

The role of emergency laparoscopic surgery for complicated diverticular disease

A systematic review and meta-analysis

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Abstract

Background: Laparoscopic surgery develops rapidly in both elective and emergency settings. The study aimed to determine the role of different laparoscopic methods for the emergency treatment of complicated diverticulitis.

Methods: MEDLINE, EMBASE, Science Citation Index Expanded, and the Cochrane database were searched up to November 2019 to identify all published articles related to the topic. Statistical analysis was performed using Stata 15.

Results: Fourteen publications were included in the analysis. Laparoscopic surgery was applied in 425 patients, and 493 patients underwent open colon resection (OCR). Postoperative mortality, morbidity, severe complications, and reoperation rates were not significantly different between the laparoscopic and open surgery groups. Subgroup analysis was performed based on the different laparoscopic methods (laparoscopic colon resection [LCR] and laparoscopic lavage and drainage [LLD]). Subgroup analysis indicated that LCR was superior to OCR in terms of morbidity, while OCR was superior to LLD in terms of severe complications.

Conclusions: The safety of laparoscopic surgery for the emergency treatment of complicated diverticulitis is related to different surgical methods. LCR is suggested to be a better choice according to the postoperative outcomes. More definite conclusions can be drawn in future randomized controlled trials.

Abbreviations: LCR = laparoscopic colon resection, LLD = laparoscopic lavage and drainage, OCR = open colon resection, BMI = body mass index, ASA = American Society of Anesthesiologists, RCT = randomized controlled trial, RR = relative risk, CI = confidence interval.

Keywords: complicated diverticulitis, emergency, laparoscopic colectomy, laparoscopic lavage and drainage, open colectomy

1. Introduction

Colon diverticulitis is a common disease in people over the age of 40, and the prevalence rises rapidly with age.^[1,2] Surgical resection is considered as the cornerstone for complicated diverticulitis,

including Hartmann procedure (sigmoid resection with end colostomy) and one-stage colectomy and primary anastomosis. In recent decades, laparoscopic surgery shows its advantages in many fields compared to open surgery, such as less intraoperative blood loss, shorter operating time and postoperative hospital stay, and lower postoperative complication rate.^[3,4] Laparoscopic surgery also presents its advantages in the treatment of acute diseases, such as cholecystitis, appendicitis, and gastric perforation.^[3,5,6] Laparoscopic colon resection (LCR) with primary anastomosis or end colostomy is the laparoscopic approach of traditional diverticulitis surgery. A systematic review analyzed emergency laparoscopic vs open sigmoidectomy for complicated sigmoid diverticulitis, and found that laparoscopic approach was associated with significant advantages in reducing postoperative complications.^[7] Another laparoscopic method, laparoscopic lavage and drainage (LLD), has gained popularity in the treatment of acute complicated diverticulitis and shows good outcomes according to the initial studies.^[8,9] However, a recent meta-analysis compared postoperative outcomes between LLD and open resection for acute diverticulitis, but revealed significantly higher incidence of intra-abdominal abscess in patients underwent laparoscopic surgery.^[10] The safety of emergency laparoscopic surgery in patients with complicated diverticulitis is unclear. This meta-analysis was designed to compare outcomes between laparoscopic surgery (LLD and LCR) and open colon resection (OCR), aiming to determine the role of different laparoscopic methods in the emergency treatment of complicated diverticulitis.

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The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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2. Materials and methods

2.1. Search strategy and study selection

A search was conducted in MEDLINE, EMBASE, Science Citation Index Expanded, and the Cochrane database until November 2019 using the terms “emergency or urgent”, “laparoscopic”, “lavage”, “open or conventional”, “colectomy”, “colon resection”, “diverticular disease”, “complicated diverticulitis”, and combinations of these words. English language studies comparing outcomes between laparoscopic and open surgery for the emergency treatment of complicated diverticulitis were included in this study. Selective surgery articles and studies with less than 10 patients were excluded. If data were duplicated from the same research group, the most recent publication was selected. The included studies were reviewed independently by 2 reviewers and group discussion held to settle disagreements. Ethical approval was not applicable for this meta-analysis.

2.2. Data extraction

Relevant data concerned with outcomes were collected by 2 reviewers, using a standardized form designed for data abstraction. Data included study group, year, study design, number of cases, type of surgery, Hinchey grade, age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, previous abdominal surgery, operating time, postoperative hospital stay, postoperative mortality and morbidity, incidence of severe complications (Clavien-Dindo classification grade IIIa or more), and reoperation.

2.3. Quality assessment

The quality of study was evaluated according to the Newcastle-Ottawa Scale designed for non-randomized studies and the Cochrane bias assessment tool for randomized controlled trials (RCT).^[11,12] The assessment of each study was accomplished independently by 2 authors.

2.4. Statistical analysis

Stata 15 was used for this meta-analysis. All measured data were categorical variables. Heterogeneity was calculated by the chi-squared test. The I^2 value was also used to evaluate the heterogeneity ($I^2 = 0\%–50\%$, no or moderate heterogeneity; $I^2 > 50\%$, significant heterogeneity). The fixed-effect model was used if there was no significant heterogeneity; otherwise the random-effect model was used. Results were expressed as forest plots and summarized with relative risks (RRs) and 95% confidence intervals (CIs). Publication bias was assessed by Harbord test.^[13] A two-sided P -value $< .05$ was considered to indicate significance.

3. Results

The present study followed the guidelines for systematic review and meta-analysis (PRISMA).^[14] As shown in Figure 1, we retrieved a total of 179 records from the electronic search. After screening titles and abstracts, 152 articles were excluded because of review articles, case reports, irrelevant publications, and overlapping studies. Twenty seven publications that met the inclusion criteria were fully reviewed with the full article, including 13 articles subsequently excluded because of containing

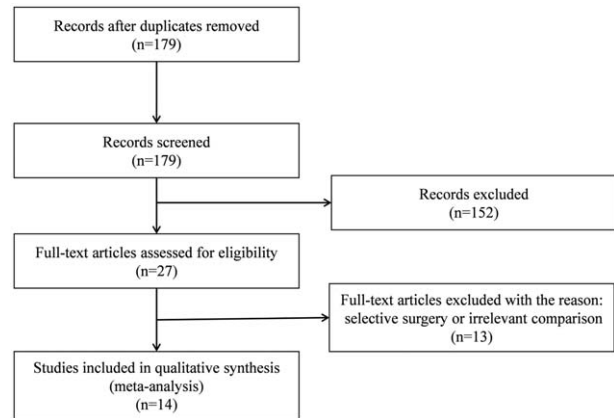


Figure 1. Flow diagram of study selection.

selective surgery or irrelevant comparison. Finally, 14 publications were selected for the present meta-analysis.

3.1. Description of included studies

The eligible studies were published between 2009 and 2017. There were 3 RCTs (6 publications) and 8 non-randomized comparative studies. All the included articles were eligible for synthesized meta-analysis after quality assessment (Table 1). A total of 918 patients were included, laparoscopic surgery was applied in 425 patients, and the remaining 493 patients underwent open surgery. Subgroup analysis was performed based on the different surgical methods in the laparoscopic group (LLD vs OCR and LCR vs OCR). Table 2 summarizes the characteristics of included studies.

3.2. Mortality

All studies reported the difference in postoperative mortality between patients underwent laparoscopic and open surgery (Fig. 2). Meta-analysis of these studies did not show any significant difference in mortality between the 2 groups (RR 0.97, 95% CI 0.56–1.70; $P = .92$). The results of the subgroup analysis were similar in accordance with the total effect.

3.3. Morbidity

Nine studies reported the difference in postoperative morbidity between patients underwent laparoscopic and open surgery (Fig. 3). The morbidity rate was not significantly different between the 2 groups (RR 0.81, 95% CI 0.58–1.14; $P = .23$). Subgroup analysis showed a significant difference between patients underwent LCR and OCR (RR 0.62, 95% CI 0.49–0.80; $P = .00$), but no significant difference was observed in the LLD vs OCR subgroup analysis. However, there was significant heterogeneity among the included studies (Total: $P = .005$, $I^2 = 63.3\%$).

3.4. Severe complications

Seven studies reported the difference in severe postoperative complications (Fig. 4). No significant difference was observed in severe complications between patients underwent laparoscopic

Table 1
Quality assessment of included studies.

RCTs								
Trial (Year)	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias	
SCANDIV, 2015	Low	Low	Low	Low	Low	Low	Low	Low
Ladies/LOLA, 2015	Low	High	High	Low	Low	Low	Low	Low
DILALA, 2016	Low	Low	Unclear	Unclear	Low	Low	Low	Low

Observational studies				
Author (Year)	Selection	Comparability	Outcome	Total score
Karoui M et al, 2009	☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Gentile V et al, 2014	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Catry J et al, 2016	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Li JC et al, 2009	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Turley RS et al, 2013	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Letarte F et al, 2014	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Vennix S et al, 2015	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆
Cassini D et al, 2017	☆☆☆☆	☆☆	☆☆☆☆	☆☆☆☆☆☆☆☆

RCT = randomized controlled trial.

and open surgery (RR 1.25, 95% CI 0.89–1.75; $P=0.19$). Subgroup analysis showed a significant difference between patients underwent LLD and OCR (RR 1.65, 95% CI 1.09–2.49; $P=.02$), but no significant difference was observed in the LCR vs OCR subgroup analysis.

3.5. Reoperation

Ten studies reported the difference in terms of reoperation between patients underwent laparoscopic and open surgery

(Fig. 5). No significant difference was observed between the 2 groups (RR 1.61, 95% CI 0.81–3.21; $P=.18$). The results of the subgroup analysis were similar to those for the total effect.

3.6. Publication bias

The results of publication bias were shown in Table 3. There was no significant evidence of publication bias in terms of postoperative mortality, morbidity, severe complications, and reoperation.

Table 2
Characteristics of included studies.

Study	Type of study	Study period	Group	No. of patients	Hinchey ≥ 3 (%)	ASA ≥ 3 (%)	Age (years)	Male (%)	Body mass index (kg/m ²)	Operating time (minutes)	Postoperative hospital stay (days)
SCANDIV, 2015	RCT	2010–2014	LLD	89	100	42	69.9 ± 13.5	49	26.6 ± 4.9	72 ± 26	6.5 (4.2–15.0)
			OCR	83	100	45	65.7 ± 15.2	54	26.0 ± 4.4	149 ± 54	7.5 (5.5–11.5)
Ladies/LOLA, 2015	RCT	2010–2013	LLD	46	100	18	62.3 ± 12.7	57	27.6 ± 6.2	60	8 (6–15)
			OCR	42	100	36	64.0 ± 12.3	60	27.0 ± 4.4	120	10 (7–14)
DILALA 2016	RCT	2010–2014	LLD	39	100	22	62 (18–86)	54	25.6 (21–32)	68 (28–194)	6 (2–27)
			OCR	36	100	36	68 (35–88)	42	24.9 (19–36)	154 (58–266)	9 (4–36)
Karoui M et al, 2009	Pro	1994–2006	LLD	35	100	29	56 (35–80)	40	NA	98 (60–180)	8 (5–18)
			OCR	24	100	21	62 (39–80)	50	NA	125 (75–180)	17 (11–52)
Gentile V et al, 2014	Retro	2009–2012	LLD	14	21	NA	62.64 ± 4.46	57	27.28 ± 2.12	75.7 ± 4.5	10.5 ± 1.3
			OCR	16	13	NA	64.81 ± 4.54	38	26.99 ± 1.56	173.1 ± 11.2	19.1 ± 2.8
Catry J et al, 2016	Pro	2010–2015	LLD	15	100	7	60 (33–74)	47	27 (21–48)	80 (60–150)	10 (5–20)
			OCR	25	100	48	65 (34–84)	48	26 (16–37)	210 (112–335)	14 (7–94)
Li JC et al, 2009	Retro	2001–2006	LCR	6	100	NA	47 (30–87)	67	NA	168 (140–210)	7 (5–9)
			OCR	12	100	NA	48.5 (16–68)	50	NA	150 (85–270)	8 (5–15)
Turley RS et al, 2013	Retro	2005–2009	LCR	67	100	47	58.5 ± 16.3	61	27.6 ± 7.8	132 ± 64	6 (5–11)
			OCR	67	100	53	59.4 ± 13.5	60	26.7 ± 6.5	138 ± 62	8 (6–11)
Letarte F et al, 2014	Retro	2000–2011	LCR	39	25	21	61.6 ± 13.7	31	26.3 ± 4.0	273.6 ± 60.3	5 (4–8.5)
			OCR	86	54	24	60.9 ± 12.0	62	26.7 ± 4.5	241.8 ± 65.5	8 (7.0–14.0)
Vennix S et al, 2015	Retro	2010–2014	LCR	39	100	39	56.2 ± 14.2	36	25.3 ± 3.5	127 (105–159)	7 (5–13)
			OCR	78	100	24	56.4 ± 13.3	31	27.1 ± 5.8	96 (87–120)	9 (7–14)
Cassini D et al, 2017	Retro	2008–2016	LCR	36	100	100	66.5 (30–86)	39	27.8 (22–32)	170 (120–240)	8.1 (4–30)
			OCR	24	100	100	65.8 (41–96)	25	26.3 (23–32)	169 (120–255)	12.8 (5–23)

ASA = American Society of Anesthesiologists, LCR = laparoscopic colon resection, LLD = laparoscopic lavage and drainage, NA = not available, OCR = open colon resection, Pro = prospective, RCT = randomized controlled trial, Retro = retrospective.

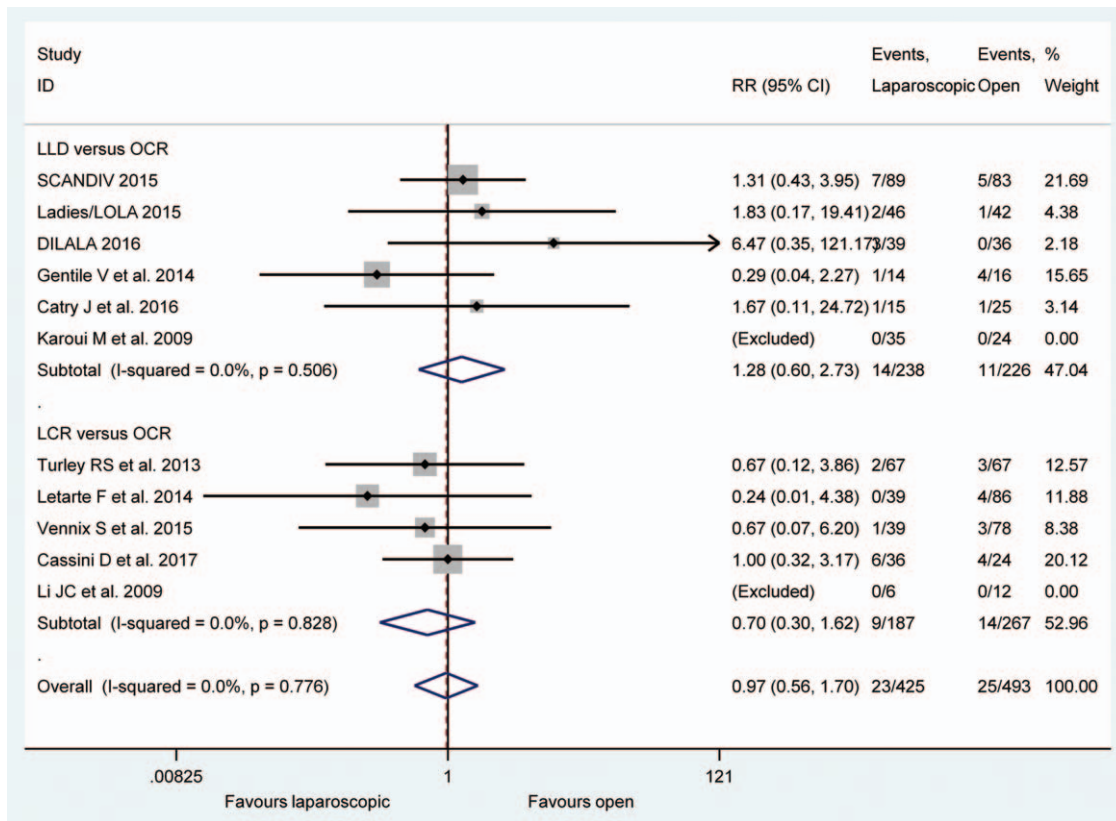


Figure 2. Forest plot of mortality.

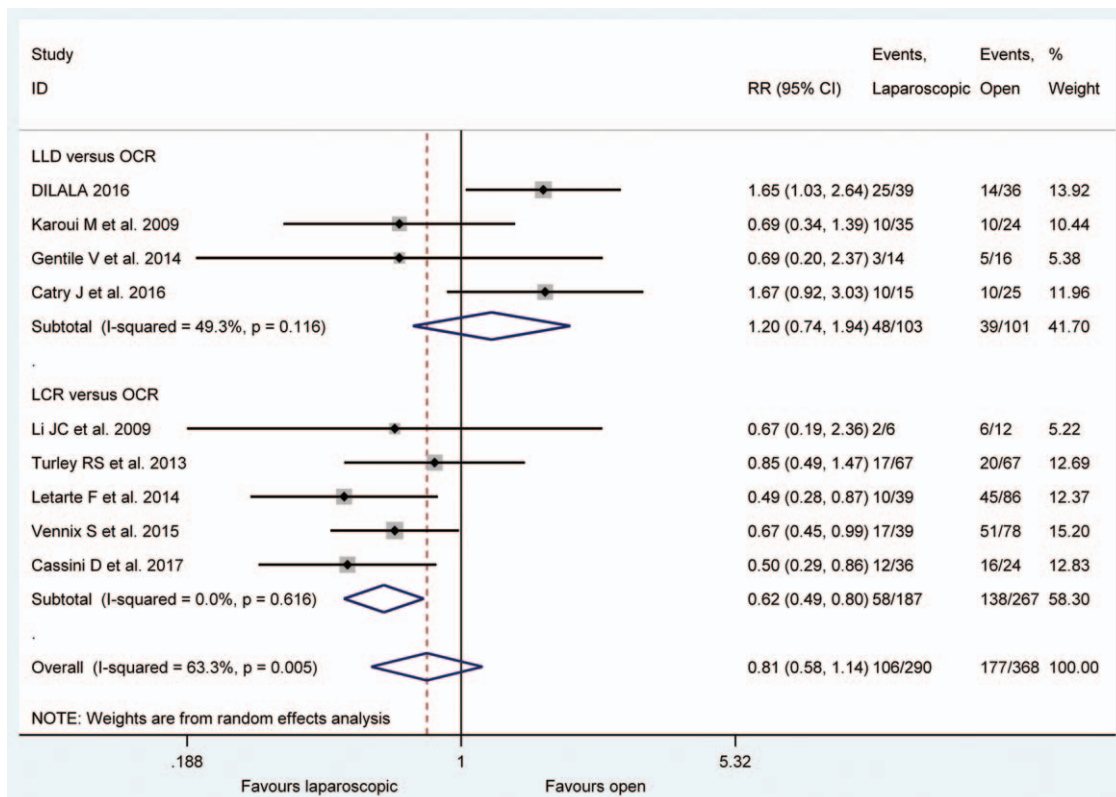


Figure 3. Forest plot of morbidity.

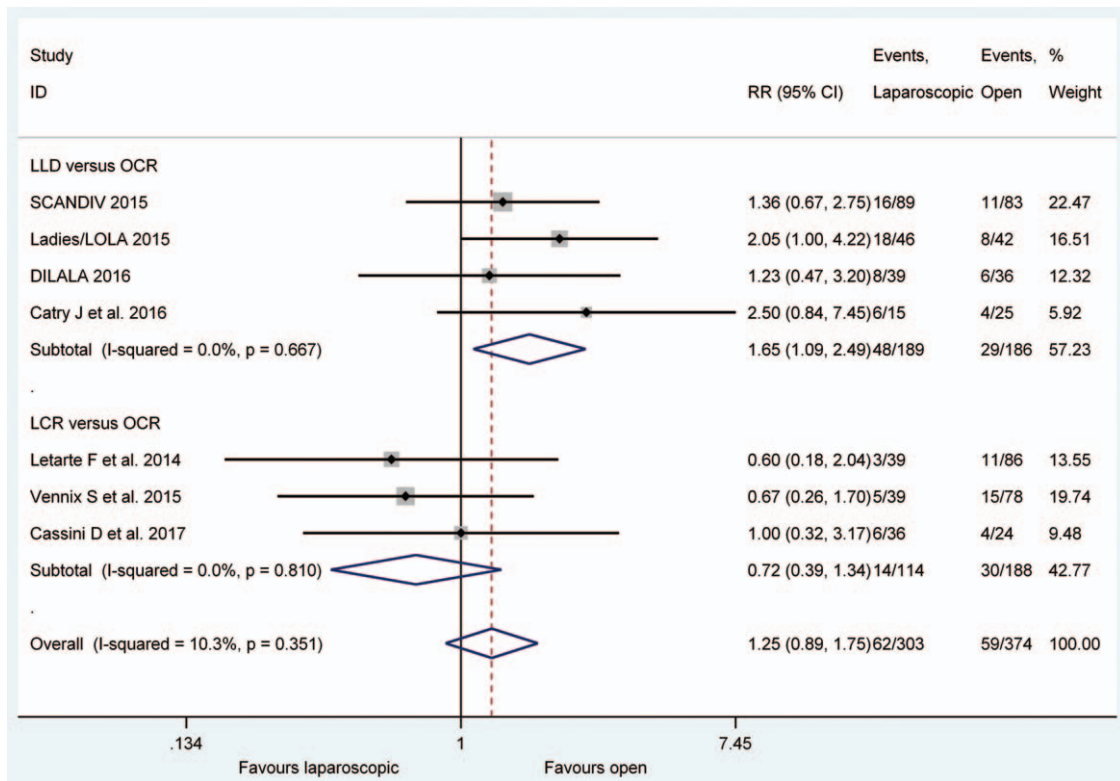


Figure 4. Forest plot of severe complications.

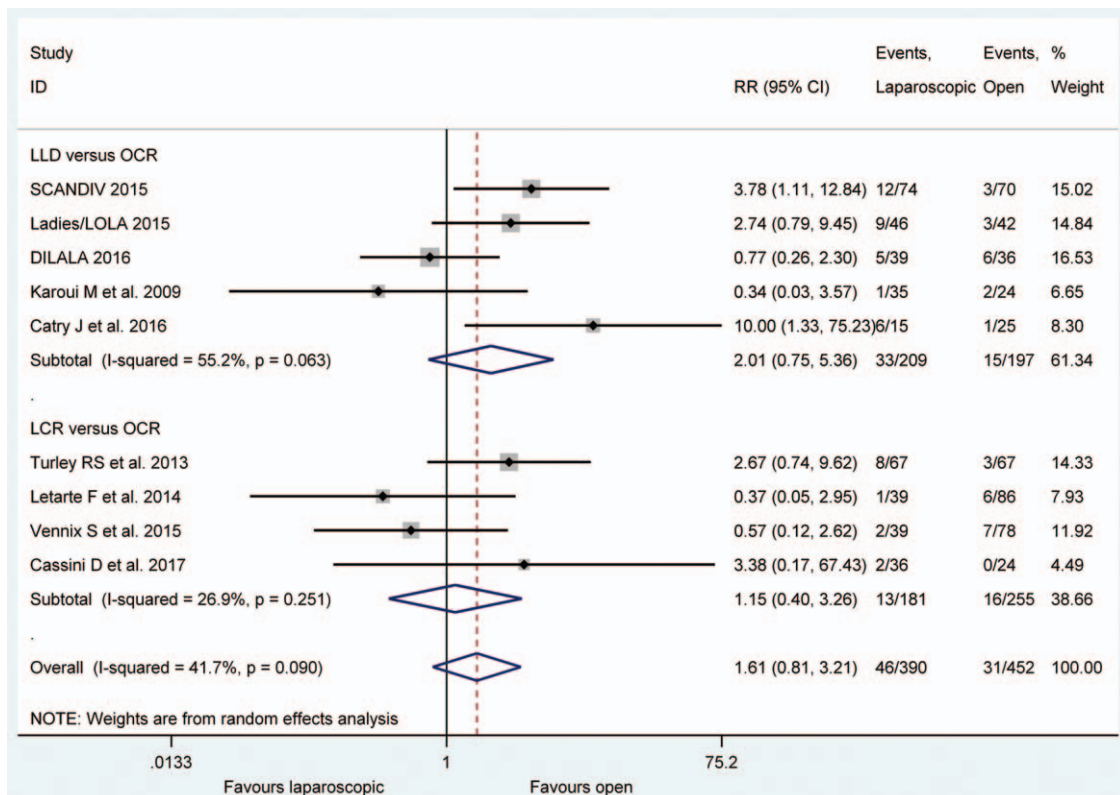


Figure 5. Forest plot of reoperation.

Table 3
The results of publication bias.

Outcome	No. of studies	Harbord bias	
		<i>t</i>	<i>P</i>
Mortality	9	0.02	.98
Morbidity	9	0.44	.67
Severe complications	7	-0.18	.86
Reoperation	9	-0.48	.64

4. Discussion

The results of this meta-analysis showed that compared to open surgery, laparoscopic surgery did not increase or reduce postoperative mortality, morbidity, severe complications, and reoperation rates in the emergency treatment of complicated diverticulitis. Subgroup analyses provided some interesting results. Great discrepancies were found between subgroup and total effects in the analysis of postoperative morbidity and severe complications. The postoperative morbidity rate was significantly lower in the LCR group than the OCR group according to subgroup analysis. However, the rate was not significantly different in the LLD vs OCR subgroup analysis. Subgroup analysis also showed that the incidence of severe complications was significantly higher in the LLD group than the OCR group, but this discrepancy was not found in the LCR vs OCR subgroup analysis. Therefore, compared to the OCR, LCR reduced the morbidity rate while LLD increased the incidence of severe complications. The use of LCR seemed to be a better option for the emergency treatment of complicated diverticulitis.

An open Hartmann procedure is considered as the standard procedure for patients with complicated diverticulitis. The disadvantages of Hartmann procedure are high mortality, high risk of fistula, re-anastomosis and wound infection, and high risk of systemic complications. The presence of a stoma also affects the quality of life.^[15] Subsequently, several studies have reported that primary resection with anastomosis after intraoperative lavage is feasible and safe in the acute setting, with mortality and morbidity rates similar to Hartmann procedure.^[16–18] The conclusion is confirmed by several RCTs.^[19–21] Data shows that there is no significant difference in terms of mortality, morbidity, or severe complications after emergency surgery. Thus, we did not further analyze the impact of different open colectomy methods in the present meta-analysis.

There is also high-quality evidence for the evaluation of laparoscopy in elective sigmoidectomy for diverticular disease. Laparoscopic surgery shows better postoperative outcomes than open sigmoidectomy in the Gervaz study and the Sigma trial,^[22–25] such as a reduction in complication rate and a shortness in hospital stay; but these advantages are not reflected in the LAPDIV-CAMIC trial.^[26,27] In the emergency treatment of complicated diverticulitis, however, RCTs comparing laparoscopic and open colectomy are not found. A recent meta-analysis by Cirocchi et al included 4 observational studies, and revealed that emergency laparoscopic colectomy was associated with significantly lower postoperative complication rate than open surgery in the treatment of complicated sigmoid diverticulitis.^[7] Our results confirmed the conclusion that postoperative morbidity rate was significantly lower in the LCR group than the OCR group. Postoperative mortality, severe complications and reoperation rates were not significant differences between the 2 groups.

LLD without resection, as a treatment alternative for acute complicated diverticulitis with peritonitis to avoid Hartmann procedure, has gained widely attention in the last decade. Its designed based on the hope that patients may avoid major complications due to open colectomy, such as anastomotic leaks, stoma, and wound infection. The early studies reported encouraging results that most patients (Hinchey stages II–IV) did not require further surgical intervention during initial hospitalization beyond lavage.^[28–30] A recent RCT, the DILALA trial, which compared outcomes between LLD and Hartmann procedure for acute diverticulitis with peritonitis, reported that no differences were observed in overall morbidity, mortality or quality of life during follow-up, and the author concluded that LLD is a better option for patients with diverticulitis Hinchey III than open Hartmann procedure.^[31,32] However, other RCTs and meta-analyses hold contrary opinions. The SCANDIV and Ladies/LOLA trials showed no decrease in major mortality and morbidity with LLD vs open colectomy, but an increased rate of reoperation in the LLD group in both trials. The Ladies/LOLA trial was early ended at 33% of the planned sample size because of a high rate of morbidity in the LLD group. A meta-analysis included 3 RCTs and 4 comparative studies comparing LLD with OCR for perforated diverticulitis with peritonitis, and found that LLD was associated with higher rates of intra-abdominal abscesses, peritonitis, and reoperations compared with colon resection. Our meta-analysis also revealed similar results that the incidence of severe complications was significantly higher in the LLD group than the OCR group. These results support the American Society for Colon and Rectal Surgeons guidelines recommendation that LLD should be used in carefully selected patients.^[33]

Nowadays, 3 different surgical procedures are available for the emergency treatment of complicated diverticulitis: LLD, LCR, and OCR. Our meta-analysis is the first study to clarify the relationship between them. However, none of the published studies shows comparisons between LLD and LCR, probably because they are 2 different steps in the surgical treatment of diverticulitis. Meanwhile, the present study has some limitations. First, this meta-analysis included both RCTs and observational studies. The quality of most included studies was not high. Second, heterogeneity was high in postoperative morbidity, possibly due to different definitions of complications. Third, some relevant data, such as blood loss, conversion to laparotomy and long-term outcomes, were not included in this study due to insufficient data.

In conclusion, laparoscopic surgery does not show significant advantages over open surgery in postoperative complications for the emergency treatment of complicated diverticulitis. The safety of laparoscopic surgery is related to different surgical methods. LCR is recommended and LLD is not supported by the current meta-analysis according to the postoperative outcomes. Future RCTs are necessary to provide more evidence to verify the above conclusions.

Author contributions

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Visualization: Xin Huang.

Writing – original draft: Hongwei Lin, Xin Huang.

Writing – review & editing: Yuanxin Li.

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