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## ORIGINAL ARTICLE

# Stenosis of the colorectal anastomosis after surgery for diverticulitis: A national retrospective cohort study

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## Abstract

**Aim:** The aim of this work was to investigate the association between early postoperative anastomotic leakage or pelvic abscess (AL/PA) and symptomatic anastomotic stenosis (SAS) in patients after surgery for left colonic diverticulitis.

**Method:** This is a retrospective study based on a national cohort of diverticulitis surgery patients carried out by the Association Française de Chirurgie. The assessment was performed using path analyses. The database included 7053 patients operated on for colonic diverticulitis, with surgery performed electively or in an emergency, by open access or laparoscopically. Patients were excluded from the study analysis where there was (i) right-sided diverticulitis (the initial database included all consecutive patients operated on for colonic diverticulitis), (ii) no anastomosis was performed during the first procedure or (iii) missing information about stenosis, postoperative abscess or anastomotic leakage.

**Results:** Of the 4441 patients who were included in the final analysis, AL/PA occurred in 327 (4.6%) and SAS occurred in 82 (1.8%). AL/PA was a significant independent factor associated with a risk for occurrence of SAS (OR=3.41, 95% CI=1.75–6.66), as was the case for diverting stoma for  $\geq 100$  days (OR=2.77, 95% CI=1.32–5.82), while central vessel ligation proximal to the inferior mesenteric artery was associated with a reduced risk (OR=0.41; 95% CI=0.19–0.88). Diverting stoma created for  $< 100$  days or  $\geq 100$  days was

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also a factor associated with a risk for AL/PA (OR=3.08, 95% CI=2–4.75 and OR=12.95, 95% CI=9.11–18.50). Interestingly, no significant association between radiological drainage or surgical management of AL/PA and SAS could be highlighted.

**Conclusion:** AL/PA was an independent factor associated with the risk for SAS. The treatment of AL/PA was not associated with the occurrence of anastomotic stenosis. Diverting stoma was associated with an increased risk of both AL/PA and SAS, especially if it was left for  $\geq 100$  days. Physicians must be aware of this information in order to decide on the best course of action when creating a stoma during elective or emergency surgery.

#### KEYWORDS

anastomotic leakage, anastomotic stenosis, diverticulitis, pelvic abscess, surgery

## INTRODUCTION

Colonic diverticulitis occurs in 209 out of 100 000 adults every year [1] and leads to elective or emergency surgery in 3 in 100 000 and 2 in 100 000 adults, respectively, per year [2, 3]. Surgical intervention for diverticulitis continues to increase [2], but surgery for left-sided diverticulitis can lead to serious early complications such as anastomotic leak (AL) (2%–2.7%) or intra-abdominal pelvic abscess (PA) (1.3%–4.3%) in the case of elective surgery [4, 5] and 0%–4% and 3%–10%, respectively, in the case of emergency surgery [6]. To limit the consequences of such complications, especially those linked to AL, researchers have devised a risk score to predict AL and therefore propose a diverting stoma with mitigating results [7].

The treatment of intra-abdominal collections presents three therapeutic options, including simple antimicrobial therapy and surgical management [8]. Interventional drainage (percutaneous drainage) can also be used as a treatment, but its indications are not homogeneous [8]. It seems, however, to remain a safe and effective alternative to surgical management [9, 10].

Despite a lack of scientific proof, AL and intra-abdominal PA are believed to be risk factors for anastomotic stenosis [11]. This last complication is a late complication of surgery for left-sided diverticulitis and is reported in 2%–17.6% of cases [12–14]. Risk factors for such complications are poorly known, and as anastomotic stenosis seems to occur more often than AL and intra-abdominal PA [15, 16], there is an urgent need to confirm the belief that these complications are linked. Also, in order to better prevent or treat anastomotic stenosis, better knowledge of its risk factors is required. Indeed, we hypothesize that radiological drainage may be associated with anastomotic stenosis because it does not permit anastomotic revision and would therefore lead to fibrosis or hypoperfusion in the region of the anastomosis.

The main aim of this study was to investigate the association between early postoperative AL or PA and symptomatic anastomotic stenosis (SAS) in patients who have undergone elective and emergency surgery for left colon diverticulitis. The secondary aim was to assess whether the treatment of AL/PA is associated with SAS.

### What does this paper add to the literature?

Anastomotic leakage and anastomotic stenosis are two complications that occur after surgery for diverticulosis. These two complications are independent, and the treatment of leakage does not influence the occurrence of stenosis. However, a diverting stoma left for  $\geq 100$  days may be associated with an increased risk of stenosis.

## METHOD

### Setting

This is a database analysis of a retrospective nationwide cohort study including all consecutive patients who have been operated on by open or laparoscopic surgery for left-sided diverticulitis with anastomosis between 1 January 2010 and 31 December 2021. The database was compiled by the Association Française de Chirurgie (French Association for Surgery, AFC) and included 7053 patients operated on for left colonic diverticulitis, electively or in an emergency department, in 41 French centres (34 of which are academic centres).

Information in the database was collected by an investigator at each centre. The investigators were responsible for the correctness of the data collected.

Patients from the database were excluded from the study analysis where there was (i) right-sided diverticulitis (as the initial database included all the consecutive patients operated on for colonic diverticulitis), (ii) no anastomosis performed during the first procedure or (iii) missing information about stenosis, postoperative abscess or AL. This database was approved by the national committee for information and liberty (CNIL no. 920361).

### Outcome measures

The main outcome measure was the occurrence of SAS, usually defined by its clinical repercussions (i.e. impaired functional outcomes

and/or obstructed defaecation) associated with the inability to traverse the anastomosis with the index finger [17] for mid or low colorectal anastomosis or the inability to traverse the anastomosis with a paediatric colonoscope for high colorectal anastomosis. Colonoscopy was performed only if patients experienced clinical signs of stenosis.

AL and intra-abdominal PA were clinically suspected and confirmed using CT scan within 90 postoperative days.

The other recorded data included patients' demographics, history of acute diverticulitis, clinical presentation and surgical procedures, duration of follow-up and short- and long-term postoperative outcomes.

Patients were routinely clinically examined 45 days after each surgery. Endoscopy was not systematically performed during the follow-up.

## Statistical analysis

Continuous data are described using mean and standard deviation, and compared using Student's *t*-test; categorical data are described using effectiveness and percentages, and compared using chi-square tests. Univariate logistic regressions were performed to provide ORs.

The relationship between stenosis, complications and the considered set of potential covariates [obstruction, stoma performed during the first surgery, smoking, transfusion, Hinchey score, age (categorized a priori as <70 years or ≥70 years), emergencies and inferior mesenteric vessel ligation at its origin] was evaluated using path analyses. Path analysis is a statistical method that aims to identify which of a number of causal pathways links a given set of covariates and a specified outcome [18, 19]. This method is effective for distinguishing direct from indirect effects and testing the strength of hypothesized patterns of causal relationships. The question arose as to whether these considered covariates were directly responsible for stenosis, regardless of the occurrence of complications, or were purely responsible for complications, which may lead to a risk of stenosis. In the first case, even if no complication were to occur, these covariates should raise fears of the occurrence of stenosis. In the second case, these fears can be heightened in the absence of complications. Path analyses are based on a closed system of nested relationships among variables, built as a set of structured statistical regression equations. In our model, the explained covariables (stenosis and complications) being dichotomous, we considered equation models with logit link functions.

Complete path analyses were performed, in which each covariate could explain both stenosis and complications, and complications could be responsible for stenosis. This model was performed to identify significant patterns of relationships and pathways and was, in the end, illustrated through a path diagram, which is a directed graph in which the different covariates are linked by arrows indicating the directions of the causal relationships between them. These analyses required the same assumptions as for classical regression – with additional restrictions linked to the considered pattern of relations among variables.

The analyses were performed using MPlus 6.1 software, considering a type I error threshold set at 0.05.

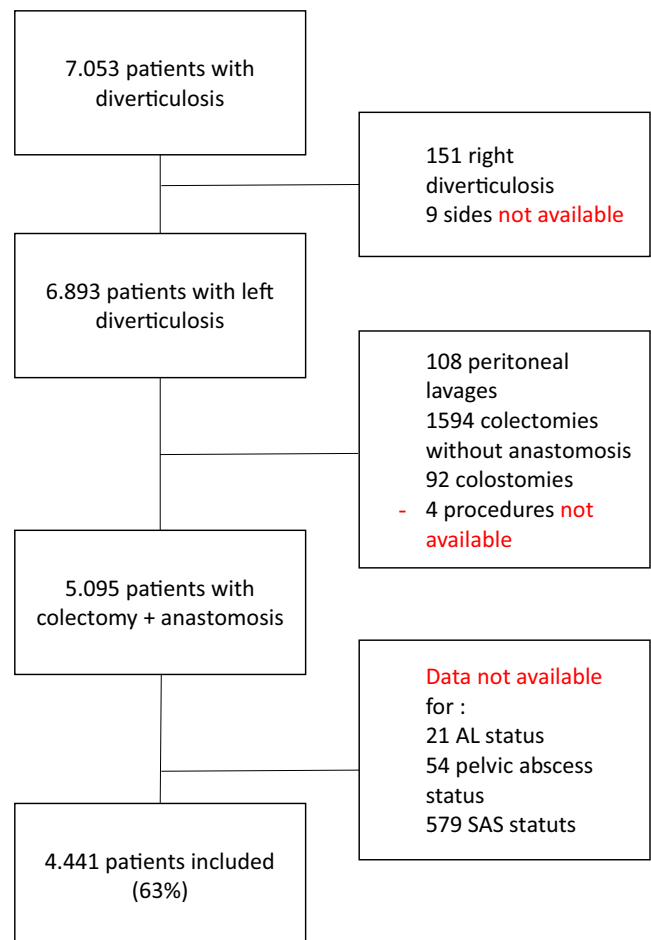
## RESULTS

A total of 7053 patients were registered in the database, of whom 151 were excluded owing to having right-sided as opposed to left-sided diverticulitis (2.1%) and nine were excluded where the side affected by diverticulitis was not known (0.1%). Another 108 patients were excluded because they had undergone lavage (1.5%), 1594 patients were excluded because they had undergone a colectomy without anastomosis (22.6%) and 92 because they had been treated with a colostomy (1.3%). The surgical procedure was not recorded for four patients (Figure 1).

Information on AL was missing for 21 patients (0.3%), information on PA was missing for 54 (0.7%) and information on stenosis was missing for 579 patients (8.2%). In the end, 4441 patients were included in the database study (63%).

### Postoperative PA and AL

AL/PA occurred in 327 patients (4.6%). These complications were associated in univariate analysis with a medical history of lung and cardiological diseases ( $p < 0.01$ ) and of diabetes ( $p < 0.01$ ).



**FIGURE 1** Flow chart of our population (AL, anastomotic leak; SAS, symptomatic anastomotic stenosis).

Anticoagulation and antiplatelet medications were also associated with PA and AL (Table 1).

Interventions made in an emergency were also associated with PA and AL ( $p < 0.01$ ), as well as preoperative colonic obstruction ( $p < 0.01$ ), a high Hinchey classification grade ( $p < 0.01$ ), conversion to open surgery ( $p < 0.01$ ) and performance of a diverting stoma ( $p < 0.01$ ) (Table 1).

## Anastomotic stenosis

Anastomotic stenosis occurred in 82 patients (1.84%) in a median follow-up of 11–15 months. Interventions made for obstruction ( $p = 0.02$ ) and in which a diverting stoma ( $p \leq 0.01$ ) was performed were associated with the occurrence of stenosis in univariate analysis (Table 2). The mean duration of the surgical procedure was longer in those patients in whom stenosis occurred than in patients with no stenosis ( $230.5 \pm 105.9$  min vs.  $207.6 \pm 90.6$  min, respectively;  $p = 0.09$ ). Patients who had experienced a AL and/or PA were more likely to experience stenosis [ $n = 20/327$  (6.1%)] than those who did not experience AL [ $62/4114$  (1.5%)] ( $p \leq 0.01$ ).

## Relationship between AL and/or PA and anastomotic stenosis and their associated factors

The complete path analysis was performed considering all possible relationships between stenosis, complications and the considered list of covariates as described in Figure 2A. Of those, the covariates that could be significantly highlighted are illustrated in Figure 2B and Table 3. Diverting stoma was left for a median of 101 days (interquartile range 72–162 days).

In multivariate analysis, the only covariate independently significantly associated with complications was a diverting stoma  $< 100$  days and  $\geq 100$  days (OR = 3.08, 95% CI = 2–4.75 and OR = 12.95, 95% CI = 9.11–18.50, respectively). Several covariates were, however, significantly associated with stenosis, such as central vessel ligation proximal to the inferior mesenteric artery (associated with reduced complications) (OR = 0.41, 95% CI = 0.19–0.88), AL/PA (OR = 3.41, 95% CI = 1.75–6.66) and diverting stoma  $\geq 100$  days itself (OR = 2.77, 95% CI = 1.32–5.82) (both associated with increased complications).

Having a stoma was therefore an independent factor associated with both complications and stenosis, meaning that a stoma was still a risk factor for stenosis even if no complications occurred.

## Relationship between anastomotic stenosis and the treatment of AL and/or PA

Neither percutaneous drainage nor surgical management as treatments for PA and/or AL were significantly associated with the risk for anastomotic stenosis (OR = 0.27, 95% CI = 0.03–2.12 and OR = 0.60, 95% CI = 0.24–1.49, respectively) (Table 4).

## DISCUSSION

Among the 4441 patients who underwent surgery for left-sided diverticulitis in the retrospective cohort study, AL/PA occurred in 327 (4.6%) and SAS in 82 (1.84%). AL/PA was significantly associated with the risk for occurrence of anastomotic stenosis, as was diverting stoma left for  $< 100$  days or  $\geq 100$  days, while central vessel ligation proximal to the inferior mesenteric artery was a factor associated with a reduced risk. Diverting stoma left for  $\geq 100$  days was also associated with a risk for AL/PA. Interestingly, radiological drainage or surgical management of AL/PA was not associated with SAS.

Our results are in accordance with the literature, which reports the occurrence of AL/PA in 0%–10% [4–6] and SAS in 2%–17.6% of patients surgically treated for left-sided diverticulitis [12–14]. The low rate of anastomotic stenosis in our study can probably be explained by the fact that only SAS was included. This may represent a bias by lowering the rate of occurrence of SAS. The bias was addressed by aiming to analyse the association between early complications and only SAS, as it was considered that SAS would benefit from clinical examination. In a recent study on diverticulitis surgery patients with systematic colonoscopy performed 3 months after the surgery, it was reported that 20% of patients with anastomotic stenosis are asymptomatic and that the most important symptom is constipation [20]. Considering that 20% of anastomotic stenoses are asymptomatic in our cohort, the rate of anastomotic stenosis would be 2.2%, as reported in literature. Furthermore, low rates of anastomotic stenosis have been reported in retrospective studies [14], while prospective studies in which specific endoscopy was performed highlighted much higher rates [12, 13, 21].

Our study is in accordance with the literature advocating that central vessel ligation proximal to the inferior mesenteric artery may be protective against SAS [22, 23] but also confirms the understanding that AL/PA is a risk factor for SAS [11] by showing a significant independent correlation between AL/PA and SAS in multivariate analysis. This information is clinically important, because it raises the question of the treatment of AL/PA. Indeed, considering that the inflammation resulting from septic complications leads to SAS, it would be questionable to propose radiological drainage or a simple antimicrobial treatment because neither permits a complete revision of the anastomosis. Interestingly, our results suggest that the treatments used in current indications are safe and effective with regard to the risk of SAS. However, this result should be considered with caution because of the high rate of missing data. In the literature, if percutaneous drainage is clearly recommended in cases of pelvic abscess due to Hinchey II diverticulitis [24, 25] indications for drainage in cases of septic complication after surgery must be standardized [8, 26].

Finally, through a path analysis, our study highlights that creation of a diverting stoma was associated with both AL/PA and SAS, independently of the occurrence of AL/PA. Regarding AL/PA, the association between postoperative morbidity and diverting stoma in diverticulitis surgery has already been highlighted [27]. This may be

**TABLE 1** Univariate analysis comparing the group of patients with no anastomotic leakage/pelvic abscess and patients with anastomotic leakage/pelvic abscess.

	No AL/PA (n = 4114)	AL/PA (n = 327)	p	OR	95% CI
Mean BMI (kg/m <sup>2</sup> )	27.3 ± 6.2	27.2 ± 6.2	0.93	1.00	0.96–1.04
Gender, male	2070 (50.32%)	174 (53.37%)	0.29	0.88	0.71–1.11
Mean age (years)	58.3 ± 13.1	59.3 ± 13.8	0.20	1.01	1.00–1.01
Age ≥70years				1.32 <sup>a</sup>	1.01–1.72 <sup>a</sup>
Medical history of neurological disease	369 (9.23%)	34 (10.66%)	0.40	0.85	0.59–1.23
Medical history of cardiological disease	1369 (34.17%)	143 (44.83%)	<0.01	0.64	0.51–0.80
Medical history of lung disease	632 (15.77%)	70 (21.88%)	<0.01	0.67	0.51–0.88
Medical history of diabetes	315 (7.84%)	41 (12.81%)	<0.01	0.58	0.41–0.82
Smoker	859 (24.20%)	100 (34.01%)	<0.01	0.62	0.48–0.80
Immunosuppression	341 (8.50%)	35 (10.87%)	0.14	0.76	0.53–1.1
Medical history of open surgery	522 (13.22%)	52 (16.67%)		0.76	0.56–1.04
Medical history of diverticulitis	3552 (87.51%)	272 (84.47%)	0.11	1.29	0.94–1.77
Medical history of complicated diverticulitis	2122 (54.02%)	179 (56.83%)	0.34	0.89	0.71–1.12
Number of episodes of acute diverticulitis	2.1 ± 1.9	1.9 ± 1.8	0.29	0.96	0.90–1.03
Emergency surgery	544 (13.22%)	66 (20.18%)	<0.01	1.66	1.25–2.21
Indication for surgery					
Smouldering diverticulitis	1717 (41.75%)	116 (35.47%)	0.06	(ref)	
Acute complication	2292 (55.73%)	197 (60.24%)		1.27	1.00–1.61
Immunosuppression	83 (2.02%)	11 (3.36%)		1.96	1.02–3.78
Haemorrhage	21 (0.51%)	3 (0.92%)		2.11	0.62–7.19
Hinchey grade					
1	3524 (85.85%)	259 (79.69%)	<0.01	(ref)	
2	326 (7.94%)	34 (10.46%)		1.42	0.97–2.06
3	211 (5.14%)	22 (6.77%)		1.42	0.90–2.24
4	44 (1.07%)	10 (3.08%)		3.09	1.54–6.22
Obstruction	201 (4.90%)	33 (10.09%)	<0.01	2.18	1.48–3.21
Surgical access					
Laparoscopy	3068 (74.65%)	194 (59.33%)	<0.01	(ref)	
Conversion to open	348 (8.47%)	43 (13.15%)		1.95	1.38–2.77
Open surgery	674 (16.40%)	88 (26.91%)		2.06	1.58–2.69
Robot	20 (0.49%)	2 (0.61%)		1.58	0.37–6.81
Blood cell transfusion	43 (1.22%)	10 (3.31%)	<0.01	0.36	0.18–0.72
Splenic flexure mobilization	3141 (82.85%)	264 (85.44%)	0.24	1.21	0.87–1.68
Central vessel ligation proximal to the IMA	943 (27.10%)	65 (22.97%)	0.13	0.80	0.60–1.07
Diverting stoma	637 (15.48%)	171 (52.29%)	<0.01	5.98	4.74–7.55
Drainage	1958 (50.37%)	190 (59.75%)	<0.01	1.46	1.16–1.84

Abbreviations: AL/PA, anastomotic leakage/pelvic abscess; BMI, body mass index; IMA, inferior mesenteric artery.

<sup>a</sup>OR calculated for age >70years.

due to the fact that the decision to create a stoma is made in more severe cases of peritonitis in patients at risk of AL and PA. Indeed, many articles have highlighted that a stoma does not reduce the risk of AL but does reduce the severity of the consequences of such a leak [16].

Regarding SAS, this association has not already been highlighted. The only risk factor for anastomotic stenosis after

diverticulitis surgery reported in the literature is older age [20]. This last piece of information is clinically significant, because diverting stoma is independently associated with AP/AL and anastomotic stenosis. This raises the question of the need for this type of stoma. A meta-analysis conducted since the relationship between age and anastomotic stenosis following diverticulitis surgery was reported did not even prove its role in reducing postoperative



**TABLE 2** Univariate analysis comparing the group of patients with no anastomotic stenosis and patients with anastomotic stenosis.

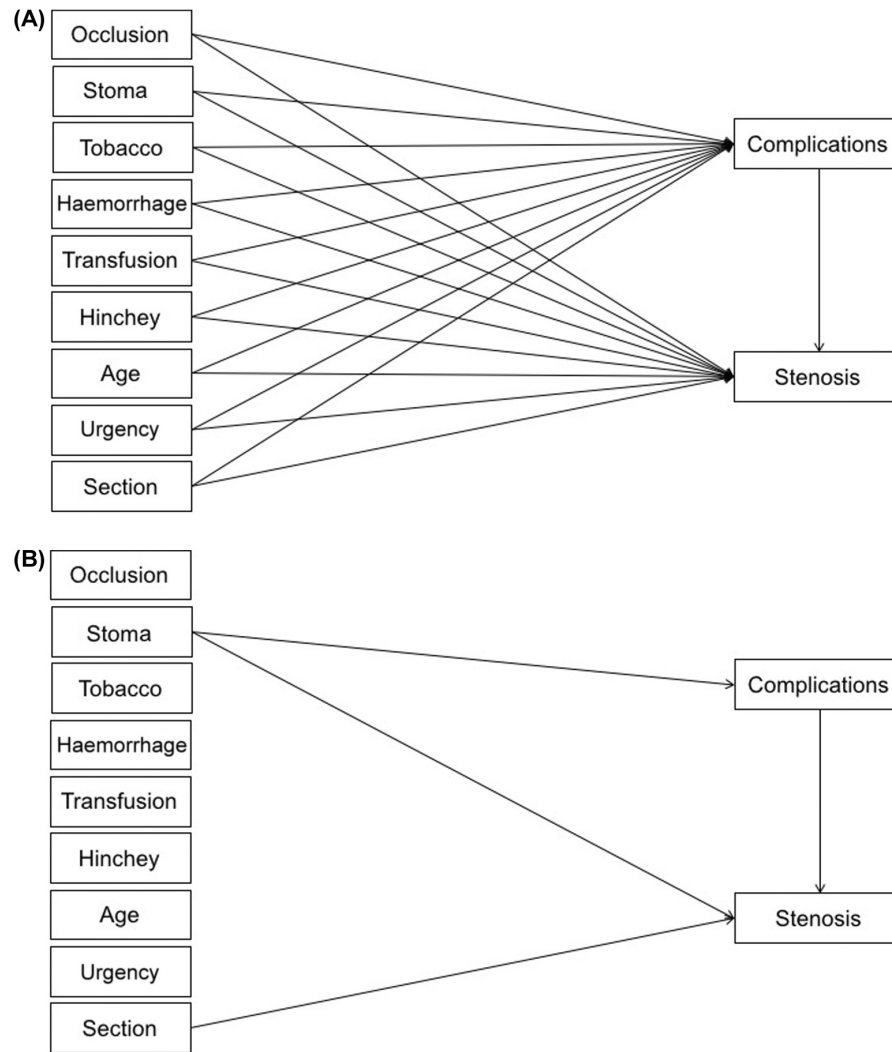
	No anastomotic stenosis (n = 4359)	Anastomotic stenosis (n = 82)	p	OR	95% CI
Mean BMI (kg/m <sup>2</sup> )	27.2 ± 6.1	27.3 ± 8.2	0.95	1.00	0.92–1.09
Gender, male	2203 (50.55%)	41 (50.00%)	0.92	1.02	0.66–1.58
Mean age (years)	58.4 ± 13.1	57.1 ± 12.1	0.37	0.99	0.98–1.01
Age ≥70 years				0.72 <sup>a</sup>	0.39–1.33 <sup>a</sup>
Medical history of neurological disease	395 (9.32%)	8 (9.88%)	0.86	0.94	0.45–1.96
Medical history of cardiological disease	1483 (34.94%)	29 (35.80%)	0.87	0.96	0.61–1.52
Medical history of lung disease	687 (16.18%)	15 (18.52%)	0.57	0.85	0.48–1.50
Medical history of diabetes	348 (8.18%)	8 (9.88%)	0.58	0.81	0.39–1.70
Smoker	937 (24.86%)	22 (29.73%)	0.34	0.78	0.47–1.29
Immunosuppression	369 (8.67%)	7 (8.75%)	0.97	0.99	0.45–2.17
Medical history of open surgery	562 (13.44%)	12 (15.00%)	0.68	0.76	0.56–1.04
Medical history of diverticulitis	3749 (87.19%)	75 (92.59%)	0.15	0.54	0.24–1.26
Medical history of complicated diverticulitis	2258 (54.23%)	43 (54.43%)	0.97	0.99	0.63–1.55
Number of episodes of acute diverticulitis	2.07 ± 1.89	2.02 ± 1.56	0.83	0.99	0.875–1.11
Emergency surgery	600 (13.76%)	10 (12.20%)	0.68	0.87	0.447–1.69
Indication for surgery					
Smouldering diverticulitis	1800 (41.30%)	33 (40.24%)	0.91	(ref)	
Acute complication	2442 (56.03%)	47 (57.32%)		1.05	0.67–1.64
Immunosuppression	92 (2.11%)	2 (2.44%)		1.19	0.28–5.02
Haemorrhage	24 (0.55%)	0 (0.00%)			
Hinchey grade					
1	3713 (85.40%)	70 (85.37%)	0.73	(ref)	
2	352 (8.10%)	8 (9.76%)		1.21	0.57–2.53
3	229 (5.27%)	4 (4.88%)		0.93	0.33–2.56
4	54 (1.24%)	0 (0.00%)			
Obstruction	225 (5.17%)	9 (10.98%)	0.02	2.26	1.12–4.57
Fistula	426 (9.77%)	8 (9.76%)	0.99	1.00	0.48–2.08
Mean duration of the procedure (min)	207.6 ± 90.5	230.5 ± 105.9	0.09	1.00	1.00–1.00
Surgical access					
Laparoscopy	3207 (73.64%)	55 (67.07%)	0.37	(ref)	
Conversion to open	380 (8.73%)	11 (13.41%)		1.69	0.88–3.25
Open surgery	746 (17.13%)	16 (19.51%)		1.25	0.71–2.19
Robot	22 (0.51%)	0 (0.00%)			
Splenic flexure mobilization	3347 (83.13%)	58 (78.38%)	0.28	0.73	0.42–1.29
Central vessel ligation proximal to the IMA	995 (26.94%)	13 (18.57%)	0.12	0.62	0.34–1.13
Diverting stoma	776 (17.80%)	32 (39.02%)	<0.01	2.95	1.88–4.64
Drainage	2101 (50.91%)	47 (60.26%)	0.10	1.46	0.92–2.31
Blood cell transfusion	52 (1.38%)	1 (1.37%)	0.99	0.99	0.13–7.26
AL/PA	307 (7.04%)	20 (24.39%)	<0.01	4.26	2.54–7.14

Abbreviations: AL/PA, anastomotic leakage/pelvic abscess; BMI, body mass index; IMA, inferior mesenteric artery.

<sup>a</sup>OR calculated for age >70 years.

morbidity in patients undergoing left-sided colon resection and anastomosis for diverticulitis [28], while another highlighted the fact that it could reduce the risk of reoperation [29]. The World

Society of Emergency Surgery guidelines for the management of acute colonic diverticulitis in the emergency setting recommend that primary resection with anastomosis with or without a



**FIGURE 2** (A) Path diagram corresponding to the statistical model performed. (B) Path diagram illustrating the significant pathways.

diverting stoma should be performed, with low-quality evidence (2B) [25]. Moreover, not creating a diverting stoma should be considered an option, owing to the risk of negative functional outcomes [30] when a stoma is created. However, this last consideration should be taken in account with caution because the reason for keeping the stoma for  $\geq 100$  days was not reported in the study. This represents a bias, because keeping a stoma for more than 100 days is not usual and may be associated with any parameter such as having chronic AL.

Our study has some limitations inherent in its retrospective methodology. Causality is difficult to investigate in a retrospective study. Although it was attempted to correct for possible confounders, there are probably more confounding factors that are difficult to evaluate. Also, as reported above, the definition of SAS is made retrospectively and is therefore limited by the symptomatic characteristic. This outcome measure is a survival outcome, and survival analysis of this parameter would have been more appropriate. Unfortunately, the design of the study did not include collection of

the date of occurrence of such a complication, but only whether it occurred. Also, many patients underwent elective surgery that is now not recommended routinely. This was because new guidelines on avoiding prophylactic surgery and preferring a tailored patient decision were published in 2017. This may induce a risk of bias that seems limited, as the results exposed are similar to the literature. Finally, the type and height of the anastomosis were not collected, nor the extent of the resection. This could represent a bias because this may be a risk factor for AL/PA or SAS. The recommendations for colorectal anastomosis favour stapled anastomosis but the design of our study cannot confirm that this parameter was observed. Also, the present study reports the occurrence of a clinically significant SAS but the study design did not plan to collect the consequences and the management of such SAS. However, despite this limitation, our study highlights some information that accords with the literature as well as shedding new light that should encourage practitioners to pursue the usual management of AL/PA and to think about the need for a diverting stoma.



	OR	95% CI	p
<b>Stenosis</b>			
Smoker	1.02	0.56–1.83	0.95
Age ≥70years	0.60	0.28–1.30	0.19
Peritonitis (Hinchey score)	0.70	0.35–1.41	0.31
Colon obstruction	1.74	0.69–4.39	0.24
Emergency surgery	0.72	0.23–2.25	0.57
Diverting stoma (Ref. no stoma)			
For <100days	1.38	0.55–3.44	0.49
For ≥100days	2.77	1.32–5.82	<0.01
Blood transfusion	1.19	0.15–9.45	0.87
Central vessel ligation proximal to the IMA	0.41	0.19–0.88	0.02
AL/PA	3.42	1.75–6.66	<0.01
<b>AL/PA</b>			
Smoker	1.23	0.90–1.69	0.20
Age ≥70	0.95	0.67–1.36	0.79
Peritonitis (Hinchey score)	0.83	0.60–1.13	0.24
Colon obstruction	1.29	0.77–2.18	0.34
Emergency surgery	0.60	0.34–1.05	0.08
Diverting stoma (Ref. no stoma)			
For <100days	3.08	2–4.75	<0.01
For ≥100days	12.98	9.11–18.50	<0.01
Blood transfusion	1.82	0.70–1.36	0.22
Central vessel ligation proximal to the IMA	0.85	0.61–1.19	0.36

Abbreviations: AL/PA, anastomotic leakage/pelvic abscess; BMI, body mass index; IMA, Inferior mesenteric artery.

**TABLE 4** Multivariate analysis of the risk of symptomatic anastomotic stenosis according to the treatment of the anastomotic leakage/pelvic abscess.

	OR	95% CI	p
Radiological drainage	0.27	0.03–2.12	0.21
Re-intervention	0.60	0.24–1.50	0.27

## CONCLUSION

AL/PA and SAS were significantly associated. The different treatments for AL/PA did not increase the risk of SAS in their usual indication, but the indication for drainage in postoperative complications has to be homogenized. A diverting stoma left for ≥100days was independently associated with increased risk for both AL/PA and SAS. Physicians have to be aware of this information when considering whether to create a diverting stoma during elective or emergency surgery.

## AUTHOR CONTRIBUTIONS

Guarantor of integrity of the entire study: Jean-Francois Hamel, Aurélien Venara. Study concepts and design: Jean-Francois Hamel, Arnaud Alves, Charles Sabbagh, Aurélien Venara. Literature

**TABLE 3** Path analysis of the factors associated with symptomatic anastomotic stenosis and anastomotic leakage/pelvic abscess.

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## CONFLICT OF INTEREST STATEMENT

Professor Venara declares conflicts of interest with Takeda, Coloplast, ThermoFisher, Biom'up, Sanofi-Aventis (consulting and lecture). The other authors have no conflicts of interest to declare.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ETHICS APPROVAL

This database was approved by the national committee for information and liberty (CNIL no. 920361).

## INFORMED CONSENT

Patients were orally informed that their data could be used for retrospective studies. They were asked to inform the staff if they disagreed with the use of their data.

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