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Systematic Review

Laparoscopic versus open colectomy for acute complicated diverticulitis: a comparative study of outcomes - a systematic review

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ABSTRACT

Acute complicated diverticulitis presents a more severe form of diverticular illness frequently needing urgent medical intervention and possibly surgical therapy. The aim of this review is to gather conclusive evidence from the literature comparing laparoscopic techniques to open and conservative ones in order to determine the most effective treatment plan for complicated diverticulitis. Online databases like PubMed, Google Scholar, Cochrane, Elsevier and many others were systematically searched according to an inclusion criterion to obtain a total of 13 studies to be included in the review. 8/13 studies presented short term outcomes while 5/13 studies concluded with long term outcomes following index surgeries. Based on the end results, it can be concluded that laparoscopic surgery, in particular laparoscopic colon resection is superior to other techniques in treating complicated diverticulitis in terms of fewer short-term complications, low mortality rate better quality of life with few recurrence rates. However, other approaches have their own advantages and can be given priority based on the unique presentation of each case. The clinicians are advised to make informed decisions keeping in view all the patient and disease associated aspects.

Keywords: Laparoscopic colectomy, Open colectomy, Diverticulitis, Systematic review

INTRODUCTION

Colonic diverticular disease encompasses a range of illnesses arising from a false diverticula or herniation of the mucosa and submucosa due to weakness in the intestinal wall, including asymptomatic diverticulosis, symptomatic acute diverticulitis, and chronic inflammation of the colon, resulting in recurring clinical episodes, blockage, or fistula formation.[1] The American Society of Colon and Rectal Surgeons defines acute complicated diverticulitis as diverticular inflammation associated with free perforation, abscess, fistula, blockage, or stricture but not phlegmon.[2] Hinchey et al presented a classification system for acute diverticulitis, which is now utilized in clinical practice in a modified version.[3] Several risk factors associated with this disease include old age,

gender, smoking, comorbidities, steroid usage, the use of non-steroidal anti-inflammatory drugs, Western dietary patterns (high in red meat, fat, and refined grains) and red meat consumption alone.[4,5] Complicated diverticulitis continues to be treated surgically, and new technologies like colonic stents (for blockage) and computed-tomography-guided percutaneous drainage (for abscess) have emerged as bridging procedures to avoid two-stage operations in certain patients. Minimally invasive surgery has been demonstrated to be safe and feasible, with numerous short-term benefits for patients over standard open surgery.[6]

The NIS database documented 1,073,397 patients admitted with diverticulitis between 2002 and 2007 in the United States.[7] From 2006 to 2013, there was a 26.8% rise in diverticulitis-related visits to emergency departments, with the rate climbing from 89.8 to 113.9 visits per 100,000 population.[8] Growing frequency of diverticulitis cases has led to a multitude of management approaches being employed in the field of medicine.[9] Conservative management is frequently effective in managing both initial and recurrent episodes of diverticulitis. Nonetheless, recurrences affect about 20% of patients, while approximately 36% experience ongoing abdominal symptoms, significantly impacting their quality of life.[10] Complicated acute diverticulitis necessitates interventional radiology or surgical intervention, although the optimal surgical method (open versus laparoscopic) remains subject to debate.[11] In the past, a Hartmann's procedure (involving the removal of the affected portion of the sigmoid colon, closure of the rectal stump, and creation of a proximal end colostomy) was considered the preferred surgical approach for managing perforated diverticulitis.[12] Laparoscopic surgery (including laparoscopic lavage or laparoscopic resection), which is a minimally invasive procedure, presents an alternative option to open surgery.[13]

In a study, the efficacy of laparoscopic peritoneal lavage (LPL) was evaluated in comparison to laparoscopic resection among a specific group of patients diagnosed with perforated acute diverticulitis. The results exhibited LPL presenting a considerable rate of inefficacy, suggesting that its routine use in clinical settings should be reconsidered.[14] According to a retrospective cohort analysis, 42 patients who required surgical intervention following unsuccessful medical treatment for complicated diverticulitis revealed a fourfold reduction in postoperative complications and notably shorter hospital stays among those who underwent laparoscopic procedures, as opposed to those who received open surgery.[15] There remains a lack of agreement regarding the most effective treatment approach for individuals diagnosed with complicated diverticulitis. The aim of this review is to find concluding evidence from the literature comparing laparoscopic approaches with open and conservative one in order to determine the most effective treatment strategy for chronic diverticular disease.

Rationale

Increase in prevalence of complicated diverticulitis through the recent years has posed a serious challenge in finding a gold standard approach for its treatment. Many. The comparison between laparoscopic and open colectomy along with conservative treatment as a therapeutic approach for acute complicated diverticulitis is an important area of research due to the lack of consensus regarding the optimal surgical approach. While laparoscopic approaches, such as laparoscopic lavage and laparoscopic colon resection, are increasingly favored for their minimally invasive nature, the low recurrence rates associated with open colectomy cannot be neglected. By systematically evaluating factors such as postoperative complications, length of hospital stay, reoperation rates, and long-term outcomes, this research aims to provide evidence-based recommendations to clinicians and surgeons in selecting the most appropriate treatment strategy for patients with acute complicated diverticulitis.

Objectives

Many different goals were examined in the subject. The first one included “to compare outcomes of laparoscopic lavage versus open colon resection in the treatment of acute complicated diverticulitis”. The second aspect is the following: “to compare outcomes of laparoscopic colon resection versus open colon resection in the treatment of acute complicated diverticulitis”. The third research question was “to compare outcomes of laparoscopic colon resection versus conservative treatment in acute complicated diverticulitis”.

METHODS

Preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines and the use of the ‘population, intervention, comparison, outcome, and study design (PICOS)’ scheme, these were utilized to generate the eligibility criteria.[16] First, the literature that was considered eligible for inclusion comprised primarily of randomized control trials, retrospective and prospective cohort studies and cross-sectional studies published after 2019 to those published before 2024. The population of interest included individuals who were newly or already diagnosed with acute complicated diverticulitis and had undergone either laparoscopic lavage, laparoscopic colon resection, open colectomy or conservative therapy in the treatment of their condition.

The studies that were utilized investigated the comparative short term or long-term outcomes of the aforementioned approaches in the treatment of acute complicated diverticulitis.

Researches published prior to 2019, non-observational and review studies, patients with colonic diverticular disease other than acute complicated diverticulitis, and studies

involving children and adolescents were excluded from consideration (Table 1).

Information sources

Many electronic sources were searched to find pertinent literature. ClinicalTrials.gov, PubMed, Google Scholar, Cochrane, Medline, and Embase are a few of them. Other sources including independent journals were available. In addition to databases, periodicals including the "Annals of the American College of Surgeons," "Journal of Gastrointestinal Surgery," "JSLS," "Elsevier," and others were used to compile the material.

Search strategy

The search strategy was devised following the PICOS scheme (explained later) to retrieve pertinent data from digital databases. In the final sample, 13 studies (from a total sample of n=94) met the eligibility criteria. A search query was formulated for PubMed encompassing the following terms: ((("Laparoscopy" OR "Endoscopy, Digestive System" OR "Surgical Procedures, Laparoscopic" OR "Minimally Invasive Surgical Procedures" OR "Surgical Mesh" OR "Herniorrhaphy" OR "Cholecystectomy, Laparoscopic" OR "Nephrectomy, Laparoscopic" OR "Hysterectomy, Laparoscopic" OR "Gastrointestinal Endoscopy")) AND (("Therapeutics" OR "Treatment Outcome" OR "Drug Therapy" OR "Surgery" OR "Drug Administration" OR "Drug Delivery Systems" OR "Pharmacological Actions" OR "Chemotherapy" OR "Radiation Therapy" OR "Immunotherapy"))) AND (("Diverticulosis, Colonic" OR "Diverticulitis" OR "Diverticulum" OR "Colonic Diseases" OR "Colonic Diverticulitis" OR "Diverticulum, Colon" OR "Perforated Diverticulitis" OR "Diverticulum, Large Intestinal" OR "Diverticulum, Large Intestinal, Congenital" OR "Diverticulum, Large Intestinal, Acquired")) Searched with the filter of free full text and studies published between 2019-2023.

Selection process

The research methodology was crafted through a careful review of peer-reviewed journals and reputable publications. We meticulously scrutinized literature that met our predefined inclusion criteria, employing the PICOS scheme for thorough examination. To mitigate publication bias, we meticulously assessed peer-reviewed journals with substantial impact factors through an extensive literature review. To streamline primary and secondary literature screening, all chosen articles underwent evaluation using Rayyan.ai, a specialized screening tool.[17] The papers suitable or excluded according to the criteria were defined with the cooperation of a team of researchers. Following the evaluation of the results, only 13 studies could be obtained for the analysis. Papers that did not correspond to the eligibility were labelled for dispute or exclusion. To solve disputes, a panel of three researchers was used to arrive at the final decision. The studies were then excluded if they referred to another population, an inadequate method, misleading outcomes, or included high bias. There could be more than one of the characteristics described above found in some of the studies.

Table 1: Systematic review: and its eligibility criteria.

Criteria	Inclusion	Exclusion
Study language	Studies published in the English language	Studies not published in the English language
Study duration	Studies published between 2019 and 2023	All the studies that were published before 2019
Study design	Primary studies (RCTs), qualitative and qquantitative	Prospective, protocols, reviews, and grey literature
Location	Global	
Target population	Patients of acute complicated diverticulitis who underwent either a laparoscopic approach, an open surgery or were treated conservatively. Patients were selected if they had been diagnosed with complicated diverticulitis	Populations with disorders other than acute complicated diverticulitis.
Follow-up	Research including a minimum of 30 days of follow-up in order to collect sufficient evidence for chronicity.	Research that presents results in less than 30 days.
Context	Trials examining the comparative outcomes of different approaches (laparoscopic, open, conservative) in the treatment of acute complicated diverticulitis. Researches comparing laparoscopic approaches with open surgery/conservative approach in the treatment of acute complicated diverticulitis in terms of post operation short- and long-term outcomes.	Studies on the risk factors, preventive measures of complicated diverticulitis. Non-comparative studies on the treatment of ACD.

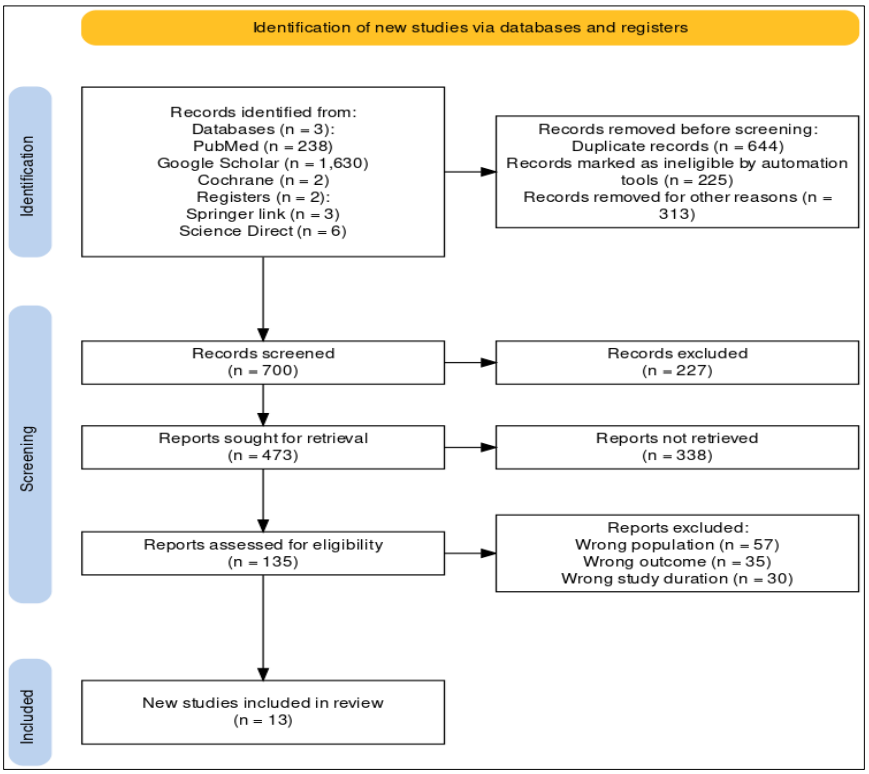

Figure 1: The literature review: PRISMA chart.[18]

Data items

After finalizing the secondary screening process, we assessed the overall sample size (n=13) pertaining to the selected literature. To create a PRISMA flow chart that follows the rules of PRISMA, we used articles from reputable journals and other sources (Figure 1). In order to mitigate bias in the analysis, several steps were implemented: rigorous selection of top-tier research materials, mandatory disclosure of conflicts of interest by peer reviewers, and preference for meta-analyses over conventional review articles. Systematic and narrative reviews were deliberately omitted to uphold the study's integrity. Utilizing randomized methods, a visual representation in the form of a "traffic light" figure was created based on the collected data (Figure 2).

Assessment of research quality

We conducted a comprehensive analysis of bias in every main study selected for quality evaluation. This required analyzing the population demographics, the characteristics of the interventions, and the region where the study was conducted. In assessing the presence of bias within the selected studies, we employed various digital and online tools. Each primary study eligible for analysis, underwent scrutiny based on the Cochrane criteria for bias evaluation. We thoroughly examined domains susceptible to bias, including first, a random sequence should be created; second, allocations should be kept a secret; third, participants and staff should be blinded; fourth, outcome assessments should be blinded; fifth, attrition bias should be addressed; sixth, selective reporting should be avoided; and seventh, other biases should be recognized and mitigated. A "traffic lights" plot was used to visually display the quality rating for each primary study. For the analytical tool, three researchers gathered comparable and pool able data. Because all of the data in our investigation were available as continuous variables, complete accessibility was guaranteed.

RESULTS

Study characteristics

Out of a sample of 237 studies on PubMed, 16,300 studies on Google Scholar and 2 studies on Cochrane databases, a final count of 13 studies was short listed to be a part of this systematic review according to a set inclusion and exclusion criteria. The data estimation points range from 30 days to 59 months. The sample sizes across these studies ranged from 38 patients to a maximum of 3581 patients. The findings of the systematic analyses unveiled that when the laparoscopic approach was weighed against open resection in terms of short- and long-term outcomes, the results varied depending upon the type of laparoscopic approach being compared. Five out of twelve studies compared laparoscopic lavage with open resection,

Short term outcomes

These results were evaluated at an average duration of 30-90 days following the index surgery.

Complications

In the current systematic review, complications after laparoscopic surgery were discussed as the primary end point in comparison to open surgery and a conservative approach. The complications were varied but most commonly included superficial incisional SSI, deep incisional SSI, anastomotic leaks, colonic fistula, pulmonary embolism (PE), deep venous thromboembolism (DVT), renal insufficiency or failure, stroke and sepsis. 8 out of a total of 13 studies commented on short term outcomes. Out of these 8 articles, 7/8 wrote about post op complications. 5/7 (71%) studies showed a significant reduction in complications where 2 studies compared laparoscopic lavage (LPL) with open colon resection (OCR) and 3 studies compared laparoscopic colon resection (LCR) with open colectomy. 2/7 (28.6%) studies reported no statistically significant difference in the complication rate while comparing LCR with OCR. These statistics help to deduce that laparoscopic surgery is superior to open in terms of few short-term complications for the treatment of acute complicated diverticulitis.

Mortality

All eight studies assessing short-term outcomes of the aforementioned surgeries provided insights into the postoperative mortality rate. 5/8 (62.5%) studies reported lower mortality rates with LPL and LCR in comparison to OCR. 3/8 (37.5%) studies reported similar odds of mortality between the laparoscopic procedures and OCR. These statistics indicate that laparoscopic surgery is more favourable than open surgery in terms of low mortality rates for the treatment of ACD.

Readmission

4/8 studies commented on post operation readmission rates. 2/4 (50%) of the studies showed a marked increase in readmission rates following laparoscopic lavage and slight increase following laparoscopic resection in comparison to OCR. In 1 out of 4 studies, (25%) comparing laparoscopic resection to open resection, no significant difference in the re-hospitalization rate was observed.1/4 (25%) study showed a reduction in readmission rates for laparoscopic colon resection post 30-day index surgeries (LCR versus OCR). Analyses of these numbers favours open surgery in terms of few readmission rates however it remains slightly inconclusive owing to one out of four studies showing low short term readmission rates with LCR.

Reoperation

Out of 8 short term outcome-based studies included, 4/8 comment on the reoperation rates. ¾ (75%) of this show no significant difference in reoperation rates between both types of laparoscopic approaches independently compared to open surgery for complicated diverticulitis. However, ¼ (25%) studies demonstrate a decreased reoperation rate following laparoscopic resection compared to open colectomy. In light of these results, laparoscopic approaches and open surgery are comparable in terms of short term re operation rates.

Index length of stay

All 8/8 studies commented on index length of stay. 7/8 (87.5%) studies reported LOS to be significantly reduced in laparoscopic approach. In 1/8 (12.5%) study, no statistically significant difference was reported in terms of length of stay. The result is conclusive towards laparoscopic approach being better in terms of shorter length of stay in comparison to an open approach for treating complicated diverticulitis.

Long term outcomes

Studies on long term outcomes were conducted over periods ranging from 6 months to 59 months**.**

Complications

Long term complications were Clavien-Dindo grade including pain, fever, superficial wound infections, anastomotic intraluminal bleeding, abscess, and anastomotic leakage. Five out of a selected total of thirteen studies presented long term outcomes of treatment through laparoscopic lavage (LPL), laparoscopic colon resection, open colon resection and a conservative treatment approach (all studied in comparison). 2/5 (40%) of the studies evaluated long-term complications, with both focusing on the comparison between laparoscopic sigmoid resection and conservative treatment. Both studies reported patients in the LCR group to have experienced major postoperative complications in comparison to conservative treatment, hence bending the scale towards a conservative approach in treating complicated diverticulitis in terms of having low long term complication rates.

Mortality

Mortality rate was reported in 4/5 of the total studies discussing long term outcomes. 1/4 (25%) of the studies demonstrated a notable increase in mortality rates following LPL when compared with OCR. Conversely, ¾ (75%) of the investigations reported no difference in the mortality rates where 2 studies compared LCR with conservative approach and 1 study compared LPL with OCR. Long term mortality rate is hence higher among patients treated with laparoscopic lavage, in other approaches, however, it remains comparable.

Reoperation

4/5 of the studies comment on the reoperation rates after the aforementioned index surgeries.

Table 2: Results of the systematic review.

S. no.	Study ID	Origin	Study design	Participants	Intervention	Outcome	Key findings
1	Baldock et al[19]	United Kingdom (UK)	Retrospective cohort study	A total of 3394 cases of perforated diverticulitis were analysed (850 patients in 2002–2006, 1124 in 2007–2011 and 1420 in 2012–2016	These diagnostic groups were ranked into three equally sized groups based on the 30-day crude in-hospital mortality rates. The primary outcome of interest was in-hospital death within 30 days of admission for conservatively managed patients and 30 days of procedure for patients who underwent any form of operative intervention (including percutaneous drainage and laparoscopic wash-out).	Short term outcomes: in hospital mortality rate, and length of stay (LOS)	Patients who had laparoscopic procedures had the lowest 30-day mortality (washout 2.8% and resection 5.3%) with open operation the highest (resection 13.6%. Patients who underwent open operations had the longest length of stay (resection 22.1 days and no resection 24.0 days), with laparoscopic washout the shortest (9.5 days, p<0.001).
2	Azhar et al[20]	Sweden and Norway	Randomized clinical trial	145 patients were suitable for trial intervention, 3 lost to follow up. Lavage group: 73 patients. Resection group: 69 patients	Patients with perforated diverticulitis were assigned to undergo laparoscopic peritoneal lavage or colon resection based on computer-generated, center-stratified block randomization	Long term outcomes observed in patients with Hinchey <4 (after 59 months): mortality rate, stoma prevalence, secondary operations, recurrence of diverticulitis, and length of hospital stay	Overall mortality was 32% (n=23) in the laparoscopic lavage group and 25% (n=17) in the resection group (p=0.36). The stoma prevalence was 8% (n=4) in the laparoscopic lavage group vs 33% (n=17; p=0.002) in the resection group among patients who remained alive, and secondary operations, including stoma reversal, were performed in 36% (n=26) versus 35% (n=24; p=0.92), respectively. Recurrence of diverticulitis was higher following laparoscopic lavage (21% [n=15] versus 4% [n=3]; p=0.004). In the laparoscopic lavage group, 30% (n=21) underwent a sigmoid resection. There were no significant differences in the EuroQoL-5D questionnaire or Cleveland global quality of life scores between the groups. Total length of hospital stay, including the index admission, were similar in both groups
3	Samuelsson et al[21]	Sweden	Retrospective cohort study	499 patients (Hinchy 3), laparoscopic lavage (evaluable patients) n=140. Colonic resection without stoma (evaluable patients) n=265.	2 observational groups formed, one with patients who underwent laparosopic lavage, another with patients who had an open surgery	Short term outcomes (3 months): mortality, complications, reoperation, re admission, and LOS	Mortality rate (low in LL, high in open surgery) within 90 days was 12.4 per cent in the resection group and 6.4% for laparoscopic lavage. Laparoscopic lavage was associated with a significantly lower 90-day comprehensive. Complication index (20.9 versus 32.0; odds ratio 0.77, 95 per cent compatibility interval (CI) 0.61 to 0.97) and overall duration of hospital stay (9 versus 15 days; ratio of means 0.84, 95 per cent CI 0.74 to 0.96) compared with resection. Patients had 82 (95 per cent CI 39 to 140) per cent more readmissions following lavage than resection (27.2 versus 21.0 per cent), but similar reoperation rates. More co-morbidity was noted among patients who underwent resection than those who had laparoscopic lavage. LOS was longer in resection group

Continued.

S. no.	Study ID	Origin	Study design	Participants	Intervention	Outcome	Key findings
4	Hoek et al[22]	Netherland	Multicenter ladies trial	Total 88 patients sigmoidectomy group: 42 laparoscopic lavage group: 46. For the 36-month follow-up, a total of 77 patients could be included, with 39 in sigmoidec-tomy group and 38 in the lavage group	Patients with perforated diverticulitis with purulent peritonitis were randomized between laparoscopic lavage and sigmoidectomy.	Long term outcomes (36 months/3 years): cumulative morbidity, mortality, re operation rates, stoma rates, and total LOS	Long-term outcomes showed that laparoscopic lavage was associated with less patients who underwent reoperations and lower stoma rates in patients alive after 36 months compared to sigmoidectomy. No differences were found in terms of cumulative morbidity or mortality Total duration of hospital stays per patient (days), 19 (15–31) (OCR), 18 (8·75–36·75) (LPL)
5	Lee et al[23]	United States of America (USA)	Retrospective cohort study	3581 cases met inclusion criteria—282 laparoscopic-completed, 3299 open	30-day outcomes between laparoscopic resection and open approaches were compared.	Short term outcomes (30 days), 30-day mortality, any complication (complications classified as Clavien–Dindo grade IIIa or higher), reoperation, readmission, length of stay (days), SSi	Higher moratality rate, length of stay, emergent of more complications with the open approach. However, readmission rate was more in laparoscopic surgery. Laparoscopic-completed patients had significantly lower rates of superficial incisional SSIs. Reoperation rates were comparable, not significantly different.
6	Hajirawala et al[24]	United States of America (USA)	Retrospective cohort study	3487 patients were included in the analysis. Of these, 1272 (36.5%) underwent MIS colectomy and 2215 (63.5%) underwent open colectomy	Patients with acute diverticulitis were then divided into 2 groups: MIS and open colectomy	Short term outcomes: mortality rates, short term complications, LOS	Odds of mortality for MIS and open groups were similar, no difference in short-term complications between groups, the odds of developing an ileus were lower following MIS colectomy, total length of stay (LOS) (12.3 versus 13.9 days) and post-operative LOS (7.6 days versus 9.5 days) were shorter for MIS colectomy
7	An et al[25]	South Korea	Retrospective cohort study/ case control	40 patients were selected for performing case- control matching	Case-control matching was performed to compare the open surgery group and laparoscopic group after reducing the differences in factors that may affect the recovery process	Short term outcomes: (within 1 month) complication rate (complications were defined as enteritis, enteroplegia, anastomotic leakage, wound infection, pneumonia, cardiovascular disease, sepsis, renal failure) reoperation rate readmission rate mortality.	No significant difference between the laparoscopic surgery group and the open surgery group with regard to the time to recovery (3.2 days versus 3.0 days; p=0.776), total duration of hospitalization (15.8 days versus 14.0 days; p=0.279), and postoperative duration of hospitalization, (12.1 days versus 10.7 days; p=0.361). In addition, there were no statistically significant differences in the complication rate (35.0% versus 32.6%; p=1.000), reoperation rate (5.0% versus 10.0%; p=0.675), readmission rate (5.0% versus 0.0%; p=0.464), and mortality (2.5% versus 2.5%; p=1.000) between groups. Based on this, we believe that the recovery and prognosis after laparoscopic surgery in peritonitis patients with perforated diverticulitis are not inferior to those after open surgery.
8	Kazi et al[26]	United States of America (USA)	Retrospective cohort study	1145 patients with ACD and liver cirrhosis compensated cirrhotic patients: 660, decompensated cirrhotic patients: 485, open	ACD patients were classified into compensated and decompensated cirrhosis groups, each group assigned to undergo either laparoscopic or open collectomy.	Post op short term outcomes in patients having ACD along with liver cirrhosis such as mortality, hospital length of stay	Laparoscopic colectomy was accompanied by shorter hospital length of stay, lower costs, and significantly decreased mortality rate compared with open colectomy in compensated and decompensated cirrhotic patients, LC-treated patients had significantly lower incidence of

Continued.

S. no.	Study ID	Origin	Study design	Participants	Intervention	Outcome	Key findings
				(n=875) or laparoscopic colectomy (n=270).		independent of treatment choice. Post op outcomes related to treatment choice hospital length of stay, costs mortality rate complications (surgical site infection (SSI), intraoperative/postoperative bleeding, anastomotic leaks)	SSIs, anastomotic leak, and ileus compared with OC ($p<0.05$).
9	Clapp et al[27]	United States of America (USA)	Retrospective cohort study	In the State of Texas between 2013–14 there were 20,454 colectomies performed. Of these 12,328 (60.3%) were OC, 7,536 (36.8%) were LC	Analysis of outcomes in patients who underwent laparoscopic colectomy or open colectomy	Short term outcomes, average total cost, average length of stay risk of a postoperative complication duration of surgery mortality	OC costs twice as much as LC and increased the length of stay by nearly 4 d. LC shows lower perioperative complications but the duration of lap cholectomy was higher SSI occured in 4.0% patients in the open group and 1.6% patients in laparocopic surgery group. Deaths 0 is lap, 1 in open group
10	Braschi et al[28]	United States of America (USA)	Retrospective cohort study	3348 patients had elective surgery, laparoscopic=1674 open=1674	The study aims was to compare 30-day outcomes of a laparoscopic versus open approach for diverticulitis among elderly patients	Short term outcomes: mortality post op complications, reoperation rate, readmission rate, LOS	Mortality, Morbidity, reoperation rate, readmission rate, LOS was significantly reduced in laparoscopic approach.
11	Santos et al[29]	Finland	Randomized clinical trial	85 patients were included in analyses for clinical outcomes. 41 in the surgery group, 44 in the conservative treatment group.	Patients were randomized into 2 groups based on their treatment for diverticulitis; laparoscopic sigmoid resection group or conservative treatment group	Long term outcomes (6 months) of 66 patients available, recurrence of diverticulitis, quality of life complications mortality	Quality of life was better for patients who underwent laparoscopic surgery but they experienced more complications (Clavien-Dindo grade). Recurrence rate for diverticulitis was higher in conventional treatment group. Mortality within 6 months was 0 in both cases
12	Santos et al[30]	Finland	Prespecified 2-year analysis of the LASER randomized clinical trial	The trial started with a total of 85 patients. Patients available after 2 years for follow up: 70 for the assessment of QOL and 78 for the recurrence outcome	Patients were contacted by mail at 12 and 24 months to analyze the long-term outcomes of laparoscopic sigmoid resection and conservative treatment.	Long term outcomes (24 months); quality of life, complications recurrences within 2 years, re operation rates mortality	Elective sigmoid resection was effective in preventing recurrent diverticulitis and improved quality of life over conservative treatment within 2 years. 18% of the patients' in the conservative treatment group underwent sigmoid resection within 2 years (re operation rate high). After the reoperation, both groups had similar quality of life. Patients in the surgery group (10%) had major postoperative complications. No mortality reported in both groups after 24 months
13	Samuelsson et al[31]	Sweden	Longitudinal cohort study	Out of 499 potential patients, 209 were included in the analysis; resection n=123, lavage n=86	Patients who underwent laparoscopic lavage and open surgery for diverticulitis meeting the inclusion criteria were invited to answer a comprehensive, study- specific questionnaire 2–3 years after the index surgery	Long term outcomes (2-3 years), reoperaton rate, recurrence rate quality of life distress associated with bowel function	No difference in overall health-related QoL in both groups; distress associated with bowel dysfunction was significantly higher in the lavage group. lavage group showed higher reoperation rates

1/4 (25%) studies reported no difference (LPL versus OCR). In 1/4 (25%) studies, laparoscopic lavage was associated with less patients who underwent reoperations (LPL versus OCR). 1/4 (25%) studies showed low reoperation rates among laparoscopic colon resection group in contrast to conservative treatment group where reoperation rate high was high. 1/4 (25%) LPL group showed higher re operation rates in contrast to open resection group. In three out of four studies comparing laparoscopic peritoneal lavage (LPL) with open colon resection (OCR), findings varied: one study found no disparity in reoperation rates, another observed lower rates with the laparoscopic lavage approach, and the third study noted higher rates among patients treated with LPL.

Recurrence

A total of 4 out of 5 studies, discussing long term outcomes, showed results for recurrence of diverticulitis (uncomplicated or complicated) in patients after initial treatment. 2/4 (50%) studies showed LPL to be associated with higher recurrence rate of diverticulitis in comparison to open colon resection. 2/4 (50%) studies showed LCR to be effective in preventing recurrent diverticulitis versus conservative treatment. Open colon resection demonstrates greater efficacy in preventing the recurrence of diverticulitis. Second best approach in terms of low post op diverticulitis recurrence rates would be laparoscopic colon resection.

Length of hospital stay

2/5 studies provided remarks on the overall duration of hospitalization following each surgical procedure. Total length of hospital stays, including the index admission, were similar in both groups (LPL versus OCR).

Quality of life

3/5 studies highlighted the difference in quality of life of patients undergoing a particular procedure for acute complicated diverticulitis. 2/3 (66.6%) studies showed improvement in quality of life of patients who had a laparoscopic colon resection in comparison to conservative treatment (antibiotics, analgesics). In 1/3 (33.33%) studies no difference was reported in overall health-related QOL in both groups (LPL versus OCR) after the lavage group underwent a reoperation (colon resection).

Quality assessment

Each study was subjected to a quality evaluation using the Cochrane risk of bias (ROBvis2) tool. A visual representation, akin to a "traffic light" plot, was crafted to illustrate the risk of bias across various domains within the studies. The outcomes of this assessment are depicted in Figure 2.

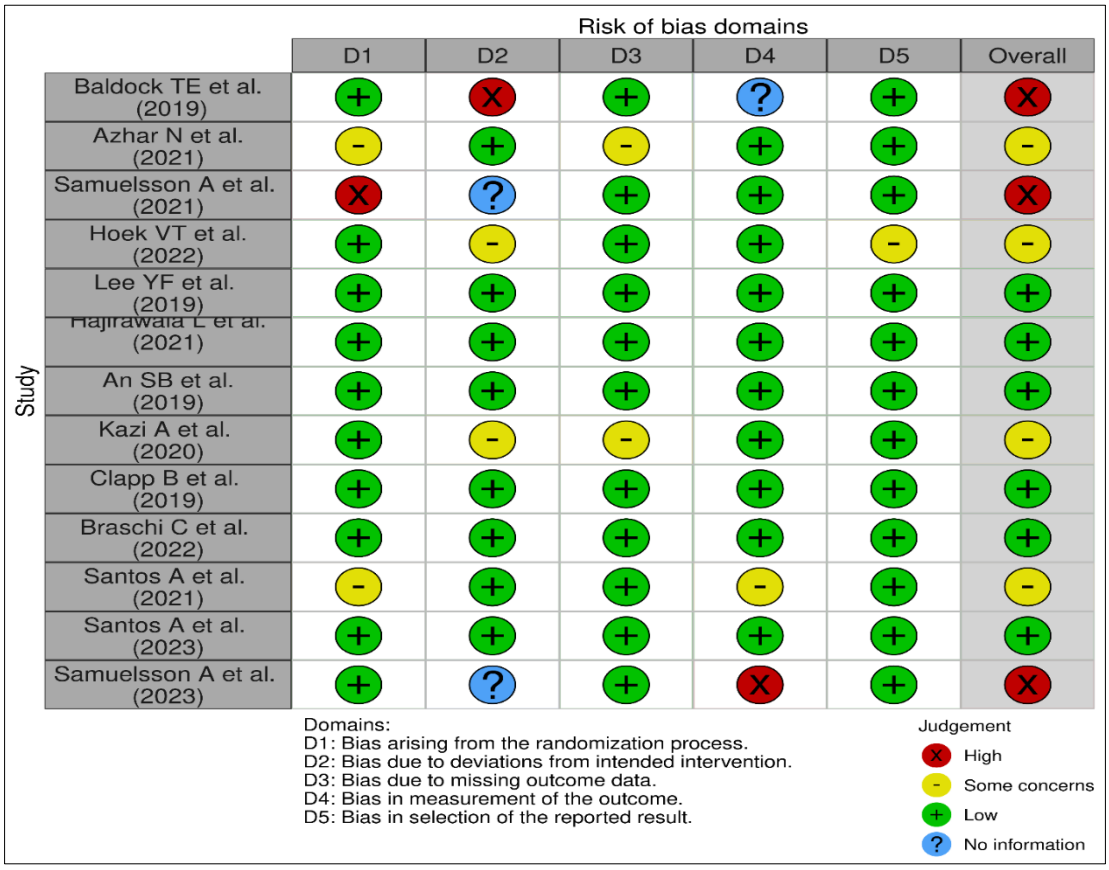

Figure 2: Traffic lights plot for risk of bias.[19-31]

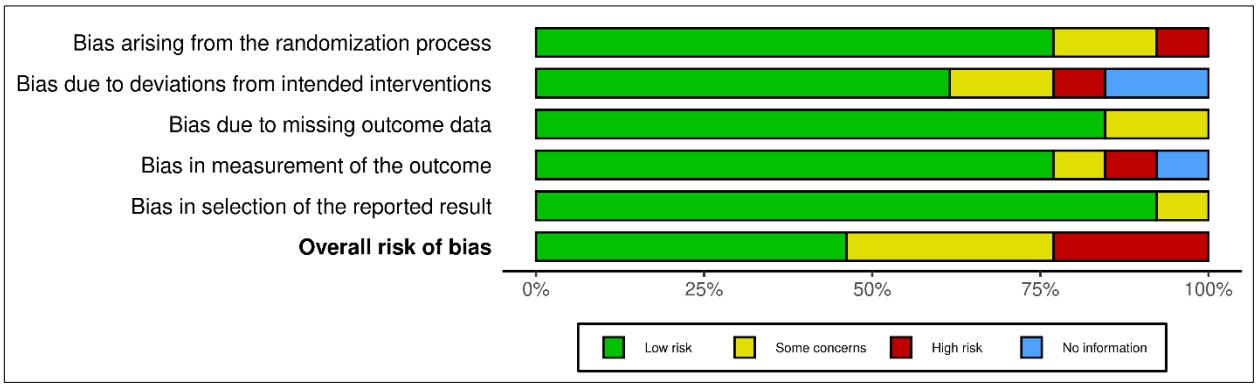

Figure 3: Evaluation of the bias risk in the selected studies.[32]

DISCUSSION

Both types of laparoscopic surgeries turn out to be superior to open resection in terms of lower post op short term complications and mortality rate. With laparoscopic lavage, readmission rates are higher, laparoscopic colon resection treated patients also showed a slightly increased readmission rate in comparison to open resection.[33,34] Hence, re-hospitalization rates are shown to plummet with an open approach. There was no difference in short term reoperations rates after laparoscopic and open approach however one study included shows a decrease in reoperation rates following LCR in comparison to OCR.[35] Both laparoscopic approaches result in a shorter length of stay after the index surgery versus open resection. In conclusion, with respect to short term outcomes such as post op complications, mortality rate, reoperations, and length of stay after the index surgery, laparoscopic approach seems to be the better choice vs open surgery. However, open surgery remains associated with a reduced readmission rate.

In terms of long-term outcomes, when laparoscopic colon resection was compared with conservative treatment, the laparoscopic group showed higher long term post op complications.[36] No comparison was reported between the long-term complications of LCR and OCR. Mortality rate was reported to increase when LPL was compared to OCR.[37] However, in most of the studies reported no difference in mortality rates among patients treated with LCR, OCR and conservative treatment. When LPL is compared to OCR in terms of number of reoperations post index surgery (including conversion from laparoscopic to open approach as well as stoma reversal), one study reports no difference in reoperations rates, another study shows a high reoperation rate with LPL approach and another third surgery suggest a decrease in number of reoperations with laparoscopic lavage.[38-40] All three studies reporting different results. When LCR is compared to conservative treatment approach, patients who underwent LCR had fewer reoperations done.

Open colon resection emerges as a more effective treatment approach at preventing diverticulitis recurrence. The second-best method in terms of low post-operative diverticulitis recurrence rates is laparoscopic colon resection. The quality of life seems to improve in patients undergoing a colon resection no matter the surgical approach (laparoscopic or open). Patients treated conservatively had poor quality of life with diverticulitis recurrence.

Independently, laparoscopic lavage as a treatment option for complicated diverticulitis is associated with reduced post op complications, index length of stay and a low short term post op mortality rate. The readmission and reoperation rates, however, are markedly increased following this procedure. In the long term, mortality among patients treated with this approach either increases or remains comparable to other approaches. LPL is associated with high rates of diverticulitis recurrence ultimately leading to conversion of the surgery into open resection. After reoperation, the quality of life among patients undergoing various approaches is similar. In a recent retrospective study with long-term follow-up, 38 patients who underwent laparoscopic lavage were observed for a median duration of 46 months. The study revealed a disease-associated mortality of 11% and an overall mortality rate of 21%.[41] Although the recurrence rate of diverticulitis was higher at 32% compared to a previous study (SCANDIV), the rate of secondary surgery, including stoma reversal, remained similar. However, the study's limitations included the lack of uniform treatment criteria for laparoscopic lavage and the absence of a control group. The laparoscopic lavage group showed higher rates of intra-abdominal abscesses and increased long-term emergency reoperations. Nevertheless, benefits such as shorter operation times, fewer wound infections, and shorter hospital stays were observed. The superior long-term outcomes of laparoscopic lavage must be evaluated against the possibility of increased short-term hazards. Therefore, reducing short-term morbidity becomes crucial, particularly for patients identified to be at risk of lavage failure based on preoperative characteristics like age, ASA grade, comorbidities, and inflammation parameters.

Laparoscopic colon resection (LCR) shows similar rates of postoperative complications and mortality compared to

open surgery, but with fewer instances of reoperation, readmission, and shorter hospital stays. Additionally, LCR outperforms other approaches in preventing long-term recurrence of diverticulitis and improving quality of life. A study published in 2020 by Cirocchi et al conducted a systematic literature search yielding four non-RCTs encompassing 436 patients undergoing either laparoscopic (181 patients, 41.51%) versus open sigmoid resection (255 patients, 58.49%).[42] This meta-analysis revealed significant advantages associated with a laparoscopic over open approach to emergency sigmoidectomy in acute diverticulitis in terms of postoperative complication rates, although no differences were found in other outcomes. Our results report a significant reduction in post op mortality and length of stay with the laparoscopic approaches. More RCTs need to be conducted comparing LCR with open surgery. Interventions should be made to reduce recurrence of diverticulitis in laparoscopic lavage treated patients, if the interventions are successful, laparoscopic lavage might be the next emerging treatment for the disease.

Strengths

Our study search method yielded a large number of articles, providing a varied viewpoint on the existing literature on treatment outcomes of acute complicated diverticulitis. To raise the bar for study quality and cut down on bias risk, we instituted stringent inclusion criteria. The described methodological changes enhance the study findings to provide critical information on the proper treatment approaches towards curing complicated diverticulitis.

Limitations

The limitations to this study include; the struggle to identify the most appropriate results and indicators to measure and report. This study tried to describe in possible detail how it was done, including the sample sizes for the multiple analysis were not conforming to the regular protocols, although different. The study ways and the sample structure and composition of the primary research concerned were mentioned without highlighting the methodological characteristics. Therefore, the use of a small number of primary studies to measure the effectiveness of such a large sample is another limitation. In addition, the contrasting aggregate effect over all sizes, we contrasted all sizes without assessing within-group or sub-group sizes. Many studies show a question within populations that shows that the results of final analyses are different.

CONCLUSION

In conclusion, this study reveals that laparoscopic procedures provide a better patient prognosis than open colectomy. Following an exhaustive review of the existing research, it was discovered that laparoscopic methods, and in particular laparoscopic colon resection, are related with superior short-term results, such as fewer postoperative problems, shorter hospital stays, and faster recovery durations. These findings indicate the potential advantages of laparoscopic surgery for the treatment of acute severe diverticulitis. However, more research and randomized controlled trials are needed to validate these findings and give more solid evidence for therapeutic decision-making in this setting.

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