic techniques and ERAS program have been applied in various kinds of surgery. However, the clinical efficacy of combination of the two methods still remains unclear. This systematic review and meta-analysis include comparative studies of the safety and efficacy of ERAS protocol and conventional care for patients underwent laparoscopic abdominal surgery from 2005 to 2017. To our knowledge, this is the first meta-analysis to give an overview of the clinical efficacy of ERAS protocol combined with laparoscopic technique for major abdominal surgery.

Hospital stay is a key index to assess the outcome of postoperative recovery. We hypothesize previously that optimal surgical outcomes may have already been achieved with minimally invasive techniques, leaving limited room for improvement via ERAS protocols. With the results of our meta-analysis, we observed that ERAS group had shorter hospital stay. This reduction was 2.37 days (95% CI − 3.00 to − 1.73) in the analysis of all included studies. This result not just statistically significant, but also have clinical significance.

In this study, almost half of the studies with appropriate data reported the outcomes of length of hospital stay are about the colorectal surgery. Therefore, we perform the subgroup analysis to test the stability of the result by excluding the studies related to colorectal surgery. The result was also consistent when only non-colorectal surgeries were evaluated, indicating that the outcome is stable.

In the included studies, the intervention items are ranged from 5 to 16. We infer that the benefit of patients may associated with the number of intervention items be applied. Interestingly, the subgroup analysis revealed that the shorter hospital stay could also be observed in ERAS group when less intervention items (intervention items < 10) were taken for consideration. However, considerable heterogeneity still existed when subgroup analysis was conducted. This may attributed to the different surgical types and discharge criteria among the included studies.

Postoperative complication is always regarded as one of the major concerns in clinical practice. Extensive researches have demonstrated that patients who underwent laparoscopic surgery are always associated with lower complication rate when compared with open surgery. Our result indicated that ERAS group was associated with lower overall postoperative complication rate. Furthermore, the subgroup analysis based on study types (RCTs or nRCTs), intervention items (intervention items ≥ 10 or intervention items < 10), and surgery types (laparoscopic non-colorectal surgery or laparoscopic colorectal surgery) still proved that ERAS was beneficial to lower postoperative complications after laparoscopic surgery. However, postoperative complications were not recorded in majority of included studies according to the Clavien–Dindo grade. Moreover, postoperative complications reported in the included studies were varied due to different types of surgery and uniform standards. So, it was not feasible for us to perform a stratified analysis according to the severity of complications.

Whether the ERAS protocol is accompanied by higher potentially readmission rate is a big concern in clinical practice, since readmission has negative effect on quality of life [48–50]. Twenty-two included studies reported the outcomes of the readmission rate, whereas nine of them had no readmission. Our results revealed no significant difference between ERAS and control groups in readmission rate and perioperative mortality, indicating that the combination of ERAS and laparoscopic had the superiority of shorter hospital stay without increasing readmission rates and perioperative mortality. Moreover, we also noticed that these results are consistent among all included studies.

With an aging population, it can be predicted that the number of elderly patients with disease that requires the surgery will increase. To date, the role of ERAS protocol in elderly patients still remains controversial. Zeng et al. [47] and Wang et al. [21] reported that the application of ERAS is safe and effective for elderly patients underwent laparoscopic colorectal surgery. However, a study

Table 2 Newcastle–Ottawa scale assessment of non-randomized studies

Study	Selection				Comparability	Outcome			Total
	1	2	3	4	5	6	7	8	
Stoot et al.	*	–	*	*	–	*	*	*	6
Vassiliki et al.	*	*	*	*	* *	*	–	*	8
Poon et al.	*	*	*	*	*	*	–	*	7
Gouvas et al.	*	–	*	*	–	*	*	*	6
Sanchez-Perez	*	*	*	*	*	*	*	*	8
Huibers et al.	*	*	*	*	*	*	–	*	7
Saar, M et al.	*	*	*	*	* *	*	*	*	9
Guan et al.	*	*	*	*	*	*	*	*	8
Sahoo et al.	*	*	*	*	*	*	*	*	8
Taupyk et al.	*	*	*	*	*	*	–	*	7
Esteban et al.	*	–	*	*	–	*	*	*	6
Richardson et al.	*	*	*	*	*	*	*	*	8
Alvarez et al.	*	*	*	*	* *	*	–	*	8
Vignali et al.	*	*	*	*	*	*	*	*	8
Rege et al.	*	*	*	*	*	*	*	*	8
Fang et al.	*	*	*	*	*	*	–	*	7
Pedziwiatr et al.	*	*	*	*	*	*	–	*	7
Sugi et al.	*	*	*	*	–	*	–	*	6
Zeng et al.	*	*	*	*	* *	*	*	*	9

1. Representativeness of exposed cohort; 2. selection of non-exposed cohort; 3. ascertainment of exposure; 4. outcome of interest was not present at start of study; 5. comparability of cohorts on the basis of the design or analysis; 6. assessment of outcomes; 7. follow-up long enough for outcomes to occur; 8. adequacy of follow-up

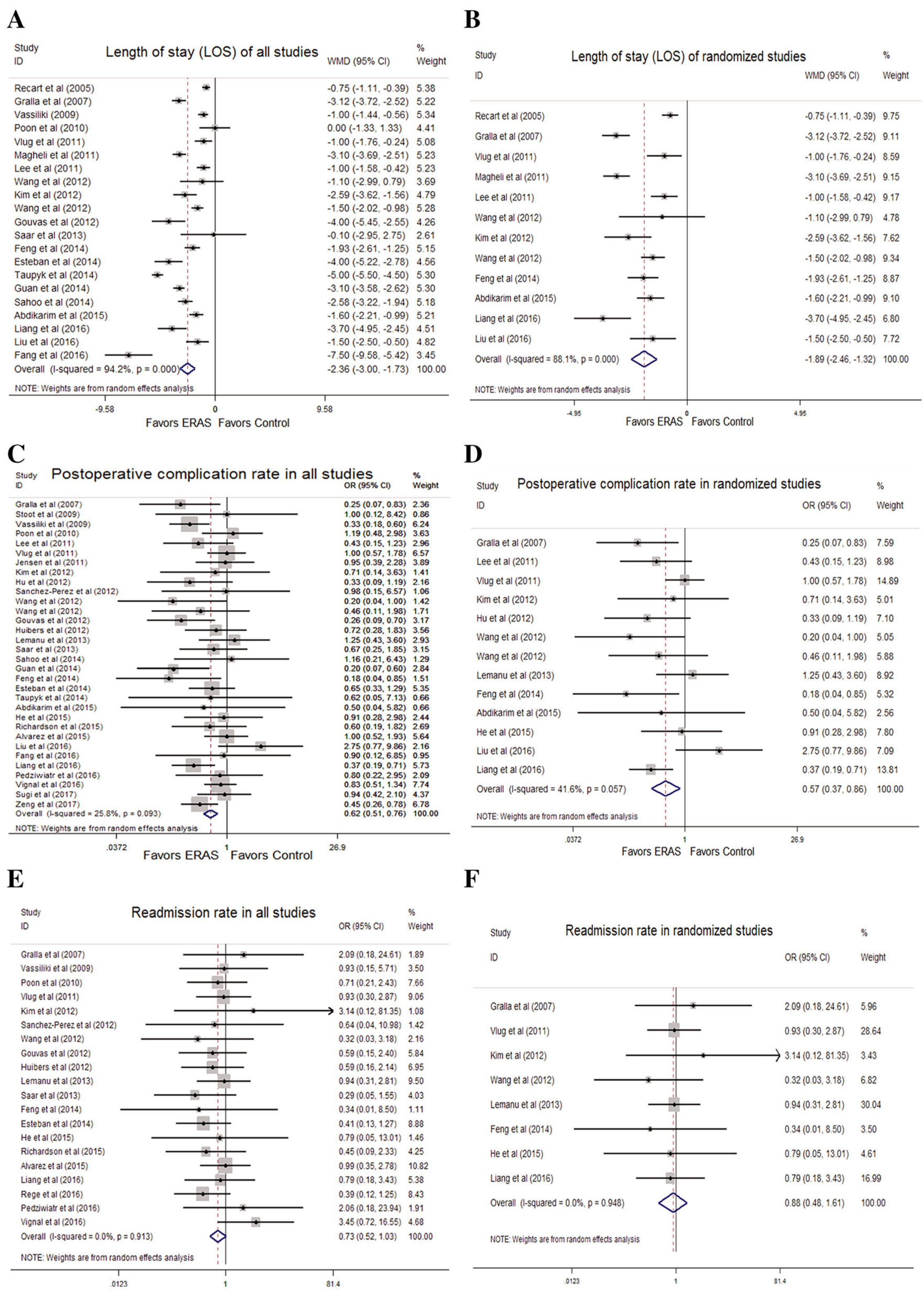


Fig. 3 Analyses of primary outcomes. **a** Length of hospital stay of all studies; **b** length of hospital stay of randomized studies; **c** postoperative complication of all studies; **d** postoperative complication of randomized studies; **e** readmission rate of all studies; **f** readmission rate of randomized studies

Table 3 Subgroup analyses of primary outcomes

Subgroup	Study no.	WMD/OR (95% CI)	P_s	I^2 (%)	P_t
Length of hospital stay	21	−2.37 (−3.00, −1.73)	0.000	94.2	0.000
RCTs	12	−1.89 (−2.46, −1.32)	0.000	88.1	0.000
NRCTs	9	−3.05 (−4.32, −1.78)	0.000	95.8	0.000
Intervention items ≥10	13	−2.49 (−3.27, −1.70)	0.000	92.3	0.000
Intervention items <10	8	−2.14 (−3.07, −1.21)	0.000	94.0	0.000
Laparoscopic non-colorectal surgery	11	−2.64 (−3.43, −1.85)	0.000	92.5	0.000
Laparoscopic colorectal surgery	10	−2.06 (−3.15, −0.97)	0.000	95.7	0.000
Postoperative complication rate	31	0.61 (0.49, 0.75)	0.089	26.6	0.000
RCTs	13	0.57 (0.37, 0.86)	0.272	41.6	0.008
NRCTs	18	0.64 (0.51, 0.80)	0.093	16.83	0.000
Intervention items ≥10	20	0.65 (0.52, 0.80)	0.412	3.6	0.000
Intervention items <10	11	0.55 (0.36, 0.84)	0.024	51.4	0.006
Laparoscopic non-colorectal surgery	16	0.63 (0.45, 0.90)	0.209	21.5	0.010
Laparoscopic colorectal surgery	15	0.59 (0.45, 0.78)	0.083	35.7	0.000
Readmission rate	20	0.73 (0.52, 1.03)	0.913	0.0	0.070
RCTs	8	0.88 (0.48, 1.62)	0.948	0.0	0.688
NRCTs	12	0.67 (0.44, 1.01)	0.663	0.0	0.055
Intervention items ≥10	12	0.78 (0.48, 1.27)	0.635	0.0	0.314
Intervention items <10	8	0.69 (0.43, 1.10)	0.940	0.0	0.121
Laparoscopic non-colorectal surgery	9	0.64 (0.37, 1.12)	0.846	0.0	0.116
Laparoscopic colorectal surgery	11	0.79 (0.52, 1.21)	0.739	0.0	0.281

WMD weighted mean difference, *OR* odds ratio, *CI* confidence interval, P_s *P* value for heterogeneity, P_t test for overall effect

conducted by Bu et al. [51] found that the elderly gastric cancer patients (range from 75 to 89 years old) did not benefit from ERAS protocol. What is more, we also needed to be alert that the ERAS group had a higher readmission rate as compared with the control group (19 vs. 5% *P* 0.013). No routine abdominal drainage is one of intervention items, and the superiority and feasibility of this have been confirmed in colorectal surgery [52, 53]. However, whether the safe and effective measures confirmed in colorectal surgery are suitable for other abdominal surgery should be evaluated in further studies.

In the present meta-analysis, only three studies mainly focus on the clinical outcome of ERAS protocol in elderly patients. In addition, large cohort studies have yet to determine the outcomes of ERAS protocol in elderly population. Studies that have reported that elderly patients who accepted ERAS protocol have a varied definition of elderly (range from 60 to 75 year old) which may limit the general application of ERAS protocol. More high-quality researches are needed to evaluate the safety and feasibility of ERAS protocol for elderly patients. Additionally, the ERAS guidelines should also consider the unique physiological and anatomical characteristics of elderly population.

Recovery of gastrointestinal function is important in postoperative recovery. We observed that the ERAS group had an earlier time to first flatus of 0.6 day, indicating that the ERAS group is superior to the control group in the recovery of gastrointestinal function. Compared with previous studies focus on open surgery, 0.6 day may seem like a relatively low reduction. However, it also means that ERAS protocol could further promote the recovery of patients based on the beneficial effect of minimally invasive techniques.

Economic burden on patients is an important issue needed to be considered in clinical practice. Our results indicate that the ERAS group had a reduction of about eight hundred dollars in hospital costs. This reduction was mainly accompanied with shorter hospital stay, earlier oral feeding, and lower complication rate. Inadequate compliance is a problem in the implementation and maintaining of ERAS protocol. Previous studies showed that the increased compliance to ERAS protocol was associated with better postoperative outcomes [54–56]. In this meta-analysis, only six studies [17, 18, 25, 42, 57, 58] mentioned the compliance of ERAS protocol. Lee et al. [18] reported that the compliance rates for major items in ERAS group were more than 80%. Vignali et al. [42] observed that the overall

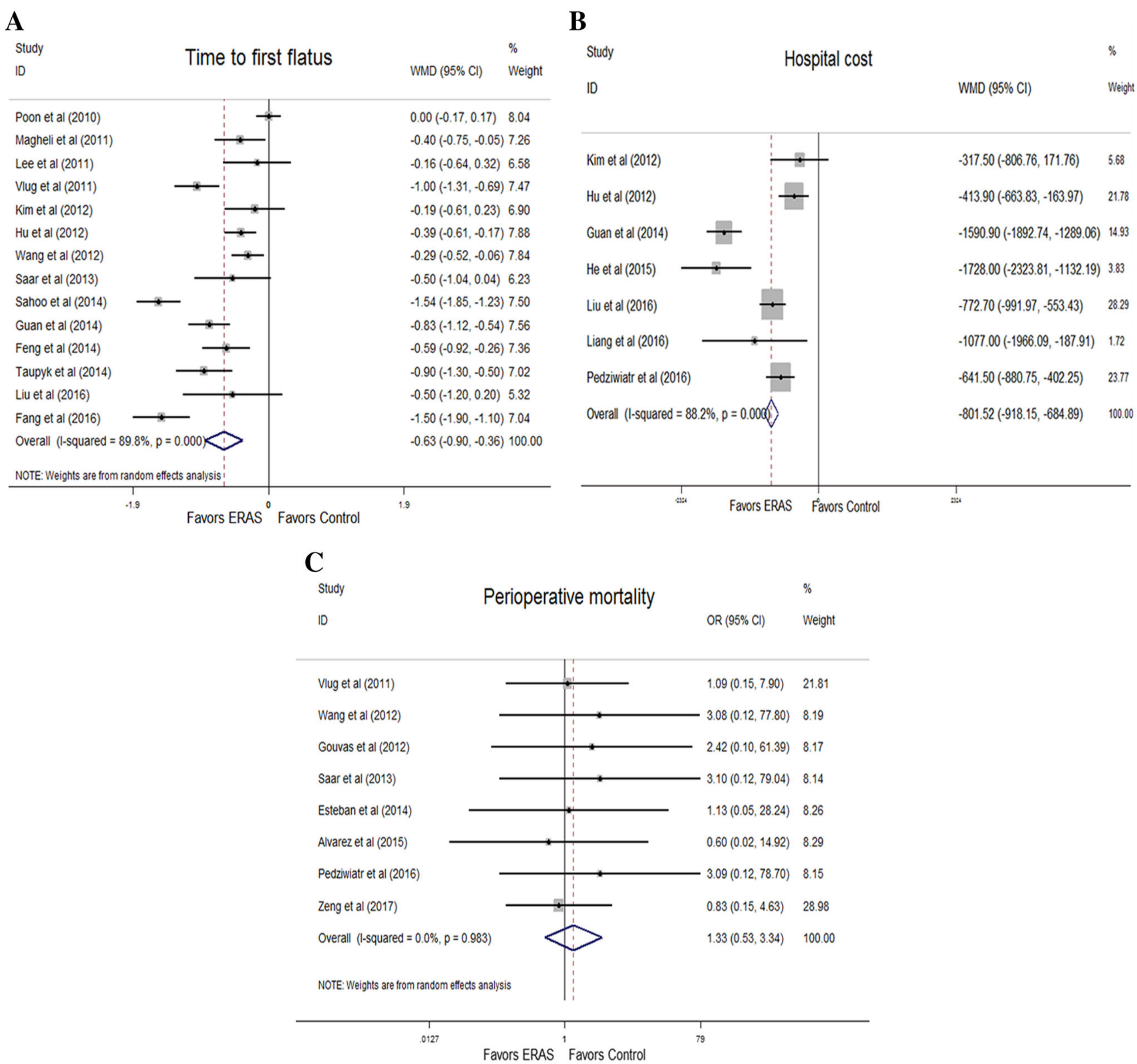


Fig. 4 Analyses of secondary outcomes. **a** Time to first flatus; **b** hospital cost; **c** perioperative mortality

compliance rate for the ERAS group was 85.7%. Regarding different ERAS items, we found that the compliance rates are varied widely and the number of items applied in current meta-analysis is ranged from 5 to 16. Meanwhile, the control group may also be implemented several ERAS items. These might create potential bias, which may decrease the benefit of ERAS group when compared with the control group.

Quality of life (QOL) after surgery is often used to assess the subjective of illness and its treatment which should also be considered [59, 60]. Compared with open surgery, studies have demonstrated that the application of laparoscopic technique is always associated with better QOL [61, 62]. In all include studies, six studies [14, 16–19, 25] assessed the patient's QOL. These results indicated that the patients in the ERAS group experience no negative satisfaction and even better QOL score.

Some limitations of our present study need to be noted. First, there are no ERAS guidelines for several abdominal surgeries, so the number and details of ERAS items are varied in these studies. Second, the compliance and ERAS items applied are varied among included studies. These might create potential bias which may therefore reduce the benefits in the ERAS group. Third, only three studies focus on the application of ERAS protocol for elderly patients which may therefore limited the generalization of our results. Finally, high heterogeneity was observed in some outcomes except for postoperative complication rate, readmission rate, and perioperative mortality.

In conclusion, the results showed that ERAS protocol for laparoscopic abdominal surgery is safe and effective. ERAS combined with laparoscopic technique is associated with faster postoperative recovery without increasing readmission rate and perioperative mortality.

Authors' contributions Zhengyan Li and Qingchuan Zhao performed the experiment conception and design. Zhengyan Li and Bin Bai performed the research and retrieved the data. Zhengyan Li, Gang Ji, and Yezhou Liu performed the data analysis. Zhengyan Li did the paper writing. All authors read and approved the final manuscript.

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Compliance with ethical standards

Conflict of interest Zhengyan Li, Qingchuan Zhao, Bin Bai, Gang Ji, and Yezhou Liu have no conflicts of interest or financial ties to disclose.

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