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Title

Factors Associated with Anastomotic Leak After Colostomy Reversal in Northwest Ethiopia: A Retrospective Case–Control Study

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ABSTRACT

Anastomotic leak is a feared complication after gastrointestinal surgery; however, the risk factors following colostomy reversal in low-resource settings remain poorly defined. We conducted an institution-based case–control study at Debre Markos Comprehensive Specialized Hospital, northwest Ethiopia, using data from all patients who underwent colostomy reversal between 1 January 2016 and 31 December 2024. Cases were patients with a documented anastomotic leak during the index hospitalization or within 30 days postoperatively, while controls had no anastomotic leak. Data were extracted using a pretested checklist and analyzed using binary logistic regression. Of 225 eligible patients, 56 (24.9%) developed an anastomotic leak. Factors independently associated with anastomotic leak were residence more than 60 km from the hospital (adjusted odds ratio [AOR] = 8.45, 95% confidence interval [CI]: 3.43–20.83), colostomy duration of less than 3 months (AOR = 2.53, 95% CI: 1.10–5.82), comorbid illness (AOR = 5.15, 95% CI: 1.97–13.49), significant intraoperative adhesions (AOR = 2.73, 95% CI: 1.15–6.49), a short distal stump (AOR = 2.82, 95% CI: 1.18–6.74), iatrogenic bowel injury (AOR = 3.20, 95% CI: 1.09–9.46), failure to pass flatus within 72 hours (AOR = 5.84, 95% CI: 1.63–20.91), and other postoperative complications (AOR = 3.48, 95% CI: 1.03–11.73). Anastomotic leak after colostomy reversal is influenced by patient-related, geographic, intraoperative, and postoperative factors, several of which are modifiable. Preoperative optimization, appropriate timing of reversal, meticulous adhesiolysis, avoidance of bowel injury, careful assessment of the distal stump, and vigilant postoperative monitoring may reduce leak-related morbidity and mortality in similar resource-constrained settings.

Keywords: Anastomotic leak; colostomy reversal; colorectal surgery; surgical outcomes; Ethiopia

1. INTRODUCTION

Colostomy is commonly performed when primary anastomosis is unsafe, particularly in complicated colorectal disease, trauma, obstruction, perforation, or contaminated emergencies. Although fecal diversion may mitigate the consequences of anastomotic leak in high-risk emergency cases, stoma formation carries substantial morbidity and frequently necessitates later reversal surgery[1-3] . Colostomy reversal, also termed stoma closure or takedown, is undertaken once the underlying indication for diversion has resolved and intestinal continuity can be safely restored. The procedure is technically demanding, requiring careful patient selection and preoperative optimization, followed by mobilization of the stoma and distal bowel, adhesiolysis, preparation of healthy bowel ends, and creation of a tension-free, well-vascularized anastomosis using hand-sewn or stapled techniques[4].

Colostomy reversal is associated with considerable postoperative morbidity, with complications reported in approximately 25%–54% of patients. Surgical-site infection is the most frequent complication, followed by ileus or bowel obstruction, wound dehiscence, enterocutaneous fistula, incisional problems, and anastomotic leak (AL). Although less common, mortality remains clinically significant, ranging from 2.2% to 5.7% in reported cohorts [2, 5, 6]. AL is a serious complication of gastrointestinal and colorectal surgery. The International Study Group of Rectal Cancer defines it as a defect at the anastomotic site that permits communication between the intestinal lumen and surrounding tissues; an adjacent pelvic abscess is also classified as AL even when direct communication with the bowel lumen is not demonstrated[1, 3, 7, 8]. Leaks are most commonly diagnosed between 2 and 13 days postoperatively, with the majority presenting within the first week and day 5 being the single most common day of diagnosis.[3, 9, 10]. Clinically, AL can lead to peritonitis, abscess formation, sepsis, reoperation, prolonged hospitalization, and death. Reported incidence varies widely owing to differences in diagnostic definitions, detection methods, surgical settings, and anastomotic location. Across colorectal procedures, leak rates range from approximately 2% to 19%, while leak-related mortality has been reported at 10%–20% in several reviews and Ethiopian studies[4].

AL is a multifactorial complication influenced by patient characteristics, operative factors, and postoperative events rather than by a single determinant. Reported risk factors in colorectal surgery include male sex, obesity or elevated body mass index, diabetes, high American Society of Anesthesiologists (ASA) score, multiple comorbidities, smoking, urgent

or emergency surgery, prolonged operative time, open surgery in some studies, significant blood loss or transfusion, and poor nutritional status, particularly hypoalbuminemia[11]. A study from Tanzania found that delayed passage of stool and flatus was significantly associated with a higher risk of AL after bowel resection and anastomosis; prolonged ileus (delayed bowel function) was among the factors independently associated with AL[12]. However, findings across studies remain inconsistent, and existing risk-prediction models are heterogeneous and imperfect.

Evidence from Ethiopia is limited and has primarily examined colorectal anastomoses in broader surgical populations rather than colostomy reversal specifically. Most evidence regarding AL originates from high-resource colorectal populations, and associated factors specific to colostomy reversal in low-resource settings remain insufficiently studied[4, 13].

Against this background, identifying context-specific associated factors for anastomotic leak after colostomy reversal is essential for improving surgical safety in resource-limited settings. Recognizing high-risk patients may facilitate preoperative optimization, careful operative planning, and closer postoperative monitoring, particularly where specialist care and timely follow-up are limited. Therefore, this study aimed to identify factors associated with anastomotic leak among patients undergoing colostomy reversal at Debre Markos Comprehensive Specialized Hospital in northwest Ethiopia, thereby generating locally relevant evidence to reduce leak-related morbidity, mortality, and healthcare costs[3, 14, 15].

2. METHOD AND MATERIALS

Study design and setting

An institution-based, unmatched case–control study was conducted at Debre Markos Comprehensive Specialized Hospital (DMCSH) in Debre Markos town in northwest Ethiopia. The town is located approximately 295 km northwest of Addis Ababa. DMCSH is a teaching hospital with 300 beds that serves a population of more than five million people. At the time of the study, the hospital had 51 specialist physicians, 63 general practitioners, 386 nurses, and other healthcare and support staff. Its surgical department was staffed by 15 surgeons, 18 general practitioners, 7 anesthetists, and 2 anesthesiologists and had 50 surgical beds for elective and emergency services. Data collection was conducted from April 1 to July 30, 2025, among patients who underwent colostomy reversal at DMCSH between January 1, 2016, and December 31, 2024.

Study population

The source population comprised all patients who underwent colostomy reversal at DMCSH. The study population included patients who underwent colostomy reversal at the hospital during the study period.

Eligibility criteria

Cases were patients who underwent colostomy reversal and had a documented anastomotic leak during the index hospitalization, including patients who died before discharge with clinical or operative evidence of anastomotic leak, or those diagnosed with anastomotic leak within 30 days after surgery. Controls were patients who underwent colostomy reversal during the same study period and had no documented evidence of anastomotic leak during hospitalization or within 30 days after surgery.

Medical records were excluded if they lacked sufficient clinical information, defined as the absence of at least one of the following: a progress note, a discharge summary, or an operative note. This criterion was applied to ensure that outcomes could be reliably determined.

Sample size and sampling procedure

The sample size was calculated using STATCALC in Epi Info version 7.0 (Centers for Disease Control and Prevention, USA), assuming a 95% confidence level, 80% power, and a

case-to-control ratio of 1:3. Calculations based on previously reported associated factors produced sample sizes ranging from 148 to 204 participants; the largest estimate was 51 cases and 153 controls. A 10% allowance for potentially incomplete records yielded a planned sample size of 225.

The sampling frame was prepared using records identified from the hospital Health Information Management System, inpatient records, and operating-theatre logbooks. All eligible cases were included, and controls were randomly selected from eligible patients who underwent colostomy reversal during the same period. After eligibility assessment, 225 records were available for analysis (56 cases and 169 controls).

Study variables

The dependent variable was anastomotic leak after colostomy reversal, categorized as yes or no.

Independent variables included the following:

- **Sociodemographic characteristics:** age, sex, residence, distance from the hospital, and educational status.
- **Preoperative and perioperative factors:** duration of the colostomy, procedure performed during the index operation, indication for colostomy, colostomy site and type, admission vital signs, admission hemoglobin level, American Society of Anesthesiologists (ASA) physical status, comorbidities, prophylactic antibiotic use, and bowel preparation.
- **Intraoperative factors:** duration of surgery, estimated blood loss, intraoperative blood transfusion, iatrogenic bowel injury, adhesion status, condition of the distal bowel stump, surgical approach, anastomotic configuration, and drain placement.
- **Postoperative factors:** passage of flatus within 72 hours, early ambulation, and postoperative complications.

Operational definition

Anastomotic leak: a documented disruption of the bowel anastomosis resulting in leakage of enteric contents, pus, or luminal fluid, diagnosed during the index hospitalization or within 30 postoperative days[7, 16].

Case: Patients who underwent colostomy reversal and had a documented anastomotic leak during the index hospitalization, including patients who died before discharge with clinical or operative evidence of anastomotic leak, or those diagnosed with anastomotic leak within 30 days after surgery.

Control: Patients who underwent colostomy reversal during the same study period and had no documented evidence of anastomotic leak during hospitalization or within 30 days after surgery.

Early postoperative ambulation: Initiation of mobilization within 24–48 hours after colostomy reversal, including sitting upright in bed, dangling the feet over the bedside, standing, or walking with or without assistance[17, 18].

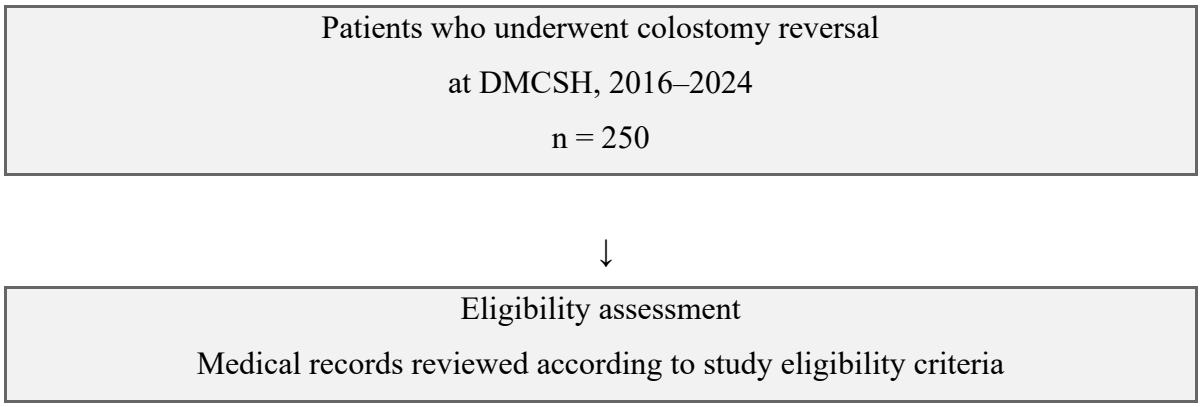
Short distal Stump: a stump of 5 cm or less from the anal verge [19].

ASA Score: The American Society of Anesthesiologists Physical Status Classification System, which categorizes patients according to the severity of their systemic disease from ASA I to ASA VI[20, 21].

Data collection procedures and tools

Patients were identified from the operating theatre logbook using their postoperative diagnosis. Their medical record numbers were recorded, and the corresponding charts were retrieved from the hospital medical records office. Data were extracted using a structured, pretested, English-language data extraction tool adapted from previous comparable studies.

The tool consisted of four sections covering sociodemographic characteristics, preoperative and clinical information, intraoperative details, and postoperative follow-up data. Data were collected by four bachelor's-level nurses under the supervision of the principal investigator.



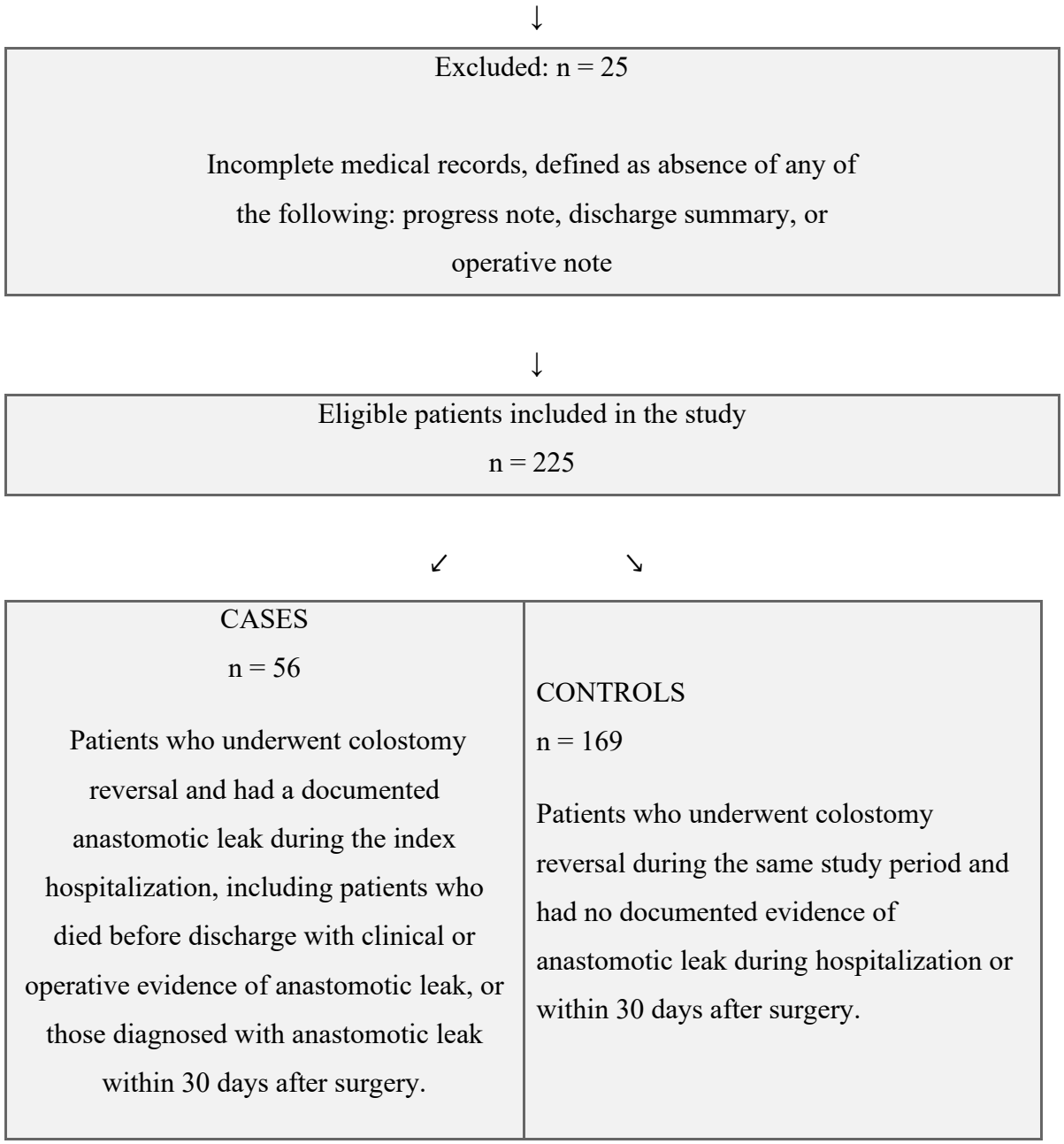


Figure 1. Flow diagram showing patient identification, eligibility assessment, exclusion, and selection of cases and controls for the retrospective case-control study.

Data quality assurance

The data extraction tool was reviewed by two experienced researchers and three surgeons to assess its content and clarity. It was pretested on 5% of the planned sample, and necessary modifications were made before the main data collection. Data collectors received training on the study objectives, medical record review, and use of the extraction tool. The principal

investigator provided continuous supervision and monitored the data collection process for completeness and consistency.

Data processing and analysis

The extracted data were checked for completeness, coded, and entered into EpiData version 4.6. The dataset was then exported to IBM SPSS Statistics version 26 for cleaning and analysis. Cross-tabulations were used to describe the distribution of study variables among cases and controls.

Binary logistic regression was used to estimate crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Variables were considered for multivariable analysis based on subject-matter expertise and bivariable screening; variables with $p < 0.25$ in bivariable analysis and variables considered clinically important a priori were included. Multicollinearity was assessed using the variance inflation factor (VIF), with VIF >10 considered indicative of potential multicollinearity; the mean VIF was 1.46. Model calibration was assessed using the Hosmer–Lemeshow test ($p = 0.80$). All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

The strength of association was reported using crude and adjusted odds ratios with corresponding 95% confidence intervals. Findings are presented using text and tables.

Ethical considerations

Ethical approval for this study was obtained from the Institutional Research Ethics Review Committee (IRERC) of the College of Medicine and Health Sciences, Debre Markos University, Ethiopia (Reference No. RCSTTD/14/11/15). Permission to access the medical records was also obtained from Debre Markos Comprehensive Specialized Hospital.

The requirement for informed consent was waived by the Institutional Research Ethics Review Committee (IRERC) of the College of Medicine and Health Sciences, Debre Markos University, because this study involved a retrospective review of existing medical records and obtaining individual informed consent from all patients was impracticable. All methods were performed in accordance with the relevant guidelines and regulations and in accordance with the principles of the Declaration of Helsinki. Patient names and

other direct personal identifiers were not recorded in the data extraction tool. All data were kept confidential and were used solely for the purposes of this research.

3. RESULTS

3.1 Sociodemographic characteristics of patients

Of the 250 patients who underwent colostomy reversal, 225 (90 %) of them were eligible for our study (56 cases and 169 controls). The mean age of patients was 48.34 ± 15.47 years, with an age range of 11 to 80 years. Most patients were in the age group of ≥45 years (73.2% cases and 57.4% controls). Among patients, 153 (68 %) were males, with the ratio of males to females being 2.13 to 1. The majority of the patients were from rural areas, 159 (70.7%). 174 (77.3 %) of the patients did not have formal education. A greater proportion of cases lived more than 60 km from the hospital (53.6%) compared to controls (11.8%).

Table1 Sociodemographic characteristics of patients with colostomy reversal procedure at DMCSH, Amhara region, Ethiopia, 2016-2024

Variables	Categories	Anastomotic leak status		n (%)
		cases (%)	Controls (%)	
Age (years)	<45 years	15(26.8)	72(42.6)	87(38.7)
	≥45 years	41(73.2)	97(57.4)	138(61.3)
Sex	Female	11(19.6)	61(36.1)	72(32.0)
	Male	45(80.4)	108(63.9)	153(68.0)
Residence	Urban	15(26.8)	51(30.2)	66(29.3)
	Rural	41(73.2)	118(69.8)	159(70.7)
Educational status	No formal education	39(69.6)	135(79.9)	174(77.3)
	Secondary education	11(19.6)	24(14.2)	35(15.6)
	Higher education	6(10.7)	10(5.9)	16(7.1)

distance from the hospital in kilometers	≤60 km	26(46.4)	149(88.2)	175(77.8)
	>60km	30(53.6)	20(11.8)	50(22.2)

3.2 Patients perioperative and clinical profiles

Most patients 155(68.9%) had a colostomy for over 3 months, with longer durations more common in cases. The majority (53.3%) had only a colostomy, while others had additional procedures. Common indications included sigmoid volvulus (36.9%), trauma (25.3%), and ISN (22.2%). End colostomy (81.3%) and the descending colon (65.8%) were most frequently involved. Complications occurred in 60%, mainly surgical site infections (55.6%), pneumonia (19.3%), and wound dehiscence (8.9%). Comorbidities were present in 16.4%, higher in cases (39.3%), with hypertension and respiratory illness most common. Smoking was rare (5.3%), but steroid use was more frequent in cases. Most patients had stable vitals and normal lab results, though 43.6% had hemoglobin <12 g/dl. All received prophylactic antibiotics and bowel preparation.

Table 2 Perioperative and clinical profiles of patients with colostomy reversal in DMCSH in Amhara region, Ethiopia, 2016-2024(n=225)

Variable	Categories	Anastomotic leak status		n (%)
		Cases (%)	Controls (%)	
Duration of colostomy	≤3 months	24(42.9)	46(27.2)	70(31.1)
	>3 months	32(57.1)	123(72.8)	155(68.9)
Procedure at the index surgery	Colostomy only	28(50.0)	92(54.4)	120(53.3)
	Colostomy and other site anastomosis	23(41.1)	48(28.4)	71(31.6)
	Colostomy and other site repair	5(8.9)	29(17.2)	34(15.1)
Primary indication for colostomy	Sigmoid volvulus	19(33.9)	64(37.9)	83(36.9)
	Trauma	12(21.4)	45(26.6)	57(25.3)
	ISN	14(25.0)	36(21.3)	50(22.2)
	Tumor	9(16.1)	20(11.8)	29(12.9)
	Other	2(3.6)	4(2.4)	6(2.7)
Type of colostomy	End	46(82.1)	137(81.1)	183(81.3)
	Loop	10(17.9)	32(18.9)	42(18.7)

Sites of colostomy	Transverse	9(16.1)	41(24.3)	50(22.2)
	Descending	40(71.4)	108(63.9)	148(65.8)
	Sigmoid	7(12.5)	20(11.8)	27(12.0)
Was there Complication at the index surgery	YES	35(62.5)	100(59.2)	135(60.0)
	NO	21(37.5)	69(40.8)	90(40.0)
Types of complication at the index surgery	SSI	13(37.1)	62(62.0)	75(55.6)
	Body cavity infection	6(17.1)	16(16.0)	22(16.3)
	Wound dehiscence	5(14.3)	7(7.0)	12(8.9)
	Pneumonia	11(31.4)	15(15.0)	26(19.3)
Comorbid illness	YES	22(39.3)	15(8.9)	37(16.4)
	NO	34(60.7)	154(91.1)	188(83.6)
Types of comorbid illness	Cardiac	4(16.7)	3(13.0)	7(14.9)
	Respiratory	4(16.7)	13(56.5)	17(36.2)
	Cancer	1(4.2)	2(8.7)	3(6.4)
	Hypertension	10(41.7)	3(13.0)	13(27.7)
	DM	5(20.8)	2(8.7)	7(14.9)
History of smoking	Yes	2(3.6)	10(5.9)	12(5.3)
	No	54(96.4)	159(94.1)	213(94.7)
History of steroid use	Yes	10(17.9)	4(2.4)	14(6.2)
	No	46(82.1)	165(97.6)	211(93.8)
Pulse Rate	≥100 beats/min	18(32.1)	37(21.9)	55(24.4)
	<100 beats/min	38(67.9)	132(78.1)	170(75.6)
Systolic BP	90mmhg or less	1(1.8)	5(3.0)	6(2.7)
	Above 90mmhg	55(98.2)	164(97.0)	219(97.3)
ASA Score	I	18(32.1)	61(36.1)	79(35.1)
	II	35(62.5)	103(60.9)	138(61.3)
	III	2(3.6)	4(2.4)	6(2.7)
	IV	1(1.8)	1(0.6)	2(0.9)
Hemoglobin(g/dl)	< 12 g/dl	22(39.3)	76(45.0)	98(43.6)
	≥12 g/dl	34(60.7)	93(55.0)	127(56.4)

ISN, Ileo sigmoid knotting; ASA, American Society of Anesthesiologists physical status classification; DM, diabetes mellitus; SSI, surgical-site infection.

3.3 Patients' intraoperative profiles

Most surgeries lasted under 180 minutes (72.9%), with longer durations more common in cases (32.1%) than controls (25.4%). Intraoperative transfusions (5.3%) and significant blood

loss (4.4%) were more frequent in cases. Drain use (9.8%) and iatrogenic bowel injury (12.9%) were also higher in cases. Adhesions were present in 51.6%, notably more in cases (76.8%).

End-to-end anastomosis was performed in 96.9%, and short distal stumps were more common in cases (44.6%). Most surgeries used a midline approach (91.1%).

Table3 Patients Intraoperative profiles after colostomy reversal, DMCSH, Amhara Region, Ethiopia, 2016-2024(n=225)

Variable	Categories	Anastomotic leak status		n (%)
		Cases (%)	Controls (%)	
Duration of Surgery (Minutes)	<180 minutes	38(67.9)	126(74.6)	164(72.9)
	≥180 minutes	18(32.1)	43(25.4)	61(27.1)
Intraoperative transfusion	Yes	7(12.5)	5(3.0)	12(5.3)
	No	49(87.5)	164(97.0)	213(94.7)
>100 ml blood loss	Yes	7(12.5)	3(1.8)	10(4.4)
	No	49(87.5)	166(98.2)	215(95.6)
Intra-abdominal drain placed	Yes	10(17.9)	12(7.1)	22(9.8)
	No	46(82.1)	157(92.9)	203(90.2)
Iatrogenic bowel injury	Yes	16(28.6)	13(7.7)	29(12.9)
	No	40(71.4)	156(92.3)	196(87.1)
Any significant adhesion	Yes	43(76.8)	73(43.2)	116(51.6)
	No	13(23.2)	96(56.8)	109(48.4)
Anastomotic configuration	End to end	54(96.4)	164(97.0)	218(96.9)
	End to side	2(3.6)	5(3.0)	7(3.1)
Nature of distal stump	Short	25(44.6)	35(20.7)	60(26.7)
	Adequate	31(55.4)	134(79.3)	165(73.3)
Surgical approach	Midline	53(94.6)	152(89.9)	205(91.1)
	Stoma site	3(5.4)	17(10.1)	20(8.9)

3.4 Patients' post-operative profiles

Most patients (76.9%) started oral intake after 3 days, with delayed initiation common in both cases and controls. Only 22.2% passed flatus within 72 hours, lower in cases (10.7%) than controls (26%). Early ambulation was low (24.9%), especially among cases (5.4%). Postoperative complications occurred in 76%, more in cases (87.5%).

The most common were SSI (55.6%), wound dehiscence (21.1%), DVT (18.7%), and pneumonia (4.7%).

Table 4 Postoperative Profiles of patients after colostomy reversal procedure, DMCSH, Amhara Region, Ethiopia, 2016-2024(n=225)

Variable	Categories	Anastomotic leak status		n (%)
		Cases (%)	(%)	
Time to initiation of oral intake	>3 days	39(69.6)	134(79.3)	173(76.9)
	≤3 days	17(30.4)	35(20.7)	52(23.1)
Passing Flatus within 72 hours	Yes	6(10.7)	44(26)	50(22.2)
	No	50(89.3)	125(74)	175(77.8)
Early ambulation	Yes	3(5.4)	53(31.4)	56(24.9)
	No	53(94.6)	116(68.6)	159(75.1)
Postoperative complication	Yes	49(87.5)	122(72.2)	171(76.0)
	No	7(12.5)	47(27.8)	54(24.0)
Types of other postoperative complications	SSI	19(38.8)	76(62.3)	95(55.6)
	Wound dehiscence	13(26.5)	23(18.9)	36(21.1)
	Pneumonia	3(6.1)	5(4.1)	8(4.7)
	DVT	14(28.6)	18(14.8)	32(18.7)

SSI, surgical-site infection; DVT, deep-vein thrombosis

3.5 Factors associated anastomotic leak after surgery for colostomy reversal

At bivariate analysis, age, sex, and placement of a drainage tube were significantly associated with anastomotic leak (AL); however, these variables were not statistically significant in the multivariable analysis.

In the multivariable binary logistic regression analysis, distance from the hospital, comorbid illness, duration of colostomy, iatrogenic bowel injury, significant adhesions, short distal stump, failure to pass flatus within 72 hours, and other postoperative complications were statistically significantly associated with AL at the 5% level of significance.

Patients residing more than 60 km from the hospital had higher odds of AL (AOR = 8.45, 95% CI: 3.43–20.83). Comorbid illness was also significantly associated with AL (AOR = 5.15, 95% CI: 1.97–13.48). A duration of colostomy of ≤3 months was significantly associated with AL (AOR = 2.53, 95% CI: 1.10–5.80).

Among intraoperative factors, iatrogenic bowel injury was significantly associated with AL (AOR = 3.20, 95% CI: 1.09–9.46). Significant adhesions were also associated with AL (AOR = 2.73, 95% CI: 1.15–6.49), as was a short distal stump (AOR = 2.82, 95% CI: 1.18–6.74).

Among postoperative factors, failure to pass flatus within 72 hours was significantly associated with AL (AOR = 5.84, 95% CI: 1.63–20.90). The presence of other postoperative complications was also significantly associated with AL (AOR = 3.47, 95% CI: 1.03–11.73).

Table 5 Bivariate and Multivariate analysis to identify factors associated with anastomotic leak after colostomy reversal in DMCSH, Amhara region, Ethiopia, 2016 - 2024

Variable	Category	Cases (%)	Controls (%)	COR (95% CI)	AOR (95% CI)
Age (years)	<45 years	15(26.8)	72(42.6)	1	1
	≥45 years	41(73.2)	97(57.4)	2.03(1.04-3.95)	1.00(0.41-2.47)
Sex	Female	11(19.6)	61(36.1)	1	1

	Male	45(80.4)	108(63.9)	2.31(1.11-4.80)	1.21(0.48-3.07)
distance from the hospital in kilometers	≤60km	26(46.4)	149(88.2)	1	1
	>60km	30(53.6)	20(11.8)	8.60(4.23-17.34)	8.45(3.43-20.83)
Duration of colostomy	≤3 months	24(42.9)	46(27.2)	2.01(1.07-3.76)	2.53(1.10-5.82)
	>3 months	32(57.1)	123(72.8)	1	1
Comorbid illness	YES	22(39.3)	15(8.9)	6.64(3.13-14.12)	5.15(1.97-13.49)
	NO	34(60.7)	154(91.1)	1	1
Drainage tube left in situ	Yes	10(17.9)	12(7.1)	2.84(1.16-7.00)	0.76(0.19-3.06)
	No	46(82.1)	157(92.9)	1	1
Iatrogenic bowel injury	Yes	16(28.6)	13(7.7)	4.8(2.14-10.79)	3.2(1.09-9.46)
	No	40(71.4)	156(92.3)	1	1
Any significant adhesion	Yes	43(76.8)	73(43.2)	4.35(2.18-8.68)	2.73(1.15-6.49)
	No	13(23.2)	96(56.8)	1	1
Nature of distal stump	Short	25(44.6)	35(20.7)	3.09(1.62-5.89)	2.82(1.18-6.74)
	Adequate	31(55.4)	134(79.3)	1	1
Passing Flatus within 72 hours	Yes	6(10.7)	44(26)	1	1
	No	50(89.3)	125(74)	2.93(1.18-7.32)	5.84(1.63-20.91)
Postoperative complication	Yes	49(87.5)	122(72.2)	2.70(1.14-6.38)	3.48(1.03-11.73)
	No	7(12.5)	47(27.8)	1	1

COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval. The reference category for each variable is indicated by an odds ratio of 1.

4. DISCUSSION

In this study, anastomotic leak (AL) after colostomy reversal was associated with several patient-, operative-, and postoperative factors. These included living more than 60 km from the treating hospital, preoperative comorbidity, iatrogenic bowel injury, colostomy duration of 3 months or less, significant intra-abdominal adhesions, a short distal stump, failure to pass flatus within 72 hours, and the occurrence of other postoperative complications. The findings suggest that AL is unlikely to result from a single technical event; rather, it may reflect the interaction of baseline patient vulnerability, operative complexity, access to care, and early postoperative recovery.

An important context-specific finding of this study is the strong association between living more than 60 km from the hospital and AL. To our knowledge, geographic distance from the treating hospital has not been extensively evaluated as a factor associated with AL after colostomy reversal, but is highly relevant in the Ethiopian context, where Distance from the hospital may represent a marker of geographic or healthcare-access barriers. Ethiopian surgical patients traveled an average of 49.2 km to primary hospitals, 107 km to general hospitals, and 284.3 km to specialized hospitals, far exceeding the LCoGS two-hour benchmark. A multicounty comparison found surgical patients in Ethiopia traveled an average of 144 km to reach surgical care, the longest among eight low-income countries studied[22-24] . These figures provide a plausible context for the present finding, although the study design does not establish that distance itself causes AL. Distance may also be correlated with socioeconomic status, referral patterns, disease severity, availability of transport, and continuity of care.

Preoperative comorbidity was independently associated with AL. Systemic diseases such as hypertension and respiratory disorders may impair tissue perfusion, alter immune function, and delay wound healing, thereby reducing the physiological reserve required for anastomotic healing. Similar associations have been described for diabetes, chronic pulmonary disease, and cardiovascular disorders in colorectal and colon cancer surgery. Meta-analyses and studies from low- and middle-income countries have likewise identified comorbidity as an important determinant of postoperative anastomotic failure[11]. The magnitude of this association is also compatible with findings from Ethiopia, where a large cohort reported that preoperative comorbidity increased the odds of AL by approximately 7.6-fold (AOR 7.62, 95% CI 2.80–20.68). Differences between studies may reflect variation in the types and severity of comorbidities, the completeness of preoperative optimization, nutritional status,

case complexity, and perioperative treatment. Accordingly, the present finding supports systematic identification and optimization of comorbid illness before reversal, but it should not be interpreted as evidence that all comorbid patients should be excluded from surgery. Rather, comorbidity should inform individualized risk assessment, timing, monitoring, and shared decision-making[25, 26].

The relationship between colostomy duration and AL remains uncertain. In this study, reversal within 3 months was associated with AL. Several retrospective and prospective studies have reported higher postoperative morbidity after very early closure, particularly when the index operation was complicated or the patient had not fully recovered; reported odds ratios for complications associated with early closure have generally ranged from 1.5 to 2.0 according to baseline risk. A delay of one or two months may allow resolution of inflammation, nutritional recovery, treatment of comorbidities, and stabilization after the initial operation[27]. Other studies have found no significant difference in AL according to closure timing, suggesting that chronological duration alone may be less important than patient selection and readiness for reversal[28]. A review from Addis Ababa reported that reversal after 16 weeks was associated with lower morbidity and an AL rate of 4.6%. In Ethiopia, longer intervals may partly reflect unavoidable delays in access, operating-room availability, investigations, or recovery. Thus, the apparent benefit of delayed reversal may represent both biological recovery and selection of patients who remain suitable for surgery. Conversely, prolonged diversion may promote adhesions, distal-stump changes, nutritional problems, or loss to follow-up. The present results therefore support individualized timing based on recovery, comorbidity, nutritional and functional status, bowel evaluation, and operative risk rather than a universal time threshold[29].

Iatrogenic bowel injury and significant adhesions were associated with AL in this study. Adhesiolysis can obscure tissue planes, prolong the operation, compromise bowel perfusion, and increase the likelihood of inadvertent enterotomy. An intraoperative bowel injury may further expose the anastomosis to contamination or require additional mobilization and repair. These mechanisms are consistent with international evidence showing that adhesions and intraoperative injury increase the risk of AL and other postoperative complications. Reported AL rates after colostomy reversal range from approximately 3.6% to 14%, depending on patient selection and operative complexity; in trauma and complex colorectal surgery, damage-control procedures have been associated with roughly twice the risk of AL, with an adjusted relative risk of approximately 2.3[30]. Comparable challenges have been described

in Ethiopian studies and case series, particularly after complicated index procedures such as Hartmann's operation. In these settings, dense adhesions and previous contamination may increase the technical difficulty of reversal, with reported AL rates ranging from 4.6% to 14.3% in high-risk adult and pediatric populations. These observations support careful preoperative review of the index operation, anticipation of adhesiolysis, appropriate surgical expertise, and a low threshold for involving experienced assistance when complex anatomy is expected. However, because adhesions and bowel injury may also reflect the severity of the original disease and operation, their independent contribution should be interpreted cautiously[29].

A short distal stump was another operative finding associated with AL. A short or fibrotic stump may be difficult to identify and mobilize, may require greater traction, and may increase tension or reduce blood supply at the anastomosis. International studies, including work in children with anorectal malformations, have linked technical difficulty involving the distal stump with AL rates as high as 14.3%[31]. Although Ethiopian data on stump length are limited, delayed reversal and complicated index surgery may increase the likelihood of a scarred or shortened distal segment. The association observed here is therefore biologically plausible, but future studies should define stump length prospectively and assess its relationship with anastomotic level, perfusion, tension, and the technique used for reconstruction.

Failure to pass flatus within 72 hours was associated with AL. Delayed flatus may indicate postoperative ileus, impaired bowel motility, obstruction, inflammation, or an early manifestation of an anastomotic complication. An East African study similarly reported an association between delayed passage of stool or flatus and AL ($p=0.001$), with an overall AL rate of 5.6%. In a randomized Chinese trial, patients who passed flatus earlier had a lower observed AL rate than those with delayed passage (1.24% versus 2.58%), although the difference was not statistically significant. These findings suggest that delayed flatus should be considered a warning sign that prompts clinical assessment rather than treated as a diagnostic marker of AL [32].

Patients who developed other postoperative complications in this study were 3.47 times more likely to have AL. This is consistent with a large Swedish cohort, in which postoperative complications other than AL were strongly associated with subsequent AL (OR 35.1, 95% CI 12.5–98.4); the association was even greater among patients with three or more complications

(OR 155.2, 95% CI 63.7–377.9)[33]. The much larger effect estimates in that cohort may reflect differences in study population, complication definitions, surveillance, and analytical methods. Importantly, the temporal relationship requires caution.

The study's strengths include its focus on a clinically important complication after colostomy reversal and its assessment of factors spanning patient characteristics, access to care, intraoperative findings, and early postoperative recovery. Including travel distance alongside conventional surgical risk factors allowed the analysis to examine an aspect of the care pathway that is not routinely captured in studies from higher-resource settings. This study has some limitations. Its retrospective design and single-center setting may limit causal inference and generalizability. The relatively small number of cases reduced statistical power, resulting in wide confidence intervals for some estimates.

5. Conclusion

In a resource-limited Ethiopian setting, anastomotic leak after colostomy reversal was associated not only with conventional patient and operative factors but also with geographic distance from the treating hospital. While several findings were consistent with the global literature, including the importance of comorbidity, intraoperative complications, and significant adhesions, the association with geographic distance highlights context-specific challenges in access to surgical care.

6. REFERENCES

1. Zarnescu EC, Zarnescu NO, Costea RJD: **Updates of risk factors for anastomotic leakage after colorectal surgery**. 2021, **11**(12):2382.
2. Goswami H, Dharap SB, Mohare DK, Navgale SS, Kirange P, Singh S, Kirange PVJC: **The Risk Factors for Complications Following Intestinal Stoma Reversal**. 2025, **17**(11).
3. Tsalikidis C, Mitsala A, Mentonis VI, Romanidis K, Pappas-Gogos G, Tsaroucha AK, Pitiakoudis MJCo: **Predictive factors for anastomotic leakage following colorectal cancer surgery: where are we and where are we going?** 2023, **30**(3):3111-3137.
4. Wako G, Teshome H, Abebe E: **Colorectal anastomosis leak: rate, risk factors and outcome in a Tertiary Teaching Hospital, Addis Ababa Ethiopia, a five year retrospective study**. *Ethiopian journal of health sciences* 2019, **29**(6).
5. Kisielewski M, Wojewoda T, Richter K, Wysocki M, Jankowski M, Krawczyk W, Wantulok J, Jeleńska-Bieńkowska K, Stańczak M, Grudzińska EJV *et al*: **Preliminary results of Polish national multicenter study on colostomy reversal–LICO (Liquidation of Colostomy) study**. 2024, **19**(2):198.
6. Mirza KL, Wickham CJ, Noren ER, Hwang GS, Ault GT, Ortega AE, Jafari MD, Cologne KGJCD: **Outcomes of colostomy takedown following Hartmann's procedure: successful restoration of continuity comes with a high risk of morbidity**. 2021, **23**(4):967-974.

7. Rennie O, Sharma M, Helwa NJFiS: **Colorectal anastomotic leakage: a narrative review of definitions, grading systems, and consequences of leaks**. 2024, **11**:1371567.
8. Bao X, Yi K, Cheng J, Shen Y, Cao S, Hu B, Wang X, Su P, Li Y, Xu QJIJoS: **Risk and protective factors for postoperative anastomotic leakage in esophageal and gastrointestinal surgery: an umbrella review of meta-analyses and systematic reviews**. 2025, **112**(1):1722.
9. Rama N, Parente D, Silva CG, Neves M, Figueiredo N, Alves P, Clara P, Amado S, Lourenco O, Guarino MPJSGO: **Anastomotic leak in Colorectal Cancer Surgery: From Diagnosisto Management or Failure—A Retrospective Cohort Study**. 2021, **26**(3):183-190.
10. Cats M, Magermans L, Wassenaar E, Van Geloven A, Wiezer M, Plate J, Boerma DJAoso: **The Clinical Presentation of Anastomotic Leakage Compared Between CRS-HIPEC and Conventional Colorectal Surgery**. 2026, **33**(2):1706-1715.
11. He J, He M, Tang J-H, Wang X-HJLsaos: **Anastomotic leak risk factors following colon cancer resection: a systematic review and meta-analysis**. 2023, **408**(1):252.
12. Dyegura OJ, MAGOHE NJIJHMNP: **Prevalence and factors associated with anastomotic leakage among patients undergoing bowel resection and anastomosis**. 2024, **6**(1):1-14.
13. Litchinko A, Buchs N, Balaphas A, Toso C, Liot E, Meurette G, Ris F, Meyer JJSe: **Score prediction of anastomotic leak in colorectal surgery: a systematic review**. 2024, **38**(4):1723-1730.
14. Brunner M, Gärtner L, Weiß A, Weber K, Denz A, Krautz C, Weber GF, Grützmann RJJoCM: **Risk factors for postoperative major morbidity, anastomotic leakage, re-surgery and mortality in patients with colonic perforation**. 2024, **13**(17):5220.
15. Venn ML, Hooper RL, Pampiglione T, Morton DG, Nepogodiev D, Knowles CHJBo: **Systematic review of preoperative and intraoperative colorectal Anastomotic Leak Prediction Scores (ALPS)**. 2023, **13**(7):e073085.
16. Ellis CT, Maykel JAJCiC, Surgery R: **Defining anastomotic leak and the clinical relevance of leaks**. 2021, **34**(06):359-365.
17. Nishijima M, Baba H, Murotani K, Tokai R, Watanabe T, Hirano K, Shibuya K, Hojo S, Matsui K, Yoshioka IJLsaos: **Early ambulation after general and digestive surgery: a retrospective single-center study**. 2020, **405**(5):613-622.
18. Madan S, Sureshkumar S, Anandhi A, Gurushankari B, Keerthi AR, Palanivel C, Kundra P, Kate VJJoGS: **Comparison of enhanced recovery after surgery (ERAS) pathway versus standard care in patients undergoing elective stoma reversal surgery-a randomized controlled trial**. 2023, **27**(11):2667-2675.
19. Patteet E, Van Hoof S, Hendrickx T, Van den Broeck S, Hubens G, Komen NJIJoCD: **Is length of the rectal stump predictive for postoperative outcome in Hartmann's reversal surgery? A multicenter experience of 105 consecutive cases**. 2022, **37**(3):617-622.
20. Mayhew D, Mendonca V, Murthy BJA: **A review of ASA physical status–historical perspectives and modern developments**. 2019, **74**(3):373-379.
21. Young J, Badgery-Parker T, Dobbins T, Jorgensen M, Gibbs P, Faragher I, Jones I, Currow DJJop, management s: **Comparison of ECOG/WHO performance status and ASA score as a measure of functional status**. 2015, **49**(2):258-264.
22. Meshesha BR, Sibhatu MK, Beshir HM, Zewude WC, Taye DB, Getachew EM, Merga KH, Kumssa TH, Alemayue EA, Ashuro AAJBHSR: **Access to surgical care in Ethiopia: a cross-sectional retrospective data review**. 2022, **22**(1):973.
23. Osebo C, Grushka J, Deckelbaum D, Razek TJSOS: **Assessing Ethiopia's surgical capacity in light of global surgery 2030 initiatives: Is there progress in the past decade?** 2024, **19**:70-79.
24. Faierman ML, Anderson JE, Assane A, Bendix P, Vaz F, Rose JA, Funzamo C, Bickler SW, Noormahomed EVJIH: **Surgical patients travel longer distances than non-surgical patients to receive care at a rural hospital in Mozambique**. 2015, **7**(1):60-66.

25. Kassahun CW, Melekamu S, Alemu MTJPo: **Clinical anastomosis leakage and associated factors among patients who had intestinal anastomosis in northwest referral hospitals, Ethiopia**. 2022, **17**(12):e0275536.
26. van Kooten RT, Voeten DM, Steyerberg EW, Hartgrink HH, van Berge Henegouwen MI, van Hillegersberg R, Tollenaar RA, Wouters MWJAoso: **Patient-related prognostic factors for anastomotic leakage, major complications, and short-term mortality following esophagectomy for cancer: a systematic review and meta-analyses**. 2022, **29**(2):1358-1373.
27. Pittman DM, Smith LEJDotc, rectum: **Complications of colostomy closure**. 1985, **28**(10):836-843.
28. Roe A, Prabhu S, Ali A, Brown C, Brodribb AJBjos: **Reversal of Hartmann's procedure: timing and operative technique**. 1991, **78**(10):1167-1170.
29. Bekele A, Kotisso B, Biluts HJE, Surgery CAJo: **Outcomes of colostomy reversal procedures in two teaching hospitals in Addis Ababa, Ethiopia**. 2008, **13**(2):119-124.
30. Grossman H, Dhanasekara CS, Shrestha K, Marschke B, Morris E, Richmond R, Ko A, Tennakoon L, Campion EM, Wood FCJTS *et al*: **Rates and risk factors for anastomotic leak following blunt trauma-associated bucket handle intestinal injuries: a multicenter study**. 2023, **8**(1):e001178.
31. Azim A, Saeed N, Kumara N, Hassan A, Chishti N, Chishti SJPJoM, Sciences H: **Complications of Colostomy Reversal in Patients with Imperforate ANUS**. 2022, **16**(05):522-522.
32. Zhou T, Wu X-T, Zhou Y-J, Huang X, Fan W, Li Y-CJWJoGW: **Early removing gastrointestinal decompression and early oral feeding improve patients' rehabilitation after colorectostomy**. 2006, **12**(15):2459.
33. Gessler B, Eriksson O, Angenete EJIJocd: **Diagnosis, treatment, and consequences of anastomotic leakage in colorectal surgery**. 2017, **32**(4):549-556.

Author Contributions

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All authors reviewed and approved the final manuscript and accept responsibility for the integrity of the work.

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Data Availability

The datasets analyzed during the current study contain potentially identifiable clinical information and cannot be made publicly available because of ethical and confidentiality

restrictions. De-identified data supporting the findings of this study may be made available by the corresponding author upon reasonable request, subject to approval by the Institutional Research Ethics Review Committee of Debre Markos University.

Additional Information

- **Competing Interests:** The authors declare no competing interests

Table and figure legends

Table 1. Sociodemographic characteristics of patients undergoing colostomy reversal at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

Data are presented as *n* (%). Cases were patients who developed anastomotic leak, whereas controls were patients who did not develop anastomotic leak during the defined follow-up period. Distance from hospital refers to the reported distance between the patient's residence and Debre Markos Comprehensive Specialized Hospital.

Table 2. Perioperative and clinical characteristics of patients undergoing colostomy reversal according to anastomotic leak status at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

Data are presented as *n* (%). Cases and controls were classified according to anastomotic leak status. ASA, American Society of Anesthesiologists physical status classification; DM, diabetes mellitus; SSI, surgical-site infection.

Table 3. Intraoperative characteristics of patients undergoing colostomy reversal according to anastomotic leak status at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

Data are presented as *n* (%). Variables include operative duration, estimated blood loss, intraoperative blood transfusion, iatrogenic bowel injury, significant adhesions, distal stump length, anastomotic configuration, surgical approach, and drain placement.

Table 4. Postoperative characteristics of patients undergoing colostomy reversal according to anastomotic leak status at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

Data are presented as *n* (%). Postoperative variables include time to initiation of oral intake, passage of flatus within 72 h, early ambulation, and postoperative complications. SSI, surgical-site infection; DVT, deep-vein thrombosis.

Table 5. Bivariable and multivariable logistic regression analysis of factors associated with anastomotic leak after colostomy reversal at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval. Variables with $P < 0.25$ in bivariable analysis and variables considered clinically relevant *a priori* were considered for inclusion in the multivariable model. Statistical significance was defined as $P < 0.05$. Reference categories are indicated by an odds ratio of 1.

Figure 1. Flow diagram of patient identification, eligibility assessment, exclusion, and selection of cases and controls for the retrospective case–control study of anastomotic leak after colostomy reversal at Debre Markos Comprehensive Specialized Hospital, Amhara Region, Ethiopia, 2016–2024.

Supplementary Files

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