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REVIEW

Surgical resection does not avoid the risk of diverticulitis recurrence —a systematic review of risk factors

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Abstract

Purpose Fifteen percent of patients undergoing elective sigmoidectomy will present a diverticulitis recurrence, which is associated with significant costs and morbidity. We aimed to systematically review the risk factors associated with recurrence after elective sigmoidectomy.

Methods PubMed/MEDLINE, Embase, Cochrane, and Web of Science were searched for studies published until May 1, 2020. Original studies were included if (i) they included patients undergoing sigmoidectomy for diverticular disease, (ii) they reported postoperative recurrent diverticulitis, and (iii) they analyzed ≥ 1 variable associated with recurrence. The primary outcome was the risk factors for recurrence of diverticulitis after sigmoidectomy.

Results From the 1463 studies initially screened, six studies were included. From the 1062 patients included, 62 patients recurred (5.8%), and six variables were associated with recurrence. Two were preoperative: age (HR = 0.96, $p = 0.02$) and irritable bowel syndrome (33.3% with recurrence *versus* 12.1% without recurrence, $p = 0.02$). Two were operative factors: uncomplicated recurrent diverticulitis as indication for surgery (73.3% with recurrence *versus* 49.9% without recurrence, $p = 0.049$) and anastomotic level (colorectal: HR = 11.4, $p = 0.02$, or colosigmoid: OR = 4, $p = 0.033$). Two were postoperative variables: the absence of active diverticulitis on pathology (39.6% with recurrence *versus* 26.6% without recurrence) and persistence of postoperative pain (HR = 4.8, $p < 0.01$).

Conclusion Identification of preoperative variables that predict the occurrence of diverticulitis recurrence should help surgical decision-making for elective sigmoidectomy, while peri- and postoperative factors should be taken into account for optimal patient follow-up.

Keywords Diverticulitis · Sigmoidectomy · Postoperative recurrence · Risk factors

Introduction

Diverticulosis is defined by the presence of colonic diverticula which are protrusions of the mucosa and submucosa through the colonic wall. More than 90% of colonic diverticula are found in the left colon and sigmoid [1]. Based on an American population aged between 30 and 80 years undergoing outpatient colonoscopies, diverticulosis was present in 42% of patients [2]. This prevalence was increased in elderly, white population, overweight, smokers, and patients with decreased bowel movements [2]. Patients may remain asymptomatic, whereas others will develop diverticular disease, defined as symptomatic diverticulosis. Therefore 10–25% of patients with diverticulosis will manifest diverticular inflammation, and 12% of patients with diverticulitis will developed a complication such as abscess, perforation, fistula, stricture or obstruction [3].

The Hinchey classification modified by Wasvary et al. [4] is often used to classify severity of episode of diverticulitis. That classification includes four stages: stage Ia corresponds to a confined inflammation or phlegmon; stage Ib is characterized by a pericolic or mesenteric abscess; stage II is characterized by a distant abscess in the abdomen, pelvis, or

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retroperitoneum; and perforation leading to purulent or fecal peritonitis correspond to stages III or IV, respectively.

The European Association for Endoscopic Surgery (EAES) and other interventional techniques and Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) published guidelines in 2019 [5] recommending emergent sigmoid resection for Hinchey III and IV diverticulitis or after failure of conservative therapies for earlier stages. Elective sigmoidectomy was recommended in the case of decreased quality of life caused by diverticular disease. Moreover, chronic symptoms or smoldering disease, severity of prior episodes, comorbidities, and patient preferences should be taken into consideration [6].

Nevertheless, sigmoidectomy, although removing the segment of the colon the most affected by diverticula, as well as the recto-sigmoid junction, does not remove diverticula from the remaining colon. After a mean follow-up of 10 years, a recurrence rate of 15% after elective surgery for diverticulitis was reported [7]. Mechanism for these recurrences is not clear. However, several risk factors were identified. Prediction of these recurrences is important to prevent associated costs and morbidity [8]. Therefore, we aimed to systematically review the risk factors associated with recurrence of diverticulitis after elective sigmoidectomy.

Materials and methods

This systematic review was performed in accordance with the recommendations of the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) statement [9] (Supplementary Table 1).

Data source and search strategy

Two reviewers (GL, ZA) independently searched PubMed/MEDLINE, Embase, Cochrane, and Web of Science for studies published until May 1, 2020, without limitation based on the publication year. The following search terms were used: “diverticulitis” OR “diverticulum” AND “inflammation”, AND “surgery” OR “colectomy”, AND “recurrence” in MeSH terms; and “diverticula” OR “diverticulosis”, AND “resection” OR “sigmoidectomy” OR “Hartmann*”, AND “recurrent” OR “failure” in non-MeSH terms. Additionally, a manual cross-reference search of bibliographies of relevant articles was performed to identify additional studies.

Study selection

Original studies written in English were eligible for inclusion if they fulfilled all the following criteria: (i) they included patients undergoing elective sigmoidectomy for diverticular disease, (ii) they reported postoperative recurrent diverticulitis, and (iii) they reported ≥ 1 variable associated with recurrence. Studies were excluded if postoperative recurrence was not confirmed by imaging or if the definition of recurrence was not specified. Studies including surgical procedure without resection (i.e., peritoneal lavage, surgical drainage) were excluded. Other exclusion criteria were case reports, conference abstracts, editorials, and protocols. There was no restriction based on the design or sample size of the study.

Data extraction

Two authors (GL, ZA) independently extracted the data, including general and methodological information of the study and baseline characteristics of the study population: sample size, age, gender, classification of diverticulitis, the number of previous episodes of diverticulitis, and indication for surgery. Intraoperative data were also extracted, including elective/emergency intervention, type of resection (sigmoidectomy/left-sided hemicolectomy/anterior resection), splenic flexure mobilization, laparoscopic/open resection, conversion, creation of ostomy, and type of anastomosis (stapled/handsewn, colorectal/colosigmoid). Postoperative extracted data were follow-up duration, pathology report (specimen length, inflammation state [active, chronic, none]), persistent complaints, complications, recurrence, and treatment for recurrence. Variables associated with recurrence on quantitative analysis and variables significant on uni- or multivariate regression analysis were also extracted.

Outcome measures

The primary outcome of the systematic review was to identify risk factors for postoperative recurrence of diverticulitis. The secondary outcomes were the incidence of postoperative recurrence of diverticulitis, treatment for postoperative recurrence of diverticulitis (medical versus surgical), postoperative complications, and mortality.

Recurrence was defined as left lower quadrant pain, inflammation (fever, elevated white blood cell, or C-reactive protein), and imaging consistent with the diagnosis of diverticulitis. Complication was defined as any deviation from the normal postoperative course and did not include recurrence.

Results

Studies selection and characteristics

The initial search identified 1463 studies (Fig. 1). After duplicates removal, 1186 records were screened. Based on the title and abstract, 963 studies were removed. From the 223 full text articles assessed for eligibility, 208 were excluded because they did not fulfill all inclusion criteria. Furthermore, nine other

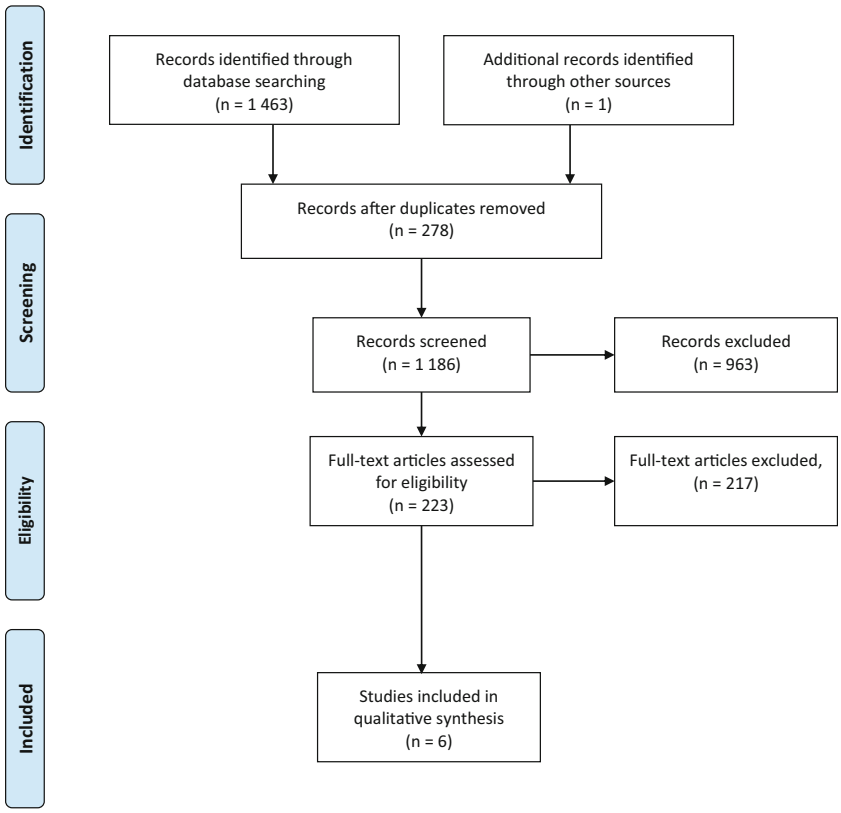

Fig. 1 Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) flowchart showing selection of publications for review

studies were removed: one study [10] contained duplicated data from another included study; two studies [11, 12] included peritoneal lavage, surgical drainage, or diverticulectomy in the resection group; in five studies [13–17] recurrences were not defined or confirmed by imaging; and one study [18] contained insufficient data. One study [19] was identified by cross-referencing. Finally, six articles [19–24] were included in the present review.

From the included studies, five studies were monocentric [19–23] and retrospective observational cohort [19–22, 24] (Table 1). Overall, 1062 patients were included (518 males and 544 females) with a mean age ranging from 56 to 63 years. Data regarding the mean follow-up duration was reported by 4 studies [19–21, 24], which ranged from 55 to 86 months. Before the surgical procedure, 765 (72%) patients experienced recurrent attacks of diverticulitis, and 128 (12%) presented their first episode (data unavailable for 169 (16%) of cases). Only two studies [22, 23] reported the severity of the diverticulitis episode, classified either with the Hinchey classification [25] or with the Hansen and Stock classification [26].

Perioperative and postoperative outcomes

Only one study [20] included emergency surgical resections, representing 73 (7%) of patients included in the review (Table 2). The remaining patients represented 953 (93%) cases, which underwent elective intervention for uncomplicated diverticulitis [19–21, 24] or complicated diverticulitis [20–22]. Other reported indications for surgery were symptomatic diverticulosis [23], persistent abdominal pain/smoldering disease [21, 22], recurrent bleeding [22], failure of conservative treatment for diverticulitis [22], and first attack of diverticulitis in immunosuppressed patients [22]. Sigmoidectomy was the procedure of choice in 928 (90%) patients, while anterior resection or left-sided hemicolectomy were not routinely performed (11 patients and 38 patients, respectively; type of intervention performed not reported for 85 patients). Details of the operative techniques are detailed in Table 2.

Pathology showed a mean specimen length from 14 to 26 cm [19–24] and the presence of diverticulitis in 536 cases, but no inflammation in 177 cases [19–21, 23] (Table 3). Moreover, inflammation at the proximal margin was reported by two studies in 13 [19] and 30 [24] patients. Data on the presence of postoperative persistent complaints was reported by one study [20] in 36 patients. Five studies [19–22, 24] reported postoperative complications, corresponding to a total of 136 events and an incidence of 14.0% (136/968); and four studies [19, 20, 22, 24] reported postoperative death, corresponding to 8 patients and a mortality of 1.3% (8/607).

Postoperative recurrence of diverticulitis

A total of 62 diverticulitis recurred after surgical resection for diverticular disease, representing 5.8% of the population

Table 1 Characteristics of included studies and baseline characteristics of participants

Study	Methodological characteristics				Population characteristics									
	Journal of publication	Study design	Monocentric or multicentric	Study period	Sample size	Age (mean ± SD or range)	Gender (male/female)	Follow-up (mean ± SD or range)	Diverticulitis severity	Previous episode of diverticulitis				
										0	1	2	3	≥ 4
Bergamaschi et al. 1998, France	Surgical endoscopy	ORC	Monocentric	1990–1994	75	60.9	48/27	55 months	-[a]	-				
Thaler et al. 2003, USA	Disease of the colon & rectum	ORC	Multicentric	1992–2000	236	60.4 ± 10	131/105	67 ± 30 months	-°	1*	62*	113*	10*	0
Regenet et al. 2005, France	Hepatogastroenterology	OPC + ORC	Monocentric	1996–2001	94	56.4	47/47	NA	Hinchey classification: 72 patients stage 0 22 patients stage 1	-				
Andeweg et al. 2008, Netherlands	World journal of surgery	ORC	Monocentric	1985–2003	183	63, 26–93	84/99	86, 0–216 months	-	63	16	88	11	5
Holmer et al. 2011, Germany	Langenbeck's archives of surgery	OPC	Monocentric	2004–2008	113	62.4, 38–92[Π]	46/67	NA	Hansen and Stock classification: 12 patients stage I 59 patients stage 2a 42 patients stage 2b	45	68: ≥ 1 episode			
Choi et al. 2019, USA	Journal of gastrointestinal surgery	ORC	Monocentric	2002–2016	361	56 ± 10.7	162/199	86, 6–190 months	-	19	214: 1–3 episodes			128

SD standard deviation, *ORC* observational retrospective cohort, - not available, *OPC* observational prospective cohort

*Based on the previous admission, data not available for all patients but 235 cases with more than one episode of diverticulitis

[Π] expressed as median, with range

[a]Complicated diverticulitis were excluded

°Perforated diverticulitis were excluded

Table 2 Operative characteristics

Study	Indication for surgery	Elective/ emergency	Type of operation		Laparoscopic/ open// conversion	Splenic flexure mobilization	Ostomy creation	Anastomosis	
			Sigmoidectomy	Other				Stapler/ Handswen	Colorectal/ Colosigmoid
Bergamaschi et al.	Uncomplicated diverticulitis	75/0	-		40/35 // 1	46	0	51/24	50/25
Thaler et al.	Uncomplicated diverticulitis	236/0	236	0	96/140 // 18	109	0	171 / 65	143 / 93
Regenet et al.	Symptomatic diverticulosis	94/0	94	0	72/22 // 0	94	0	94/0	94/0
Andeweg et al.	Uncomplicated and complicated diverticulitis	110/73	150	5 LH 18 AR*	-	-	68	-	21/90[¥]
Holmer et al.	Persistent abdominal pain Covered perforation ± abscess Recurrent bleeding Failure of conservative treatment First attack in immunosuppressed	113/0	113	0	-	113	0	113/0	-
Choi et al.	Uncomplicated recurrent diverticulitis Localized perforation ± abscess Fistula Stricture Smoldering disease	361/0	335	6 LH 20 AR	359 / 2 // 41	0	5	361/0	361/0

- not available, *LH* left-sided hemicolectomy, *AR* anterior resection

*10 classified as miscellaneous

[¥] 4 anastomosis classified as other

Table 3 Postoperative outcomes

Study	Pathology		Complications (timepoint)	Persistent complains	Mortality (timepoint)
	Specimen length (mean ± SD or range)	Pathologist assessment			
Bergamaschi et al.	14.3 cm	75 diverticulitis[Π]	8	-	0
Thaler et al.	17.9 ± 5.9 cm	-[Π]	54 (30 days)	-	1 (30 days)
Regenet et al.	26.3 cm	94 diverticulitis	-	-	-
Andeweg et al.	17.3, 7-35 cm	166 acute diverticulitis 17 no inflammation	9*	36	7
Holmer et al.	-	-	16	-	0
Choi et al.	17.7 cm	141 acute diverticulitis 60 chronic diverticulitis 158 diverticular disease 2 no disease	49 (perioperative)	-	-

SD standard deviation, *cm* centimeter, - not available

[Π] inflammation at the proximal margin was reported in 13 cases by Bergamaschi et al. and in 30 cases by Thaler et al.

*only severe complications were reported

included in the review. Mean time to recurrence ranged between 38 [20] and 78 months [24], and the cumulative time-related incidence at 15 years ranged between 6.3 [21] and16% [20] (Table 4). The treatment for postoperative recurrence was conservative in 43 patients, but 14 patients required another surgical intervention (treatment not reported by one study [23]).

Preoperative variables associated with postoperative recurrence of diverticulitis

Eight preoperative variables were considered for their association with recurrence of postoperative diverticulitis (Table 5). Age was not associated with postoperative recurrence in the retrospective study by Choi et al. [21] ($p = 0.12$). However, Andeweg et al. [20] reported a lower age to be associated with recurrence (mean 54, range 33–75, *versus* without recurrence: mean 64, range 27–93, $p < 0.02$). On regression analysis (Cox-model), younger age was still an independent predictor of recurrence (univariate: hazard ratio (HR) = 0.96, 95% CI 0.93–0.99, $p = 0.02$; multivariate: stated as significant but no value reported). Irritable bowel syndrome was the other preoperative variable associated with recurrence on univariate analysis (33.3% with recurrence *versus* 12.1% without recurrence, $p = 0.02$) [21]. Nevertheless, the latter was not significant on regression analysis ($p = 0.053$). Six preoperative variables showed no significant association with recurrence: the number of preoperative episodes of diverticulitis (reported by four studies [20–22, 24]), gender (reported by three studies

Table 4 Reported recurrences of included studies

Study	Number of recurrence (%)	Time until recurrence (mean ± SD or range)	Cumulative time-related incidence of recurrence	Treatment for recurrent diverticulitis	
				Conservative	Surgical
Bergamaschi et al.	4 (5.3%)	-	-	4	0
Thaler et al.	12 (5.1%)	78 ± 25 months	-	11	1
Regenet et al.	5 (5.3%)	-	-	-	
Andeweg et al.	16 (8.7%)	38, 6–144 months	1 year: 3% (SE 1.3)5 years: 8.2% (SE 2.3) 10 years: 12% (SE 3.0)15 years: 16% (SE 3.7)	8	8[Π]
Holmer et al.	4 (3.5%)	-	-	4	0
Choi et al.	21 (5.8%)	55, 6–109 months	1 year: 0.3%5 years: 3.0%10 years: 6.3%15 years: 6.3%	16	5*
Overall	62 (5.8%)	-	-	43	14

SD standard deviation, - not available, *SE* standard error

[Π] 3 left hemicolectomy, 3 partial resection of transverse colon, 2 subtotal colectomy

*5 left colectomies

Table 5 Preoperative variables associated with postoperative recurrence of diverticulitis

Study	Univariate analysis	Univariate regression analysis	Multivariate regression analysis
Number of preoperative episodes of diverticulitis			
Thaler et al.	-	NS	-
Andeweg et al.	NS	NS	-
Choi et al.	NS	-	-
Holmer et al.	NS	-	-
Gender			
Thaler et al.	-	NS	-
Andeweg et al.	NS	-	-
Choi et al.	NS	-	-
Age: mean, range with recurrence *versus* without recurrence			
Andeweg et al.	54, 33–75 *versus* 64, 27–93, $p < 0.02$	HR 0.96, 95% CI 0.93–0.99, $p = 0.02$	Significant (value NA)
Choi et al.	NS	-	-
ASA class			
Thaler et al.	-	NS	-
Comorbidity			
Choi et al.	NS	-	-
Irritable bowel syndrome: *n* (%) with recurrence *versus* without recurrence			
Choi et al.	5 (33.3%) versus 42 (12.1%), $p = 0.02$	NS	-
Previous treatment modality: antibiotic IV *versus* antibiotic PO *versus* drainage			
Choi et al.	NS	-	-
Previous abdominal surgery			
Thaler et al.	-	NS	-

NS not significant, *ASA* American Society of Anesthesiologists, *IV* intravenous, *PO* per os, - not available

[20, 21, 24]), American society of anesthesiologists (ASA) class and previous abdominal surgery (both reported by one study [24]), comorbidity, and previous treatment modality (both reported by one study [21]).

Operative variables associated with postoperative recurrence of diverticulitis

From the eight operative variables, only two [20, 21, 24] were associated with recurrence (Table 6). The first variable was uncomplicated recurrent diverticulitis as indication for surgery (73.3% with recurrence *versus* 49.9% without recurrence, $p = 0.049$), but the association was not significant on univariate regression analysis [21]. Anastomotic level was considered by three studies [20, 23, 24], but significant in two studies [20, 24] on univariate regression analysis. Andeweg et al. [20] reported increased recurrences associated with colorectal anastomosis compared with colostomy (univariate regression analysis: HR = 11.4, 95% CI 1.2-109.5, $p = 0.02$; multivariate regression analysis: stated as significant but no value reported). In the other hand, Thaler et al. [24] reported colosigmoid anastomosis as a risk factor for postoperative recurrent diverticulitis (univariate regression analysis: odds ratio (OR) = 4, 95%CI 1.1-15.0, $p = 0.033$; no multivariate regression analysis). Six other factors were not associated with postoperative recurrence of diverticulitis: emergency/elective surgery [20], laparoscopic/open approach [19, 23, 24], length of resected bowel [20, 21, 23], type of resection [20, 21], splenic flexure mobilization [24], stapled/handsewn anastomosis [24].

Postoperative variables associated with postoperative recurrence of diverticulitis

Four postoperative variables were included in the analysis for their association with diverticulitis (Table 7). The absence of active diverticulitis on pathology was significant on univariate analysis only in the study by Choi et al. [21] (39.6% with recurrence *versus* 26.6% without recurrence, $p = 0.01$). However, two studies [20, 24] reported no association between the pathology and the recurrence of postoperative diverticulitis. Persistence of postoperative pain was associated with recurrence on univariate analysis but also on uni- and multivariate regression analysis (22% with recurrence *versus* 5.4% without recurrence, $p < 0.01$; HR = 4.8, 95% CI 1.8–12.5, $p < 0.01$; stated as significant but no value reported; respectively) [20]. Two postoperative factors were not associated with recurrence, as reported by one study [24]: postoperative complications and reoperation.

Table 6 Operative variables associated with recurrence associated with postoperative recurrence of diverticulitis

Study	Univariate analysis	Univariate regression analysis	Multivariate regression analysis
Unomplicated recurrent diverticulitis as indication for surgery: n (%) with recurrence *versus* without recurrence			
Choi et al.	11 (73.3) *versus* 171 (49.9%), $p = 0.049$	NS	-
Emergency *versus* elective surgery			
Andeweg et al.	NS	-	-
Laparoscopic *versus* open			
Thaler et al.	-	NS	-
Regenet et al.	NS	-	-
Bergamaschi et al.	NS	-	-
Anastomotic level: n (%) of recurrence			
Andeweg et al.	Colorectal: 3 (14.3%), colosigmoid: 12 (13.3%) *versus* colostomy 1 (1.5%), $p = 0.04$	Colorectal: HR 11.4, 95% CI 1.2-109.5, $p = 0.02$, colosigmoid: NS	Colorectal: Significant (value NA)
Thaler et al.	-	Colosigmoid: 7 (12.5%) *versus* colorectal: 4 (2.8%); OR = 4, 95% CI 1.1–15.0, $p = 0.033$	-
Regenet et al.	NS	-	-
Length of resected bowel			
Choi et al.	NS	-	-
Andeweg et al.	NS	-	-
Regenet et al.	NS	-	-
Type of resection: sigmoidectomy versus anterior resection *versus* left-sided hemicolectomy			
Choi et al.	NS	-	-
Andeweg et al.	NS	-	-
Splenic flexure mobilization			
Thaler et al.	NS	-	-
Anastomotic technique: stapled *versus* handsewn			
Thaler et al.	NS	-	-

NS not significant

- not available

Table 7 Postoperative variables associated with recurrence associated with postoperative recurrence of diverticulitis

Study	Univariate analysis	Univariate regression analysis	Multivariate regression analysis
Acute diverticulitis on pathology: *n* (%) with recurrence *versus* without recurrence			
Choi et al.	4 (26.6%) *versus* 137 (39.6%), $p = 0.01$	NS	-
Andeweg et al.	NS	-	-
Thaler et al.	-	NS$^{\Pi}$	-
Persistent postoperative pain: n (%) of recurrences in patients with persistent pain *versus* n (%) of recurrences without persistent pain			
Andeweg et al.	8 (22.2%) *versus* 8 (5.4%), $p < 0.01$	HR 4.8, 95% CI 1.8–12.5, $p < 0.01$	Significant (value NA)
Postoperative complication			
Thaler et al.	-	NS	-
Reoperation			
Thaler et al.	-	NS	-

NS not significant

- not available

$^{\Pi}$ described as inflammation at the proximal margin

Discussion

The present systematic review included six observational cohorts [19–24], totalizing 1062 patients with diverticular disease. Recurrence occurred in 62 cases and needed conservative (43 cases) or surgical (14 cases) treatment. Three variables were significantly associated with postoperative recurrence of diverticulitis, one for each pre-, peri- or postoperative category. From the eight preoperative variables, a lower age [20] was associated with recurrence. From the eight perioperative factors, the anastomotic level was significant on regression analysis. Three studies [20, 21, 24] integrated four postoperative variables, of which persistent postoperative pain [20] was associated with recurrence on Cox regression model.

Our review had several limitations. Firstly, regression analysis was not undertaken by all the included studies. Secondly, risk of bias was high due to the design of the included studies (one prospective [22], four retrospectives [19–21, 24], and one mixed [23] observational cohorts). Thirdly, the study populations were small, and only one study [24] was multicentric. Fourthly, data were heterogeneous across studies (i.e. severity staging of the diverticulitis, indication fur surgery, operative technique, and definition of complications). Fifthly, the search strategy may have not retrieved all relevant studies.

Importantly, diverticulosis in limited to the descending colon and sigmoid in > 90% of cases [1] and sigmoidectomy seemed a good option for the treatment of diverticulitis [5]. However, it might not be a definitive cure for all patients, as showed by a cumulative time-related incidence of postoperative recurrence at 15 years ranging between 6.3 and 16% [20, 21]. Risk factors for recurrence should be identified, to avoid increased costs and morbidity. A systematic review by Hupfeld et al. [27] identified three factors with high likelihood to increase the risk of diverticulitis recurrence after non-surgical management: young age, diverticulitis complicated by an abscess formation, and recurrent diverticulitis. Compared with the latter review [27], we presently included two studies [20, 21] which assessed the relationship between age and postoperative recurrence. While one study [21] failed to find an association, another study [20] showed decreased recurrence in older patients (HR = 0.96, 95 % CI 0.93–0.99, $p = 0.02$). This might be explained by the decreased life expectancy while reappearance of diverticulitis could occur.

Herein, we presented the first systematic review of variables associated with postoperative recurrence. Identification of these factors could help optimization of the treatment strategy. From six identified variables, only the anastomotic level is modifiable. Based on a low level of evidence, the EAES and SAGES recommended colorectal anastomosis to decrease the risk of postoperative recurrence. This statement is supported by the study by Thaler et al. [24] reporting increased recurrences with colosigmoid anastomosis *versus* colorectal anastomosis. However, Andeweg et al. [20] showed increased recurrences with colorectal anastomosis *versus* colostomy, and Regenet *et al.* [23] found no association between the anastomotic level and postoperative recurrence. Because the results are conflictual, we could not favor an anastomotic level over another. Moreover, five additional non-modifiable risk factors were identified. Because elective sigmoidectomy is associated with postoperative complication rate of 22.5% and 30-day mortality rate of 0.5% [28], benefices should be weight against the risks. This balance should consider postoperative recurrence and associated risk factors, together with the patient preferences and global condition.

Future researches are needed to identify risk factors for postoperative recurrence. Our review reported conflicting

results, and significant association between variable and recurrence were reported by isolated study. Moreover, future trials should include larger prospective cohorts.

Conclusions

To conclude, surgeons should be aware of the risk of postoperative diverticulitis recurrence, and patients should be informed. Preoperative variables associated with postoperative recurrence should be considered by clinicians for adequate patient selection and aid surgical decision-making for elective sigmoidectomy. Moreover, peri- and postoperative variables should be emphasized for optimal patient follow-up and early recognition of recurrence to avoid complication and reoperation.

Authors' contribution GL and ZA conceived and designed the study. GL and ZA acquired the data. GL, ZA, JM, CT, NCB, and FR interpreted the data. GL, ZA, JM, CT, NCB, and FR contributed to the writing of the manuscript and to its critical revision. GL, ZA, JM, CT, NCB, and FR approved the final version of the manuscript.

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Availability of data and material The authors confirm that the data supporting the findings of this study are available within the article.

Compliance with ethical standards

Conflicts of interests The authors have no conflicts of interest to disclose.

Ethics approval Not applicable

Consent to participate Not applicable.

Consent for publication Not applicable.

Code availability Not applicable.

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