Int J Clin Exp Med 2015;8(8):13045-13055
www.ijcem.com /ISSN:1940-5901/IJCEM0009326

Original Article

Diverting stoma with anterior resection for rectal cancer: does it reduce overall anastomotic leakage and leaks requiring laparotomy?

Zhi-Jie Cong[1,2], Liang-Hao Hu[2], Ming Zhong[1], Lu Chen[1]

[1]*Department of General Surgery, Colorectal Surgery Team, Ren Ji Hospital, School of Medicine, Shanghai Jiao Tong University, Shanghai, China;* [2]*Digestive Endoscopy Center, Changhai Hospital, Second Military Medical University, Shanghai, China*

Received April 19, 2015; Accepted August 3, 2015; Epub August 15, 2015; Published August 30, 2015

Abstract: Anastomotic leakage (AL) after resection for rectal carcinoma accelerates morbidity and mortality rates, extends hospital stay, and increases treatment costs, particularly when requiring laparotomy. The role of a protective diverting stoma (DS) in avoiding leakage has repeatedly been discussed, but prospective randomized studies on this subject are rare and their results contradictory. The MEDLINE database was searched for studies of AL requiring laparotomy and of the associated rate of protective DSs in initial anterior resection (AR) to review these studies systematically. The collected data were used to determine the average rate of AL requiring laparotomy after rectal cancer surgery in the DS group compared with that in the non-DS group. A total of 930 abstracts were retrieved from MEDLINE; 15 articles on AR and 22 on low/ultralow AR (LAR) were included in the review and analysis. The overall rate of AL requiring laparotomy was 6.57% (813/12, 376) in the AR studies and 4.13% (157/3, 802) in the LAR studies. In the AR studies, the pooled AL rate in the DS group was higher than that in the non-DS group (12.30% vs. 9.16%, $P < 0.001$). However, the pooled rate of AL requiring laparotomy in the DS group was lower than that in the non-DS group (3.69% vs. 7.42%, $P < 0.001$). In the LAR studies, the pooled AL rate in the DS group was lower than that in the non-DS group (7.74% vs. 9.64%, $P = 0.045$). The pooled rate of AL requiring laparotomy in the DS group was also lower than that in the non-DS group (2.67% vs. 5.21%, $P < 0.001$). By contrast, the pooled rate of definitive stomas and mortality caused by AL did not have any statistical difference between the DS and non-DS groups in both AR studies (definitive stomas: 0% vs. 0.65%; mortality: 0.95% vs. 1.19%) and LAR studies (definitive stomas: 1.03% vs. 1.01%; mortality: 0.35% vs. 0.36%). Protective DSs significantly decrease the rate of AL in LAR. AL requiring surgical correction was significantly reduced in the DS group in both AR and LAR studies. Protective DSs did not affect the definitive stomas and mortality rate; this lack of an effect warrants further high-quality clinical trials.

Keywords: Anastomotic leakage, diverting stoma, anterior resection, rectal cancer, complication

Introduction

Advances in surgical procedures and concepts, such as total mesorectal excision (TME), have dramatically increased the proportion of sphincter-saving procedures as the treatment of choice for rectal cancer patients. Simple and easy reconstruction has been facilitated by circular stapling devices, even in low-level anastomosis within a narrow pelvis. However, increased risk of anastomotic leakage (AL) is associated with sphincter-saving procedures. Clinically manifest anastomotic leaks are observed after 1-21 percent of resections for rectal carcinoma [1, 2]. The mortality rate associated with symptomatic anastomotic leaks varies between 6 and 22 percent [3]. The role of a protective diverting stoma (DS) in avoiding this serious complication has repeatedly been discussed, but prospective randomized studies on this subject are rare and their results contradictory. Several authors have also argued that the stoma only mitigates the consequences of a leakage but does not lower the leakage rate itself [4].

This study aimed to systematically review studies of AL requiring laparotomy and the associated rate of DSs in initial anterior resection (AR) for rectal cancer. We gathered relevant data

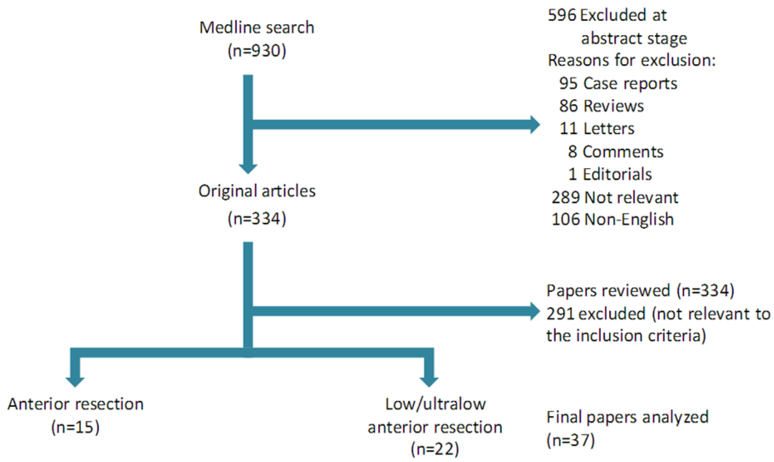

Figure 1. Literature search, review, and analysis (From January 2000 to December 2012).

from these studies and determined the average rate of ALs requiring laparotomy after rectal cancer surgery in the DS group compared with that in the non-DS group. Given the impact of TME and stapling devices on AL, only studies using these techniques after the year 2000 were included in this review.

Methods

Definition of AL

The International Study Group of Rectal Cancer defines AL as a defect in intestinal wall integrity at the colorectal or coloanal anastomotic site, including the suture and staple lines of neorectal reservoirs. This defect leads to communication between the intra- and extra-luminal compartments. A pelvic abscess near the anastomosis is also considered AL [5]. In the systematic review, we used the number of ALs as defined in the study. Regarding the difference in impact and consequences for a patient, clinically relevant AL should be distinguished from radiologic leakage. In this review, we assessed clinical anastomotic leakage.

Literature search and selection strategy

Relevant studies published between January 2000 and December 2012 were identified from the MEDLINE search results. The following search terms were used: (rectum OR rectal OR proctectomy) AND (leakage OR failure OR integrity OR insufficiency OR breakdown OR defect OR separation OR dehiscence). Additional relevant articles were obtained from the citations in the publications identified by the initial search. Publications in English that met the following criteria were included in the review: availability of data on (i) laparotomic or laparoscopic sphincter-saving resection for rectal cancer, (ii) DS and non-DS groups, and (iii) the subsequent management of AL, including conservative treatment or laparotomy. Studies of preoperative chemoradiation therapy were excluded from the analysis, as were those that used single-access laparoscopic or robot-assisted surgery. Two authors (C. ZJ and H. LH) independently reviewed each of the included studies and extracted data from them. Any discrepancies were resolved by discussion. To increase the sensitivity of the search strategy, the reference lists of the retrieved literature were manually cross-searched for additional relevant publications.

Data extraction and analysis strategy

We used the number of ALs according to their definition in the studies. The selected studies were grouped into two: AR and low/ultralow AR (LAR). The pooled AL rates of the DS and non-DS groups in each group of studies were compared. Similarly, the data on AL requiring laparotomy for the DS and non-DS groups in each group were compared. When available, data on patients with AL managed by permanent colostomy or Hartmann's procedure and on the mortality rate associated with AL were also extracted and compared between the two groups.

Statistical analysis

The relative frequencies were statistically analyzed through the chi-squared test in SPSS 13.0 for Windows (SPSS, Chicago, Illinois, USA). A two-sided P value of < 0.05 was considered statistically significant.

Results

Bibliometrics

A total of 930 abstracts were retrieved from MEDLINE from January 1, 2000, to December

Table 1. Detail of reoperation from 26 studies with 434 patients of AL

No (%)	Reoperation
29 (6.68%)	Only drainage
266 (61.29%)	Only diverting stomas*
3 (0.69%)	Drainage and repair anastomosis
61 (14.06%)	Drainage with stoma†
2 (0.46%)	Repair anastomosis via the anus
2 (0.46%)	Repair anastomosis via the anus with stoma
2 (0.46%)	Reconstruct anastomosis
6 (1.38%)	Reconstruct anastomosis with stoma
21 (4.84%)	Permanent end colostomy
38 (8.76%)	Hartmann's procedure
4 (0.92%)	Abdominoperineal resection

*Including 139 for loop ileostomy, 44 for loop colostomy, and 83 unspecified. †Including 6 for loop ileostomy, 7 for loop colostomy, and 48 unspecified.

5, 2012. Among these articles, 106 non-English articles and 289 non-relevant English articles with no or minimal association with AL were excluded. More articles (201) were excluded after the downloaded abstracts were examined according to the criteria in **Figure 1**. A total of 334 full papers were examined, 291 of which were rejected because of irrelevance. The final analysis included 37 studies: 15 AR studies [4, 6-19] and 22 LAR studies [20-41].

The selected studies

Thirty-seven studies of the rate of DSs and AL requiring laparotomy after AR or LAR were analyzed. The included studies had a total population of 16,178 patients. The sample sizes of the studies varied from 27 to 2,729 patients. No clear, applicable criteria for DS construction were stipulated in any of the included studies, and the DS construction decision was made by the surgeon in each study except in three randomized controlled trials [8, 26, 27]. Twenty studies reported a total of 2,069 DS cases: loop ileostomy (1628, 78.69%), loop transverse colostomy (366, 17.69%), and percutaneous ileostomy (75, 3.62%).

Fourteen studies reported a total of 124 AL cases cured by conservative treatment: 23 (18.54%) by transanal drainage, 21 (16.94%) by endoscopic drainage, 14 (11.29%) by computed tomography (CT)-guided/percutaneous drainage, 44 (35.48%) by drain irrigation, and 22 (17.74%) by conservative antibiotherapy.

Twenty-six studies reported a total of 434 AL patients who underwent reoperation. The detail of reoperation was described in **Table 1**. The rate of temporary stomas was 77.65%, and definitive stomas, such as permanent stomas, Hartmann's procedure, and abdominoperineal resection, made up only 14.52% of all ALs requiring surgical re-intervention.

Incidence of ALs and ALs requiring laparotomy

The 15 AR studies had a total of 12,376 patients. The number of patients per study confirmed to have anastomotic leaks ranged from 6 to 390 (1,222 in total). The overall rate of AL was 9.87%. The highest AL rate reported was 19.23%, whereas the lowest was 2.52% (**Figure 2**). The number of patients per study confirmed to have AL requiring laparotomy ranged from 3 to 218 (813 in total). The overall rate of AL requiring laparotomy was 6.57%; in other words, 66.53% (813/1222) of AL patients required surgical correction. The highest rate of AL requiring laparotomy was 11.97%, whereas the lowest was 2.52% (**Figure 2**).

The 22 LAR studies had a total of 3,802 patients. The number of patients per study confirmed to have anastomotic leaks ranged from 2 to 51 (338 in total). The overall rate of AL was 8.89%. The highest AL rate reported was 20.59%, whereas the lowest was 1.89% (**Figure 3**). The number of patients per study confirmed to have AL requiring laparotomy ranged from 0 to 26 (157 in total). The overall rate of AL requiring laparotomy was 4.13%; in other words, 46.45% (157/338) of AL patients required surgical correction. The highest rate of AL requiring laparotomy was 17.65%, whereas the lowest was 0% (**Figure 3**).

DS vs. non-DS group in AR

AL rate: The 15 AR studies had a total of 2820 patients with a DS (ranging from 0 to 881). The overall rate of DS was 22.79%. The highest DS rate reported was 56.60%, whereas the lowest was 0%. Interestingly, the pooled AL rate in the DS group was 12.30% (347/2820), higher than that in the non-DS group (9.16%, 875/9556). The difference between these rates was statistically significant ($P < 0.001$).

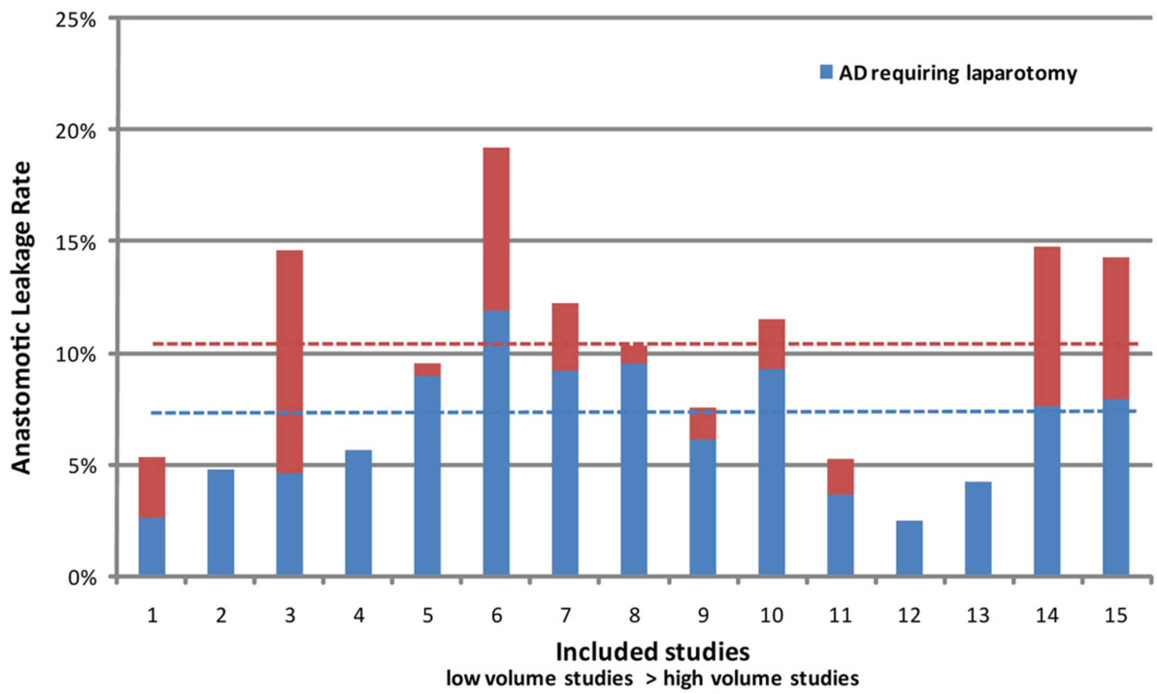

Figure 2. Rates of anastomotic leakage and anastomotic leakage requiring laparotomy in AR studies.

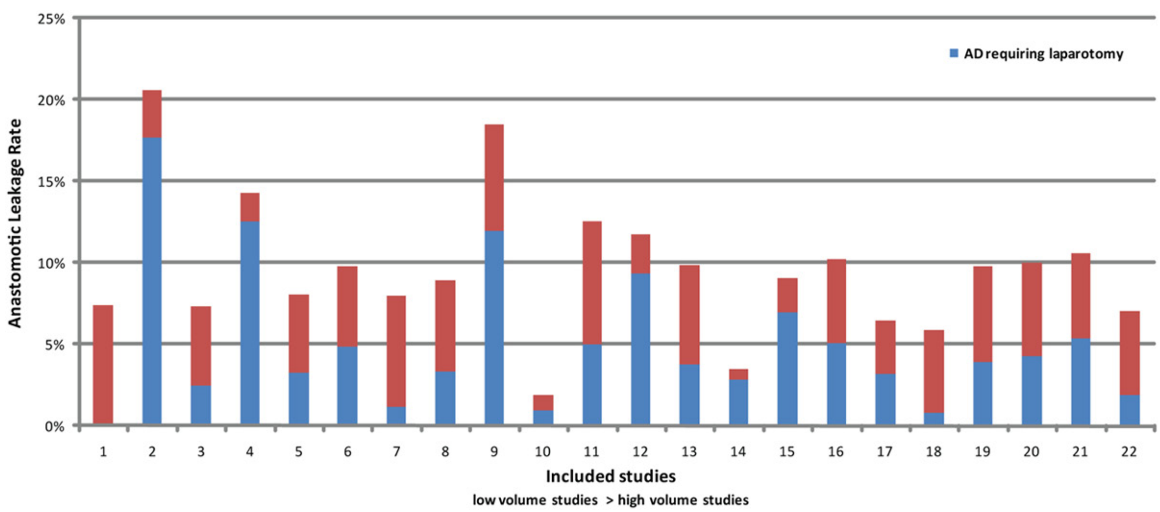

Figure 3. Rates of anastomotic leakage and anastomotic leakage requiring laparotomy in LAR studies.

Rate of AL requiring laparotomy: The pooled rate of AL requiring laparotomy in the DS group was 3.69% (104/2820), significantly lower than that in the non-DS group (7.42%, 709/9556) ($P < 0.001$). Only 29.97% (104/347) of the AL cases in the DS group needed surgical re-intervention, whereas the proportion in the non-DS group was as high as 81.03% (709/875). The AL rates in patients with or without a DS in the 15 AR studies are described and compared in **Table 2**.

Definitive stoma after AL: For patients with AL requiring re-operation, a permanent stoma, Hartmann's procedure, or abdominoperineal resection was usually considered the possible definitive stomas that led poor quality of life. In eight AR studies that reported the re-operation procedures for AL between the groups, the overall number of patients in the DS group was 315, and AL requiring re-operation occurred in three patients, none of whom developed a definitive

Table 2. Rate of anastomotic leakage in patients with or without diverting stoma in AR studies

Author	Year	Study Design	Patients (n)	Anastomotic Leakage			AL Requiring Laparotomy		
				DS (%)	Non-DS (%)	*P*	DS (%)	Non-DS (%)	*P*
Bittorf B	2003	-	150	14 (18.18%)	8 (10.96%)	.211	1 (1.30%)	6 (8.22%)	.044
Matthiessen P	2004	Retrospective	432	11 (15.28%)	42 (11.67%)	.393	2 (2.78%)	37 (10.28%)	.042
Gastinger I	2005	Prospective	2729	128 (14.53%)	262 (14.18%)	.806	32 (3.63%)	186 (10.06%)	< .001
Vlot EA	2005	-	144	-	7 (4.86%)		-	7 (4.86%)	
Peeters KC	2005	Retrospective	924	43 (8.22%)	64 (15.96%)	< .001	26 (4.97%)	60 (14.96%)	< .001
Ptok H	2007	-	2044	125 (15.78%)	178 (14.22%)	.331	39 (4.92%)	118 (9.42%)	< .001
Matthiessen P	2007	RCT	234	12 (10.34%)	33 (27.97%)	< .001	0 (0%)	28 (23.73%)	< .001
Eberl T	2008	Retrospective	472	4 (3.64%)	45 (12.43%)	.008	2 (1.82%)	44 (12.15%)	.001
Jung SH	2008	Retrospective	1391	0 (0%)	35 (2.62%)	.228	0 (0%)	35 (2.62%)	.228
Choi DH	2010	Prospective	178	1 (4.55%)	16 (10.26%)	.393	0 (0%)	16 (10.26%)	.115
Shin US	2010	-	1838	-	79 (4.30%)		-	79 (4.30%)	
Lin JK	2011	Retrospective	821	8 (5.52%)	35 (5.18%)	.867	2 (1.38%)	35 (5.18%)	.045
Chen W	2011	-	750	0 (0%)	57 (7.65%)	.519	0 (0%)	46 (6.17%)	.566
Zhao WT	2012	-	158	-	9 (5.70%)		-	9 (5.70%)	
Yamamoto S	2012	Prospective	111	1 (4.35%)	5 (5.68%)	.801	0 (0%)	3 (3.41%)	.369
Total			12,376	347 (12.30%)	875 (9.16%)	< .001	104 (3.69%)	709 (7.42%)	< .001

AL, anastomotic leakage; DS, diverting stoma; RCT, randomized controlled trial.

Table 3. Rate of anastomotic leakage in patients with or without diverting stoma in LAR studies

Author	Year	Study Design	Patients (n)	Anastomotic Leakage			AL Requiring Laparotomy		
				DS (%)	Non-DS (%)	*P*	DS (%)	Non-DS (%)	*P*
Law WI	2000	Prospective	196	5 (4.85%)	15 (16.13%)	.009	0 (0%)	10 (10.75%)	< .001
Nesbakken A	2001	-	92	5 (17.24%)	12 (19.05%)	.835	1 (3.45%)	11 (17.46%)	.063
Z'graggen K	2001	-	41	3 (7.32%)	-		1 (2.44%)	-	
Ho YH	2002	-	88	7 (7.95%)	-		1 (1.14%)	-	
Leester B	2002	Retrospective	249	7 (9.46%)	9 (5.14%)	.204	0 (0%)	8 (4.57%)	.061
Marusch F	2002	Prospective	482	16 (10.81%)	35 (10.48%)	.913	3 (2.03%)	23 (6.89%)	.029
Kanellos I	2002	-	82	-	8 (9.76%)		-	4 (4.88%)	
Eckmann C	2004	-	306	-	30 (9.80%)		-	12 (3.92%)	
Vorobiev GI	2004	-	27	2 (7.41%)	-		0 (0%)	-	
Chamlou R	2007	-	90	8 (8.89%)	-		3 (3.33%)	-	
Chude GG	2008	RCT	256	3 (2.21%)	12 (10.00%)	.008	0 (0%)	4 (3.33%)	.031
Lefebure B	2008	Retrospective	132	3 (7.14%)	10 (11.11%)	.476	0 (0%)	5 (5.56%)	.119
Ulrich AB	2009	RCT	34	1 (5.56%)	6 (37.50%)	.021	0 (0%)	6 (37.50%)	.004
Peng J	2010	-	639	-	45 (7.04%)		-	12 (1.88%)	
Akasu T	2010	Retrospective	120	14 (13.21%)	1 (7.14%)	.519	6 (5.66%)	0 (0%)	.361
Kruschewski M	2011	-	128	15 (11.72%)	-		12 (9.38%)	-	
Shiomi A	2011	Retrospective	329	9 (7.50%)	24 (11.48%)	.246	1 (0.83%)	13 (6.22%)	.019
Fouda E	2011	-	56	1 (5.88%)	7 (17.95%)	.235	0 (0%)	7 (17.95%)	.061
Glancy DG	2012	-	144	5 (8.93%)	8 (9.09%)	.973	5 (8.93%)	5 (5.68%)	.454
Biondo S	2012	-	106	2 (1.89%)	-		1 (0.94%)	-	
Rondelli F	2012	-	143	5 (3.50%)	-		4 (2.80%)	-	
Gong H	2012	Retrospective	62	5 (19.23%)	0 (0%)	.006	2 (7.69%)	0 (0%)	.090
Total			3,802	116 (7.74%)	222 (9.64%)	.045	40 (2.67%)	120 (5.21%)	< .001

AL, anastomotic leakage; DS, diverting stoma; RCT, randomized controlled trial.

stoma. In the non-DS group (3536 patients), AL requiring re-operation occurred in 223 patients, 23 of which (0.65%) developed a definitive stoma. However, the difference was not significant (P = 0.151). The proportion of definitive stomas in patients with AL requiring re-operation was zero in the DS group and 10.31% (23/223) in the non-DS group.

Mortality after AL: We also extracted the number of postoperative mortalities caused by AL as defined in the studies between the two groups. In 10 AR studies that met the criteria, the overall number of patients in the DS group was 1680; AL occurred in 314 patients, 16 of which died because of AL. The number of patients in the non-DS group was 5,272, and AL occurred in 676 patients, 63 of which died. Therefore, the rate of mortality caused by AL in the DS and non-DS groups was 0.95% (16/1680) and 1.19% (63/5272), respectively, with no significant difference (P = 0.413).

DS vs. non-DS group in LAR

AL rate: The 22 LAR studies had a total of 1498 patients with DS (ranging from 0 to 148). The overall rate of DS was 39.4%. The highest DS rate reported was 100%, whereas the lowest was 0%. The pooled AL rate in the DS group was 7.74% (116/1498), lower than that in the non-DS group (9.64%, 222/2304); the difference was statistically significant (P = 0.045).

Rate of AL requiring laparotomy: As to AL requiring laparotomy, the pooled rate in the DS group (2.67%, 40/1498) was also much lower than that in the non-DS group (5.21%, 120/2304), with a significant difference (P < 0.001). Only 34.48% (40/116) of those with AL in the DS group required surgical re-intervention, whereas the proportion in the non-DS group was as high as 54.05% (120/222). The AL rates in patients with or without a DS in the 22 LAR studies are described and compared in **Table 3**.

Definitive stoma after AL: In 13 LAR studies that reported the re-operation procedures for AL between the groups, the overall number of patients in the DS group was 679; AL requiring re-operation occurred in 21 patients, 7 of which (1.03%) developed a definitive stoma. In the non-DS group, which had a total of 1683 patients, AL requiring re-operation occurred in 79 patients, 17 of which (1.01%) developed a definitive stoma. The difference in the incidence of definitive stomas was not significant (P = 0.963). However, the proportion of definitive stomas in patients with AL requiring re-operation was higher in the DS group (33.33%, 7/21) than in the non-DS group (21.52%, 17/79).

Mortality after AL: Twenty-one LAR studies obtained the rate of mortalities caused by AL between the two groups. The overall number of patients in the DS group was 1442; AL occurred in 111 patients, 5 of which died because of AL. The number of patients in the non-DS group was 2226; AL occurred in 214 patients, 8 of which died. Therefore, the rate of mortality caused by AL in the DS and non-DS groups was 0.35% (5/1442) and 0.36% (8/2226), respectively, with no significant difference (P = 0.949).

Discussion

Leakage accelerates the morbidity and mortality rates, extends hospital stay, and increases treatment costs, particularly when requiring laparotomy. Leakage is also associated with postoperative local recurrence and functional results and influences long-term outcomes [19, 38, 42-44]. Therefore, AL has become an urgent problem among colorectal surgeons.

Patients with AL requiring laparotomy are often in critical condition, presenting most often with purulent/fecal drains and markedly increased parameters of infection (e.g., leukocytosis and C-reactive proteins). These patients usually have abdominal pain and fever and develop signs of peritonitis (e.g., tenderness to palpation, abdominal wall rigidity, and tachycardia). Imaging studies, such as of CT with transrectal instillation of contrast, reveal considerable leakage at the anastomotic site with fluid collection in the pelvis. With significant clinical sepsis after rectal anastomosis, infection control should meet three requirements: drainage of the infected material, eradication of the source of infection, and prevention of recurrent sepsis [45, 46]. The source of infection may be removed from AL by diverting colostomy or Hartmann's procedure. If such operative re-intervention is delayed or not performed, the clinical conditions of the patient deteriorate and ultimately result in sepsis with clinical signs of hypothermia, leukopenia, and organ failure.

AL development depends on numerous factors. AL occurs in medically fragile patients, after a technically difficult operation, or with intraoperative adverse events. However, AL also occurs in patients with no obvious risk factors [47]. The difficulty in predicting AL, including in patients considered at low risk, has generated several studies aiming to identify risk factors [8, 48-50]. One risk factor found by retrospective studies with multivariable analysis is the absence of a DS [16, 51].

Fecal diversion in rectal cancer surgery is an old concept. To minimize the risk of clinical leakage, the construction of a DS seems useful for patients with distal rectal cancer. As a result, routine DS is usually recommended when risk factors for AL are present. However, this recommendation is not universally accepted [3, 47, 52, 53] because closing a protective DS indicates additional surgery, admission to a hospital, and a risk of complications and death [54, 55]. However, many surgeons feel that they would harm their patients by abandoning a protective DS.

The role of a protective DS in avoiding AL and its related complications has repeatedly been discussed. Theoretically, a DS is constructed to divert the fecal stream from a healing anastomotic site and protect fragile such sites. However, whether diverting the fecal stream in itself directly prevents AL remains unconfirmed, and the necessity of a protective DS remains controversial because of the lack of data from large randomized controlled trials. The results of rat studies on this subject are similarly contradictory [56-58]. Other prospective and retrospective studies also had different conclusions. Some studies found that the absence of a DS was a risk factor for leakage in LAR. In Peeters et al. [16], for instance, 9% of defunctioned patients leaked, compared with the 24% of those not defunctioned. Other studies found that the stoma does not lower the leakage rate but only mitigates the consequences of a leakage [18-21, 38]. The rate of AL requiring surgical intervention is significantly reduced by a protective stoma provided after LAR [20]. The overall rate of AL is also not influenced by the presence of a DS, although patients with a stoma developed significantly fewer leaks that required surgical correction [4]. Thus, several authors suggest that a protective DS does not prevent AL itself but only mitigates the consequence of the AL.

Our review revealed that a DS can reduce the rate of AL requiring laparotomy. The pooled proportion of ALs requiring laparotomy was lower in the LAR studies (46.45%) than in the AR studies (66.53%) probably because of the higher DS rate in the former (39.40%) than in the latter (22.79%). The relationship was more obvious when the rate of AL requiring laparotomy in the DS group was compared with that in the non-DS group. In the AR studies, the proportion of re-laparotomy in AL patients with a DS (29.97%) was much lower than that in AL patients without a DS (81.03%). The same observation was made in the LAR studies (34.48% in DS vs. 54.05% in non-DS). The rate of AL requiring laparotomy in the DS group was significantly lower than that in the non-DS group, in both the AR studies (3.69% in DS vs. 7.42% in non-DS, $P < 0.001$) and the LAR studies (2.67% in DS vs. 5.21% in non-DS, $P < 0.001$).

As to the protective effect of a DS on reducing the overall AL rate, our findings revealed that the AL rate in the LAR studies was significantly reduced (7.74% in DS vs. 9.64% in non-DS, $P = 0.045$). Interestingly, in the AR studies, the overall rate of AL in the DS group was unexpectedly higher than that in the non-DS group (12.30% in DS vs. 9.16% in non-DS, $P < 0.001$). However, because of the general selection bias of most of the non-randomized studies in our review, we cannot conclude whether a DS can prevent overall leakage. This selection bias resulted from the selective creation of a protective DS based on the subjective judgment of surgeons for predicting “risky” anastomoses to minimize potential consequences. Therefore, the protective effect of a DS might even be greater than what our results imply. Another bias is the incidence of asymptomatic ALs that might have been missed in either group because anastomoses in clinically stable patients were not systematically assessed in nearly all the studies. Therefore, estimating the overall percentage of AL patients that benefit from a DS is difficult, but ALs requiring laparotomy can be estimated without this bias.

The protective effect of a DS on reducing AL requiring laparotomy is confirmed by our review. However, can this evidence justify the creation of a routine DS despite associated additional surgery, admission to hospital, risk of complications and death, and additional costs? We propose that reducing AL requiring laparotomy is not enough to prove the value of a DS. Our results show that 33.47% of ALs in the AR studies and 53.55% of those in the LAR studies were cured by conservative treatment, such as drainage placement and irrigation. Even for AL requiring laparotomy, most patients may be treated with only an ileostomy or colostomy. Only 14.52% of patients required an emergency operation to sever the anastomosis and create a terminal stoma and a Hartmann's pouch because of post-AL pelvic sepsis after AL, which may affect the quality of life of the patient in the future. Therefore, we should focus on the protective effect of a DS on reducing definitive stomas and AL-associated mortality.

We extracted and compared data on the definitive stomas and AL-associated mortality of the DS and non-DS groups. No cases of definitive stoma were found in the DS group in the eight AR studies, whereas the non-DS group had a rate of 0.65%; however, the difference was not statistically significant (P = 0.151). The same result was obtained in 22 LAR studies (1.03% vs. 1.01%, P = 0.963). The rate of AL-associated mortality in the 10 AR studies did not have significant difference between the DS and non-DS groups (0.95% vs. 1.19%, P = 0.413) either. The same result was obtained in 21 LAR studies (0.35% vs. 0.36%, P = 0.963). However, few studies have focused on these endpoints to evaluate the value of a DS; therefore, the pooled data were too limited to allow a definitive conclusion. More studies about the DS in relation to this topic are recommended for future research.

This article is limited by the source of the publications reviewed. All abstracts were retrieved from MEDLINE, and non-English language papers were excluded from the final analysis. A formal meta-analysis will provide more powerful evidence; the methodology used in this study was not as powerful as a meta-analysis. However, our systematic review provides data consolidated directly from original publications on the rate of AL requiring laparotomy between DS and non-DS groups.

In conclusion, DSs, as a mode of fecal diversion, significantly decreased the rate of AL in LAR studies. AL requiring surgical correction was significantly reduced in the DS group in both AR and LAR studies. However, a protective DS did not affect the definitive stoma and mortality rates; this lack of an effect warrants further high-quality trials because the data were too limited to produce powerful evidence on the subject. Considering the morbidity and mortality associated with DSs and the uncertain effect of DSs on reducing definitive stomas and mortality, DSs should be used only in situations of intra-operative difficulty, for lower rectal carcinomas, and in patients with poor general health conditions.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Lu Chen, Department of General Surgery, Ren Ji Hospital, School of Medicine, Shanghai Jiao Tong University, 1630 Dongfang Road, Shanghai 200127, P. R. China. Tel: +86-21-68383985; E-mail: chenlu_65@126.com

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