Original article

Multicentre international trial of laparoscopic lavage for Hinchey III acute diverticulitis (LLO Study)

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Background: **Laparoscopic lavage was proposed in the 1990s to treat purulent peritonitis in patients with perforated acute diverticulitis. Prospective randomized trials had mixed results. The aim of this study was to determine the success rate of laparoscopic lavage in sepsis control and to identify a group of patients that could potentially benefit from this treatment.**

Methods: **This retrospective multicentre international study included consecutive patients from 24 centres who underwent laparoscopic lavage from 2005 to 2015.**

Results: **A total of 404 patients were included, 231 of whom had Hinchey III acute diverticulitis. Sepsis control was achieved in 172 patients (74·5 per cent), and was associated with lower Mannheim Peritonitis Index score and ASA grade, no evidence of free perforation, absence of extensive adhesiolysis and previous episodes of diverticulitis. The operation was immediately converted to open surgery in 19 patients. Among 212 patients who underwent laparoscopic lavage, the morbidity rate was 33·0 per cent; the reoperation rate was 13·7 per cent and the 30-day mortality rate 1·9 per cent. Twenty-one patients required readmission for early complications, of whom 11 underwent further surgery and one died. Of the 172 patients discharged uneventfully after laparoscopic lavage, a recurrent episode of acute diverticulitis was registered in 46 (26·7 per cent), at a mean of 11 (range 2–108) months. Relapse was associated with younger age, female sex and previous episodes of acute diverticulitis.**

Conclusion: **Laparoscopic lavage showed a high rate of successful sepsis control in selected patients with perforated Hinchey III acute diverticulitis affected by peritonitis, with low rates of operative mortality, reoperation and stoma formation.**

*Members of the LLO Study Group are co-authors of this study and can be found under the heading Collaborators

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Introduction

Purulent peritonitis due to perforated acute sigmoid diverticulitis is a surgical challenge, traditionally managed with segmental resection and stoma formation. In the 1990s, laparoscopic lavage (LL) was proposed to treat patients affected by peritonitis owing to perforated acute diverticulitis (AD)[1]. Initial results encouraged surgeons to perform LL, with good success rates[2–4]. In the 2000s, four RCTs were proposed to evaluate this procedure; three of these[5–7] were completed, but had mixed results.

The Laparoscopic Lavage Observational (LLO) Study was conceived in 2015, with the aim of evaluating the outcomes of LL based on data from a large series of consecutive patients from different institutions. The goal of the study was to define the success rate of LL as well as to identify of a subgroup of patients who could benefit maximally from this treatment.

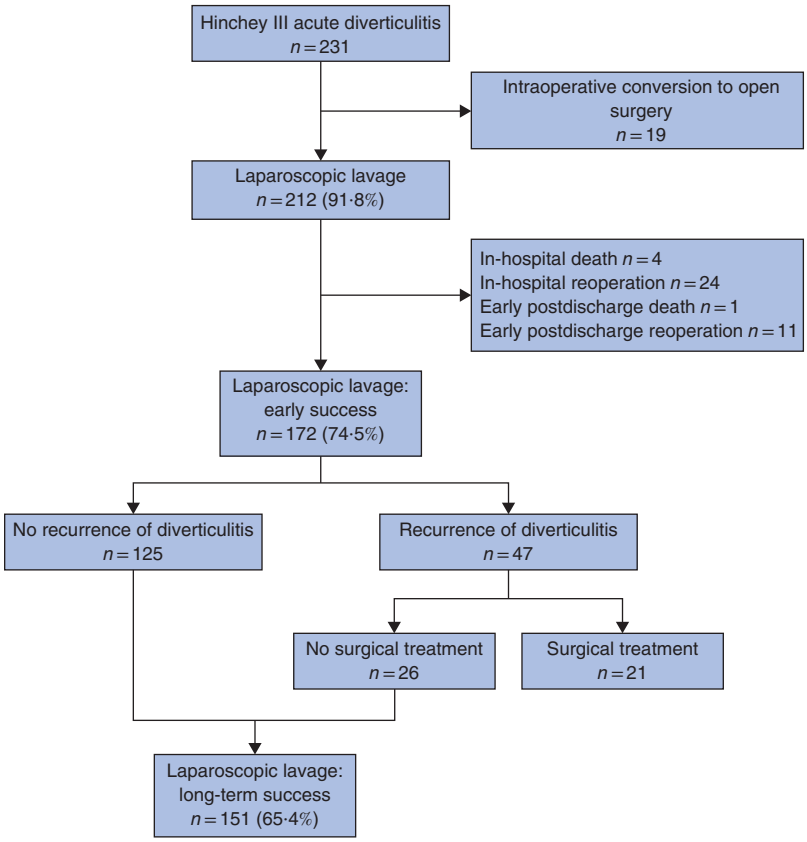

Fig. 1 Study flow chart, showing outcomes of laparoscopic lavage for Hinchey III acute diverticulitis

Methods

This multicentre international study was registered at ClinicalTrials.gov (NCT02662088) and was approved by the local ethics committee. An *ad hoc* responsive web application accessible using personal computers, tablets and smartphones was created. A designated physician at each participating centre entered retrospective data for consecutive patients into a specifically designed database. Data were checked automatically for consistency. Inclusion criteria were: all consecutive patients with colonic AD submitted to LL, age at least 18 years, and admission between 2005 and 2015. AD was staged according to the Hinchey classification[8]. All patients with Hinchey stage I, II and IV disease were excluded. Each centre had to include a minimum of five patients to be included in the study.

Data recorded in the case report form included: patient characteristics, preoperative data, surgical details, postoperative data, in-hospital complications, early complications after discharge, readmission for recurrent episodes of AD, and further surgery during follow-up.

Patients were classified for operative risk and severity of peritonitis according to the ASA grade and the Mannheim Peritonitis Index (MPI)[9]. Preoperative CT findings were classified according to the World Society of Emergency Surgery (WSES) score for AD[10].

The primary outcome was the success rate of LL in patients identified as having Hinchey III AD at operation. This was defined as the rate of patients alive and free from sepsis after the index episode, with no need for further surgery or death within 60 days after discharge. Secondary outcomes were: conversion to any form of laparoscopic procedure different from peritoneal lavage (with or without bowel resection); conversion to laparotomy (with or without bowel resection); 30-day postoperative mortality and morbidity; hospital readmission rate for AD within 60 days after discharge; hospital readmission rate for recurrent AD, defined as a further episode of AD after at least 60 days following discharge; and need for surgery for a recurrent episode of AD.

Statistical analysis

Continuous data are presented as mean(s.d.) unless indicated otherwise. χ^2 or Fisher's exact univariable tests were used to test associations between each clinically relevant

Table 1 Patient demographics

	All patients ($n = 231$)	Successful laparoscopic lavage ($n = 172$)	Failure of laparoscopic lavage ($n = 59$)	P†
Age (years)*	61·2(13·7)	60·6(13·3)	62·9(15·0)	0·252‡
Sex ratio (F : M)	102 : 129	73 : 99	29 : 30	0·448
BMI (kg/m^2)*	26·0(3·3)	26·0(3·2)	26·0(3·4)	0·908‡
MPI score*	19·2(6·0)	18·4(5·9)	21·6(5·8)	< 0·001‡
ASA grade				0·001
I	39 (17·0)	29 (17·0)	10 (17)	
II	96 (41·7)	80 (46·8)	16 (27)	
III	82 (35·7)	58 (33·9)	24 (41)	
IV	13 (5·7)	4 (2·3)	9 (15)	
Missing	1	1	0	
Previous abdominal surgery				0·256
No	152 (67·3)	109 (64·9)	43 (74)	
Yes	74 (32·7)	59 (35·1)	15 (26)	
Missing	5	4	1	
Previous events of diverticulitis				0·004
No	146 (64·3)	99 (58·9)	47 (80)	
Yes	81 (35·7)	69 (41·1)	12 (20)	
Missing	4	4	0	
Abdominal CT before surgery				0·297
No	11 (4·8)	10 (5·8)	1 (2)	
Yes	219 (95·2)	161 (94·2)	58 (98)	
Missing	1	1	0	
WSES score (CT before surgery)				0·157
1A–1B	14 (6·4)	10 (6·2)	4 (7)	
2A–2B	67 (30·6)	55 (34·2)	12 (21)	
≥ 3	138 (63·0)	96 (59·6)	42 (72)	

Values in parentheses are percentages unless indicated otherwise; *values are mean(s.d.). MPI, Mannheim Peritonitis Index; WSES, World Society of Emergency Surgery. †Fisher's exact test, except ‡t test.

categorical variable and outcomes; the t test of equality of means was used for continuous variables. The Wald test was used in multivariable logistic regression analysis to estimate the association, in terms of odds ratio (OR), between outcomes and patient characteristics. Two-tailed probabilities were reported and a significant level α of 0·050 was used. All analyses were carried out using Stata® version 14.1 (StataCorp, College Station, Texas, USA).

Results

Twenty-four centres from eight countries participated in the study. Data from 404 patients undergoing LL were included in the registry; 231 patients (57·2 per cent) with an intraoperative diagnosis of Hinchey stage III AD were analysed (*Fig. 1*). The characteristics of these patients are shown in *Table 1*, and surgical details in *Table 2*.

Conversion

At the index surgery, the operation was converted to an open procedure in 19 patients (8·2 per cent), in 16 of these owing to recognition of a free perforation; 17 patients underwent resection and two had suture repair of a perforation. Conversion to open surgery was associated with identification of free colonic perforation (OR 35·39; $P < 0·001$) and an increased ASA grade (OR 2·86 per unit increase; $P = 0·016$) (*Table 3*).

A total of 212 procedures were completed laparoscopically. Overall, free colonic perforation was detected in 47 patients (20·7 per cent), with conversion to an open procedure in 16 (resection in 14, suturing in 2); 17 patients underwent laparoscopic suturing and ten laparoscopic drainage. Free colonic perforation was less frequent after previous events of AD (OR 0·39; $P = 0·034$) and in WSES 2 CT stage compared with WSES 1 (OR 0·15; $P = 0·029$). Detection of free colonic perforation was associated with extensive adhesiolysis (OR 3·17; $P = 0·012$) (*Table 3*).

Operative morbidity

Of 212 patients who underwent surgery that was completed laparoscopically, 70 (33·0 per cent) had postoperative complications. Forty-one (19·3 per cent) recovered with

Table 2 Surgical data

	All patients ($n = 231$)	Successful laparoscopic lavage ($n = 172$)	Failure of laparoscopic lavage ($n = 59$)	P†
Interval between admission and surgery surgery (h)*	14·9(52·5)	13·8(57·9)	18·2(32·5)	0·582‡
No. of trocars inserted				0·633
≤ 3	153 (66·2)	112 (65·5)	41 (69)	
> 3	77 (33·8)	59 (34·5)	18 (31)	
Missing	1	1	0	
Lavage volume (litres)*	4·5(2·3)	4·5(2·2)	4·6(2·4)	0·733‡
Type of treatment				n.a.
Laparoscopic lavage	212 (91·8)	172 (100)	40 (68)	
Open – sutured	2 (0·9)	–	2 (3)	
Open – resection	17 (7·4)	–	17 (29)	
Degree of adhesiolysis				0·320
None	34 (15·0)	27 (16·1)	7 (12)	
Limited	153 (67·4)	115 (68·5)	38 (64)	
Extensive	40 (17·6)	26 (15·5)	14 (24)	
Missing	4	4	0	
Identification of free colonic perforation during laparoscopic lavage				< 0·001
No	180 (79·3)	146 (86·9)	34 (58)	
Yes	47 (20·7)	22 (13·1)	25 (42)	
Missing	4	4	0	
Surgical strategies used if colonic perforation detected				n.a.
Drainage	10 (23)	6 (33)	4 (16)	
Suturing	19 (44)	12 (67)	7 (28)	
Resection	14 (33)	0 (0)	14 (56)	
Missing	4	4	0	
Duration of surgery (min)*	87·4(38·0)	79·2(26·9)	111·3(52·9)	< 0·001‡
Estimated blood loss (ml)*	49·9(57·3)	46·3(52·3)	60·3(69·3)	0·115‡
Intraoperative complications	0 of 227 (100)	–	–	–
Intraoperative death	0 (100)	–	–	–

Values in parentheses are percentages unless indicated otherwise; *values are mean(s.d.). n.a., Not applicable as related to the definition of failure. †Fisher's exact test, except ‡*t* test.

conservative treatment, whereas 29 (13·7 per cent) required further surgery during the same admission. Twenty-five patients (11·8 per cent) underwent bowel resection, with a synchronous stoma in 18 (8·5 per cent) (*Table 4*). Operative morbidity was related to presence of a free perforation, a longer interval from admission to surgery, and a longer duration of operation (*Table 3*). Only one patient (0·5 per cent) required further surgery for a diagnosis of cancer. Four patients (1·9 per cent) died at a median interval of 6 (range 4–21) days after the index procedure, owing to persisting sepsis (3) and pulmonary embolism (1). They had a mean age of 76·7 (range 66–89) years, ASA grade was III in two patients and IV in two, and one patient underwent further surgery.

Early readmissions

Of the 184 patients (86·8 per cent) discharged after LL alone, 21 (11·4 per cent) required readmission within 60 days for early complications: recurrent AD (6), intra-abdominal abscess (6), peritonitis (3) and others (6) (*Table 5*). Eleven patients underwent resection (3 with stoma creation) and one died from sepsis, whereas nine recovered with non-operative treatment, including percutaneous drainage in three. Overall, five of 212 patients (2·4 per cent) who underwent LL died, and 21 (9·9 per cent) received a stoma.

Successful outcome

Of 231 patients in whom LL was attempted for Hinchey III perforated diverticulitis, 172 (74·5 per cent) were treated successfully as they were free from sepsis with no need for further surgery during the index admission and up to 60 days after discharge (*Fig. 1*). Multivariable analysis showed that higher values of MPI (MPI 24 or more *versus* less than 24: OR 2·79; $P = 0·036$), a high ASA grade (OR 1·84; $P = 0·025$), identification of a free perforation (OR 5·87; $P < 0·001$) and extensive adhesiolysis (extensive *versus* limited or none: OR 2·94; $P = 0·026$) were associated with a higher risk of failure of LL, whereas previous episodes of AD seemed to be a positive prognostic factor (OR 0·35; $P = 0·016$) (*Table 6*). No other technical details, such as number of trocars or quantity of lavage fluid, influenced outcomes.

Table 3 Results of multivariable logistic regression to identify factors associated with in-hospital outcomes

	Identification of free colonic perforation (47 of 227 patients)		Conversion of laparoscopic lavage to open surgery (19 of 231 patients)		In-hospital reoperation after laparoscopic lavage (29 of 212 patients)		30-day morbidity after laparoscopic lavage (70 of 212 patients)	
	Odds ratio	*P*	Odds ratio	*P*	Odds ratio	*P*	Odds ratio	*P*
Age (years)†	1·01 (0·97, 1·04)	0·666	1·00 (0·94, 1·07)	0·914	0·97 (0·93, 1·02)	0·209	1·02 (0·99, 1·05)	0·223
Sex (M *versus* F)	0·96 (0·40, 2·31)	0·933	0·71 (0·16, 3·17)	0·656	1·06 (0·29, 3·87)	0·925	1·11 (0·45, 2·74)	0·818
BMI (kg/m^2)†	1·07 (0·95, 1·20)	0·273	–*		0·94 (0·81, 1·10)	0·424	0·91 (0·81, 1·02)	0·115
MPI score†	1·05 (0·97, 1·14)	0·229	0·87 (0·75, 1·02)	0·097	1·11 (0·99, 1·24)	0·078	0·98 (0·91, 1·05)	0·559
ASA grade†	0·73 (0·42, 1·25)	0·172	2·86 (1·21, 6·76)	0·016	1·77 (0·80, 3·90)	0·157	1·55 (0·85, 2·81)	0·153
Previous abdominal surgery (yes *versus* no)	–*		0·55 (0·11, 2·91)	0·484	–*		–*	
Previous diverticulitis (yes *versus* no)	0·39 (0·16, 0·93)	0·034	0·49 (0·09, 2·69)	0·411	–*		0·71 (0·33, 1·54)	0·390
WSES score		0·029		0·294				
2A–2B *versus* 1	0·15 (0·04, 0·62)		0·14 (0·01, 1·91)		–*		–*	
≥ 3 *versus* 1	0·30 (0·08, 1·10)		0·51 (0·05, 4·88)		–*			
≥ 3 *versus* 2A–2B	–*		–*		1·40 (0·46, 4·25)	0·552		
Interval between admission and surgery (h)†	–*		–*		–*		1·04 (1·02, 1·07)	0·001
Adhesiolysis (extensive *versus* limited or none)	3·17 (1·30, 7·78)	0·012	4·03 (0·95, 17·10)	0·059	1·47 (0·36, 5·98)	0·587	–*	
Lavage volume (litres)†	–*		–*		1·20 (0·94, 1·52)	0·136	1·13 (0·95, 1·34)	0·165
Identification of free colonic perforation (yes *versus* no)	–		35·39 (7·38, 169·66)	< 0·001	1·55 (0·38, 6·30)	0·540	3·26 (1·17, 9·14)	0·024
Duration of surgery (per 15-min increase)	–*		–*		1·71 (1·33, 2·20)	< 0·001	1·68 (1·36, 2·08)	< 0·001

Values in parentheses are 95 per cent confidence intervals. MPI, Mannheim Peritonitis Index; WSES, World Society of Emergency Surgery. *Removed from the model because does not contribute to overall significance ($P > 0·800$) or not strictly clinically relevant. †Odds ratios are per unit increase.

Table 4 In-hospital complications and reoperations after laparoscopic lavage in 212 patients

			Type of reoperation			
	Complications	Reoperation for complications	Stoma	Resection without stoma	Lavage or drainage	Adhesiolysis
Overall	70 (33·0)	29 (13·7)	18 (8·5)	7 (3·3)	3 (1·4)	1 (0·5)
Diffuse peritonitis	14 (6·6)	14 (6·6)	10 (4·7)	4 (1·9)		
Persisting sepsis	15 (7·1)	6 (2·8)	4 (1·9)	1 (0·5)	1 (0·5)	
Persisting perforation	5 (2·4)	3 (1·4)	3 (1·4)			
Bowel occlusion	6 (2·8)	2 (0·9)		1 (0·5)		1 (0·5)
Abdominal collection or pelvic abscess	6 (2·8)	3 (1·4)		1 (0·5)	2 (0·9)	
Bleeding	1 (0·5)					
Other complications	23 (10·8)	1 (0·5)	1 (0·5)			
Pulmonary	8 (3·8)					
Superficial-site infection	4 (1·9)					
Cardiovascular	3 (1·4)					
Cancer	1 (0·5)	1 (0·5)	1 (0·5)			
Other, minor	7 (3·3)					

Values in parentheses are percentages.

Recurrence

Overall median follow-up was 22·4 (95 per cent c.i. 6·6 to 54·0) months. Among the 172 patients (74·5 per cent) discharged uneventfully after LL, a recurrent episode of AD was recorded in 46 (26·7 per cent). The mean time to recurrence was 11 (range 2–108) months. The median time to recurrence was not reached, but the time by which 25 per cent of patients had an episode of recurrent AD was 15 months. When AD recurred, Hinchey stage was I in 35 patients, II in two patients, III in seven patients, IV in one patient and unknown for one patient. Twenty-one patients underwent further

Table 5 Results of multivariable logistic regression to identify factors associated with events after discharge in patients who had laparoscopic lavage

	60-day morbidity (21 of 184 patients)		60-day reoperation (11 of 184 patients)		Recurrence* (46 of 172 patients)	
	Odds ratio	*P*	Odds ratio	*P*	Odds ratio	*P*
Age (years)‡	0·96 (0·92, 1·01)	0·156	1·01 (0·94, 1·09)	0·757	0·95 (0·90, 0·99)	0·023
Sex (M *versus* F)	0·78 (0·20, 3·02)	0·715	0·22 (0·02, 2·17)	0·194	0·32 (0·11, 0·93)	0·036
BMI (kg/m^2)‡	1·02 (0·87, 1·20)	0·798	1·39 (1·04, 1·87)	0·026	0·95 (0·82, 1·10)	0·477
MPI score‡	1·16 (1·03, 1·29)	0·012	1·25 (1·02, 1·54)	0·035	0·98 (0·89, 1·07)	0·630
ASA grade‡	–†		0·56 (0·15, 2·05)	0·380	1·40 (0·66, 2·95)	0·382
Previous abdominal surgery (yes *versus* no)	0·36 (0·09, 1·46)	0·153	0·07 (0·01, 0·94)	0·045	2·27 (0·90, 5·80)	0·086
Previous diverticulitis (yes *versus* no)	0·30 (0·08, 1·13)	0·075	0·13 (0·02, 1·00)	0·049	3·36 (1·33, 8·49)	0·011
WSES score		0·213				0·088
2A–2B *versus* 1	1·65 (0·16, 16·65)		–†		9·65 (0·82, 113·15)	
≥ 3 *versus* 1	0·63 (0·06, 6·65)		–†		4·17 (0·39, 44·83)	
Interval between admission and surgery (h)‡	–†		1·00 (0·99, 1·01)	0·646	–†	
Adhesiolysis (extensive *versus* limited or none)	2·29 (0·54, 9·71)	0·261	3·25 (0·26, 40·60)	0·360	0·31 (0·07, 1·40)	0·129
Lavage volume (litres)‡	–†		–†		0·92 (0·72, 1·17)	0·505
Identification of free colonic perforation (yes *versus* no)	1·39 (0·33, 5·89)	0·653	4·03 (0·55, 29·50)	0·170	–†	
Duration of surgery (per 15-min increase)	0·92 (0·69, 1·24)	0·597	0·64 (0·38, 1·07)	0·091	0·89 (0·67, 1·19)	0·437
Duration of postoperative hospital stay (days)‡	–†		–†		1·10 (0·97, 1·25)	0·155
30-day morbidity (yes *versus* no)	0·67 (0·17, 2·58)	0·559	0·31 (0·02, 3·94)	0·366	0·37 (0·08, 1·73)	0·207

Values in parentheses are 95 per cent confidence intervals. MPI, Mannheim Peritonitis Index; WSES, World Society of Emergency Surgery. *Patients who had laparoscopic lavage as first operation, no reoperation (resection or stoma), and excluding patients who died within 60 days after discharge. †Removed from the model because does not contribute to overall significance ($P > 0·800$) or not strictly clinically relevant. ‡Odds ratios are per unit increase.

Table 6 Results of multivariable logistic regression analysis to identify factors associated with failure of laparoscopic lavage

	Odds ratio	*P*
BMI (kg/m^2)*	1·06 (0·94, 1·19)	0·323
MPI score (≥ 24 *versus* < 24)	2·79 (1·07, 7·28)	0·036
ASA grade*	1·84 (1·08, 3·12)	0·025
Previous abdominal surgery (yes *versus* no)	0·47 (0·20, 1·11)	0·084
Previous diverticulitis (yes *versus* no)	0·35 (0·15, 0·82)	0·016
WSES score		0·430
2A–2B *versus* 1	0·56 (0·11, 2·71)	
≥ 3 *versus* 1	0·94 (0·21, 4·32)	
Interval between admission and surgery (h)*	1·00 (0·99, 1·00)	0·397
Adhesiolysis (extensive *versus* limited or none)	2·94 (1·14, 7·59)	0·026
Identification of free colonic perforation (yes *versus* no)	5·87 (2·51, 13·74)	< 0·001

Values in parentheses are 95 per cent confidence intervals. MPI, Mannheim Peritonitis Index; WSES, World Society of Emergency Surgery. Odds ratios were adjusted for age and sex. *Odds ratios are per unit increase.

surgery. Multivariable analysis for recurrence showed age (OR 0·95; $P = 0·023$), male sex (OR 0·32; $P = 0·036$) and absence of previous AD events (presence *versus* absence: OR 3·36; $P = 0·011$) to be favourable prognostic factors (*Table 5*).

Discussion

The criteria for LL as successful treatment for purulent peritonitis have not yet been standardized. The LL approach is accomplished successfully when it can be completed technically, does not increase surgical mortality[11], is able to control sepsis without further operative management, and avoids a permanent stoma[12,13]. Even secondary surgery for recurrence of diverticulitis after resolution of the index surgical episode might be considered a long-term failure of LL. However, recurrent AD in the long term may be hardly related to the index event, but more likely linked to the natural history of the disease.

According to the above definitions, the overall success rate of LL in patients with Hinchey III peritonitis ranged from 52 to 92 per cent in prospective studies and RCTs[3,6,7,12]. In the present study, the success rate was 74·5 per cent, confirming that a high proportion of patients may benefit from this approach to overcome acute peritonitis-related sepsis.

It would be helpful clinically to identify reliable criteria to help surgeons select patients with Hinchey III AD for LL with a high probability of success in controlling sepsis. Previous studies[14–16] with smaller sample sizes and different outcomes identified ASA grade at least III and chronic use of immunosuppressants as independent predictors of LL failure.

In the present study, free perforation, extensive adhesiolysis, high ASA grade and MPI scores, and absence of previous diverticulitis, were associated with increased failure rates. Although only one of these findings (adhesiolysis) is modifiable, the others predict risk and contribute to the preoperative decision-making process. Consequently, a fit patient with previous AD and without severe sepsis might be the best candidate for LL.

The intraoperative conversion rate in this study was 8·2 per cent, compared with 2–5 per cent in previous RCTs[5–7,17]. Predictors of intraoperative conversion were higher ASA grade and the identification of a free perforation.

The complication rate was high at 33·0 per cent, but 59 per cent of these patients were managed without reoperation. Higher morbidity rates were associated with preoperative delay and increased duration of surgery, and intraoperative identification of free perforation.

Four patients (1·9 per cent) died a median of 6 days after surgery. Postoperative mortality was associated with increasing age, higher ASA grade and MPI score, suggesting that the surgical procedure may be less relevant. Although other studies[1,4,5,18–29] reported no deaths, the rate in the present multicentre study is similar to that in other trials (1·4 per cent[15], 1·6 per cent[2]) and lower than that reported in previous cohort studies and RCTs (3–6·7 per cent)[3,5–7,13,30–33].

The 30-day reintervention rate for complications was 13·7 per cent, with most patients requiring further surgery for ongoing sepsis; resection with or without a stoma was performed in 25 patients (11·8 per cent). In the literature, the 30-day postoperative reintervention rate ranges from 0 per cent[1,21,22,24,25] to 34·3 per cent (2·9 per cent[20], 6·4 per cent[14], 6·7 per cent[29], 9·5 per cent[2], 13·2 per cent[13], 14·3 per cent[4], 16·9 per cent[15] and 34·3 per cent[18]), with a mean of 5·0 per cent[12]. In previous studies, the stoma rate after LL varied widely, ranging from 0 to 24 per cent. The rate of 9·9 per cent here is comparable to that in RCTs and substantially lower than that following resection[33–35].

The LL-associated risk of misdiagnosing a perforated cancer was emphasized after concerning evidence from the LADIES trial[7] (10 per cent), but it remains anecdotal in other reports.

Although the volume of lavage fluid did not influence outcomes, extensive adhesiolysis in this cohort was significantly associated with a higher rate of free perforation and also a higher failure rate of LL. This technical aspect has not been investigated previously, and different methods of adhesiolysis have been used in observational studies[12] and RCTs[5–7,17,34,35]. The association between free perforation and previous episodes of diverticulitis and adhesiolysis suggests that adhesiolysis may transform a covered perforation into a free one. Consequently, the authors recommend that adhesiolysis should be avoided. The intraoperative assessment of free perforation should rely on careful visual inspection and manipulation of the affected colon[36], possibly supported by other tools, such as flexible sigmoidoscopy and a hydropneumatic test if doubt persists. This would also allow the presence of an underlying colonic malignancy to be excluded.

Some 26·7 per cent of patients had a long-term relapse of AD after LL, with a higher risk for young patients, women and those with previous episodes of diverticulitis. Most relapses (37 of 46) involved Hinchey I and II AD. The duration of follow-up in this study does not allow further inferences and comparison with other long-term data[31]. If confirmed by others, however, factors increasing the risk of relapse in these series might be used to help individual decision-making for elective resection[37–39].

The present study population is the broadest described so far on this issue. An additional strength of this study is its pragmatic real-world assessment, without defined protocols of a large multicentre series of patients undergoing LL, and outcomes comparable to those of most previous studies. A possible limitation is the widely variable number of patients enrolled by each surgical centre. This variability reflects different criteria and attitudes in selection of patients for LL (such as age and general condition), indications for intraoperative conversion, emergency and/or laparoscopic surgical skill, and the LL technique itself. Further limitations of this study are its retrospective design and the lack of a control group that could reveal a selection bias among patients with Hinchey III disease undergoing LL.

These findings suggest that LL without extensive adhesiolysis should be considered as a reasonable first step in the treatment of a fair number of patients presenting with Hinchey III diverticulitis, keeping in mind that the presence of a free visible perforation, high ASA grade, high MPI score and absence of history of diverticulitis are significant risk factors for failure of LL, and possible indications for resection.

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