RESEARCH PAPER

Incidence and Risk Factors of Postoperative Anastomotic Leak Following Resection Anastomosis

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ABSTRACT

Background: Anastomotic leak (AL) is one of the most severe complications of the gastrointestinal resection anastomosis causing serious morbidity and mortality. The purpose of the study was to estimate the prevalence of AL and the risk factors that are associated with the occurrence of the disease in a tertiary care unit.

Methods: The study was a retrospective one carried out in a tertiary care hospital. Medical records of 30 patients that had gastrointestinal resection with primary anastomosis within a 18-month period (between January 2023 and June 2024) were examined. Hospital records were used to obtain patient demographics, comorbidities, operative variables, and postoperative outcomes. Univariate analysis was conducted based on the Fisher exact test where it identified factors that were related to AL.

Results: The total AL incidence was 13.3 per cent (4/30). On univariate analysis, hypoalbuminemia (<3.0 g/dL) (OR 23.00, p=0.012), diabetes mellitus (OR 12.60, p=0.038), and intraoperative blood loss >500 mL (OR 12.60, p=0.038) were significantly related with AL. There was a tendency of significance in emergency surgery (OR 10.00, p=0.064). The patients with AL had a much longer hospital period (21.8±7.4 vs. 9.4±3.8 days, p=0.001) and increased the percentage of ICU admission (75.0 vs. 11.5, p=0.012). AL after resection anastomosis is accompanied with a high morbidity. Hypoalbuminemia, diabetes mellitus and excessive intraoperative blood loss proved to be decisive risk factors. Bigger multicentre studies should be done to confirm these preliminary results.

Conclusion: AL following resection anastomosis carries substantial morbidity. Hypoalbuminemia, diabetes mellitus, and excessive intraoperative blood loss emerged as significant risk factors. Larger multicentre studies are warranted to validate these preliminary findings.

Keywords: Anastomotic leak, resection anastomosis, risk factors, postoperative complications, gastrointestinal surgery, retrospective study

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Introduction

Anastomotic leak (AL) can be described as a failure of the intestinal wall integrity at the anastomotic site which allows communication between the intra- and extraluminal compartments. It is one of the most dreaded complications involving gastrointestinal surgery, and reported incidence rates tend to range between 1 and 30 percent according to the anatomical location, surgical procedure, and population of patient under study.2,3 As much as there has been an improved surgical instrumentation, stapling devices, and perioperative care protocols.

The outcome of AL is extensive clinically. AL is also also associated with protracted hospital stay, higher rates of reoperation, higher intensive care unit hospitalization, and significantly higher mortality rates in patients who develop a leak, as well as a higher economic burden as the management of a single anastomotic leak raises the overall hospital expenses significantly.9

The AL pathogenesis is multifactorial and is associated with a complex interdependence of patient-related, disease-related, and surgery-related variables. Advanced age, malnutrition, diabetes mellitus, smoking, obesity, and immunosuppression are some of the patient factors identified to have an impact on reduced wound healing at the anastomotic site.10,11 sexual diseases like the presence of peritonitis, bowel obstruction, and malignancy could compromise local tissue conditions. The level of anastomosis, surgical time, blood loss, surgical procedure, and experience of the operating surgeon also contribute significantly to the situation of intraoperative hypotension, vasopressor use, and blood transfusion as a means of worsening anastomotic perfusion and healing.14

The prevention of AL requires the initial detection of the patients at risk to inform prophylactic actions and provide timely diagnosis and treatment. A variety of scoring systems and predictive models have been suggested, but there is still no universal tool as the clinical manifestations of AL, such as fever, tachycardia, leucocytosis, and peritonitis may be nonspecific and imaging techniques such as computed tomography with water-soluble contrast are used to confirm the diagnosis.15,16 Since the prevalence of the complication remains high in a range of surgical procedures, there is still a need to conduct research on its occurrence and risk factors. The current research was conducted to find out the rates of postoperative anastomotic leak after gastrointestinal resection anastomosis and the risk factors related to the occurrence of the condition in a tertiary care hospital environment.

Material and Methods

Study Design and Setting

This retrospective analysis was done in the Department of General Surgery in Chettinad Academy of Research and Education (CARE), Kelambakkam. The reviews were conducted on medical records of patients who had undergone gastrointestinal resection with primary anastomosis during the 18 months between January 2023 and June 2024. The protocol of the study received the Institutional Ethics Committee (IEC/2022/GS/087) approval, and informed consent was not required due to the retrospective character of the study.18

Study Population

All patients who had undergone elective or emergency gastrointestinal resection with primary anastomosis at age 18 years and above were screened to include medical records of all consecutive patients who matched the study period. Patients with history of anastomotic leak before the operation, those who have undergone an anastomotic operation but with a protective diverting stoma, and those who have incomplete medical records were excluded. A total of 30 patients that fit into the inclusion criteria were found and included in the ultimate analysis.19,20

Data Collection

Standardised data collection form was used to extract data retrospectively using hospital medical records, anaesthesia charts, operative notes and laboratory databases. The variables retrieved were demographic variables (age, sex, body mass index), comorbid variables (diabetes mellitus, hypertension, chronic obstructive pulmonary disease, cardiovascular disease), lifestyle variables (smoking, alcohol consumption), preoperative laboratory variables (serum albumin and haemoglobin levels, total leucocyte count), the American Society of Anesthesiologists (ASA) physical status, and disease variables. Operation variables were obtained that comprised the urgency of surgery, anatomical location of the anastomosis, anastomosis type, operative time, estimated blood loss, requirement of intraoperative blood transfusion, and intraoperative vasopressors.21

Definition and Grading of Anastomotic Leak

Anastomotic leak was defined according to the International Study Group of Rectal Cancer (ISREC) classification as a defect of the intestinal wall integrity at the anastomotic site leading to communication between intra- and extraluminal compartments, confirmed by clinical signs, radiological imaging, or intraoperative findings.[22] Leaks were graded as: Grade A (requiring no active therapeutic intervention), Grade B (requiring active therapeutic intervention but manageable without relaparotomy), and Grade C (requiring relaparotomy).[22]

Follow-up and Outcome Assessment

Review of postoperative records was done at least 30 days after surgery. Clinical evaluation clinical assessments such as vital signs, findings of abdominal examination, the character and volume of drain output, and laboratory tests were extracted into documented ones. The review involved records of computed tomography with oral water-soluble contrast that was done at the time AL was suspected clinically. The main event was the development of AL during 30 days of surgery. The secondary outcomes were 30-day mortality, hospital stay, intensive care unit hospitalization, the rate of reoperation, and wound infection.23

Statistical Analysis

The statistical analysis was done by means of SPSS 26.0 (IBM Corp., Armonk, NY, USA). The frequencies and percentages of the categorical variables were presented and compared with the help of Fisher exact test, which is because of the small sample size. Continuous variables were presented in the format of mean standard deviation and compared with the help of the MannWhitney U test. Odds ratios (OR) with 95 percent confidence interval (CI) were used to determine the strength of relationship between individual risk factors and AL. The Multivariate logistic regression was not done because of the scarce number of outcome events (n=4), which did not allow the addition of multiple predictor variables in a regression model in accordance with the recommended number of 10 events. A two-tailed p-value <0.05 was considered statistically significant.

Results

A total of 30 patients were included in the study. The mean age was 52.1±13.9 years, and 19 (63.3%) were male. The most common indications for surgery were colorectal malignancy (36.7%), small bowel pathology (33.3%), and gastric or oesophageal disease (30.0%). Elective procedures accounted for 70.0% (21/30) of surgeries, while 30.0% (9/30) were performed as emergencies. The baseline demographic and clinical characteristics of the study population, stratified by the occurrence of anastomotic leak, are presented in Table 1.

Table 1: Demographic and Clinical Characteristics of the Study Population (N=30)

Variable	No Leak (n=26)	Leak (n=4)	p-value†
Age (years, mean±SD)	51.2±13.8	58.5±14.2	0.312*
Male sex	16 (61.5%)	3 (75.0%)	1.000
BMI >30 kg/m²	4 (15.4%)	1 (25.0%)	0.536
Diabetes mellitus	5 (19.2%)	3 (75.0%)	0.038
Hypertension	7 (26.9%)	1 (25.0%)	1.000
Smoking	6 (23.1%)	2 (50.0%)	0.283
COPD	2 (7.7%)	1 (25.0%)	0.348
Albumin <3.0 g/dL	3 (11.5%)	3 (75.0%)	0.012
Haemoglobin <10 g/dL	5 (19.2%)	2 (50.0%)	0.226
ASA grade III/IV	5 (19.2%)	2 (50.0%)	0.226

*†Fisher's exact test; *Mann–Whitney U test*

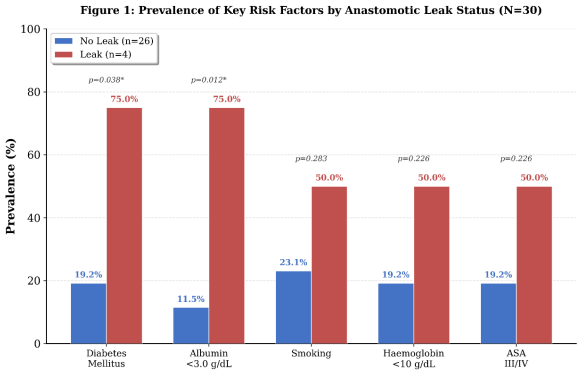

Fig 1: Grouped bar chart comparing the prevalence of key risk factors (diabetes,hypoalbuminemia, smoking, anaemia, ASA III/IV) between the leak and no-leak groups.

Anastomotic leak was diagnosed in 4 of 30 patients, yielding an overall incidence of 13.3%. The median time to diagnosis was postoperative day 5.5 (interquartile range 4–8). According to the ISREC classification, 1 patient (25.0%) had a Grade A leak managed conservatively, 1 (25.0%) had a Grade B leak requiring percutaneous drainage, and 2 (50.0%) had Grade C leaks necessitating relaparotomy. The site-specific leak rates were 18.2% (2/11) for colorectal anastomoses, 11.1% (1/9) for gastric/oesophageal anastomoses, and 10.0% (1/10) for small bowel anastomoses.

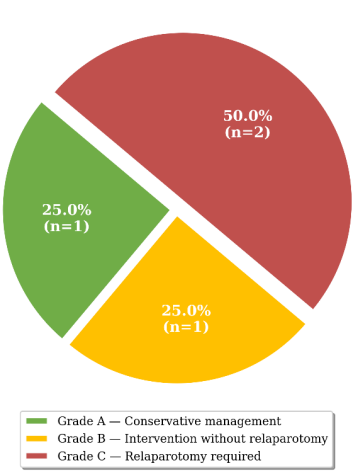

Fig 2: Pie chart illustrating the distribution of anastomotic leaks by ISREC grade (A, B, C).

The operative characteristics of the study population are presented in Table 2. On univariate analysis, intraoperative blood loss exceeding 500 mL was significantly associated with AL (p=0.038), while emergency surgery showed a trend toward significance (p=0.064). Other operative variables including colorectal anastomotic site, operative duration, type of anastomosis, intraoperative transfusion, and vasopressor use did not reach statistical significance.

Table 2: Operative Characteristics of the Study Population (N=30)

Variable	No Leak (n=26)	Leak (n=4)	p-value†
Emergency surgery	6 (23.1%)	3 (75.0%)	0.064
Colorectal anastomosis	9 (34.6%)	2 (50.0%)	0.608
Gastric/Oesophageal	8 (30.8%)	1 (25.0%)	1.000
Small bowel	9 (34.6%)	1 (25.0%)	1.000
Stapled anastomosis	13 (50.0%)	2 (50.0%)	1.000
Operative time >180 min	7 (26.9%)	2 (50.0%)	0.565
Blood loss >500 mL	5 (19.2%)	3 (75.0%)	0.038
Intraoperative transfusion	4 (15.4%)	2 (50.0%)	0.163
Vasopressor use	3 (11.5%)	1 (25.0%)	0.452

†Fisher's exact test

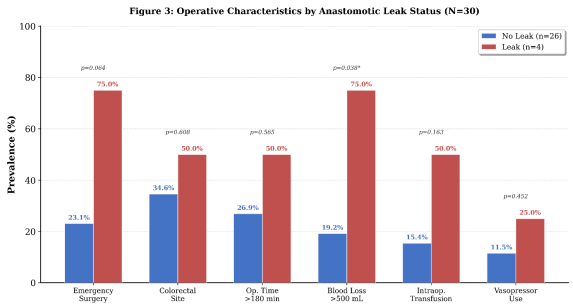

Fig 3: Grouped bar chart comparing operative variables between the leak and no-leak groups.]

Table 3 shows univariate odds ratios of risk factors that are associated with anastomotic leak. Three of them were statistically significant: hypoalbuminemia (<3.0 g/dL) had the highest predictive value (OR 23.00, 95% CI 1.80294.70, p=0.012), then diabetes mellitus (OR 12.60, 95% CI 1.08147.30, p=0.038), and intraoperative blood loss over 500 mL (OR 12.60 A significant difference was observed in emergency surgery (OR 10.00, 95% CI 0.86116.40, p=0.064) but failed to reach the conventional level of statistical significance. Multivariate logistic regression was not done because the number of outcome events (n=4) was too small and it could not have been excluded with many predictor variables.

Table 3: Univariate Analysis of Risk Factors for Anastomotic Leak (N=30)

Variable	Odds Ratio	95% CI	p-value†
Albumin <3.0 g/dL	23.00	1.80–294.70	0.012
Diabetes mellitus	12.60	1.08–147.30	0.038
Blood loss >500 mL	12.60	1.08–147.30	0.038
Emergency surgery	10.00	0.86–116.40	0.064
ASA grade III/IV	4.20	0.46–38.60	0.226
Haemoglobin <10 g/dL	4.20	0.46–38.60	0.226
Smoking	3.33	0.37–30.10	0.283
Male sex	1.88	0.17–20.90	1.000

†Fisher's exact test; CI = Confidence Interval

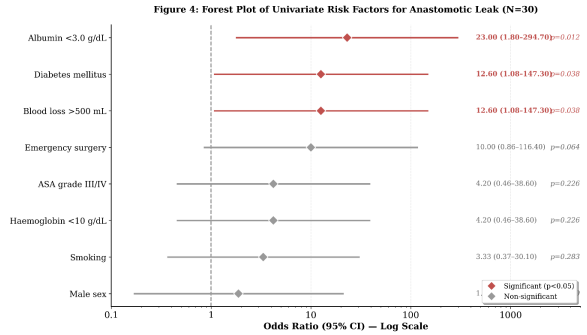

Fig 4: Forest plot displaying univariate odds ratios with 95% confidence intervals for all analysed risk factors.

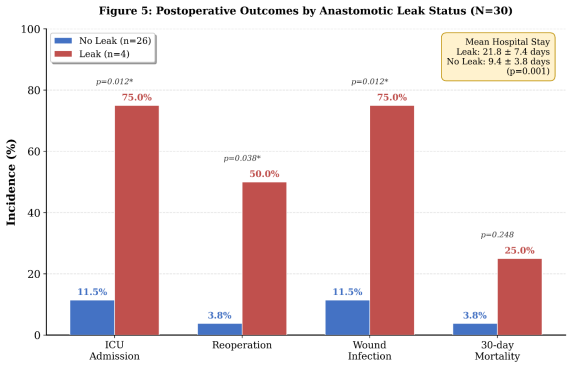

Fig 5: Grouped bar chart comparing postoperative outcomes (hospital stay, ICU admission, reoperation, wound infection, mortality) between the two groups.

The patients with AL had much poor outcomes than non-AL (Table 4). The average hospitalization had increased by more than two-fold (21.8+/-7.4 vs. 9.4+/-3.8 days, p=0.001). The leak group had significantly more frequent ICU admission (75.0% vs. 11.5% p=0.012), reoperation (50.0 percent vs. 3.8 percent p=0.038) and wound infection (75.0 percent vs. 11.5 percent p=0.012). The number of AL group patients dying within 30 days was one patient (25.0%), versus non- leak group dying one patient (3.8%), but it is not statistically significant (p=.248).

Table 4: Postoperative Outcomes Stratified by Anastomotic Leak Status (N=30)

Outcome	No Leak (n=26)	Leak (n=4)	p-value
Hospital stay (days)	9.4±3.8	21.8±7.4	0.001*
ICU admission	3 (11.5%)	3 (75.0%)	0.012†
Reoperation	1 (3.8%)	2 (50.0%)	0.038†
Wound infection	3 (11.5%)	3 (75.0%)	0.012†
30-day mortality	1 (3.8%)	1 (25.0%)	0.248†

**Mann–Whitney U test; †Fisher's exact test*

Discussion

The current retrospective case study indicates that there is a general anastomotic leakage rate of 13.3% (4/30) after anastomosis of gastrointestinal resection. This number matches the literature reports which have reported AL rates of 3-19% in colorectal surgery and 3-8% in small bowel surgery.2, 25 The reason as to why the incidence in our study population is higher could be due to the presence of emergency cases which comprised 30.0 of the study population and had a higher leak rate as compared to elective procedures.

Hypoalbuminemia was found to be the best predictor of AL on univariate analysis with a significantly high odds ratio of 23.00 in patients having serum albumin level less than 3.0 g/dl. Irrespective of the fact that the small sample size comes with a wide confidence interval, this result is in line with other vast evidence on the importance of nutritional status in the repair of surgical wounds.

Preoperative hypoalbuminemia has been found to be one of the most effective predictors of postoperative complications including anastomotic failure, even in malnourished patients having gastrointestinal resection, and this fact has been confirmed by National Surgical Quality Improvement Program (NSQIP) data.26,27 Preoperative nutritional assessment and optimization are important as it has been demonstrated that hypoalbuminemia is a predictor of postoperative complications including anastomotic failure.

Diabetes mellitus had turned into a significant risk factor in our research and likelihood of acquiring AL had increased by twelve folds. The risk of AL in diabetic patients who have colorectal surgery increases 60 percentage points above normal control levels by diabetes affecting neutrophil chemotaxis and

phagocytosis, increasing oxidative stress, accumulation of advanced glycation end-products in the extracellular matrix, and microvascular dys.31 Diabetes modulates the capacity of neutrophils to generate an anti-inflammatory effect and to prevent infectious complications in diabetic patients having colorectal surgery in several ways: impaired neutrophil chemotaxis and phagocytosis, amplified oxidative stress, accumulation of advanced glycation end-products in the extracellular matrix, and microvascular dys.

Diabetes mellitus was recognized to be a major threat in our research and it increased the likelihood of developing AL by twelve times. Diabetes is a condition that negatively affects wound healing in several ways, such as neutrophil chemotaxis and phagocytosis, elevated oxidative stress, the build-up of advanced glycation end-products in the extracellular matrix, and microvascular dysfunction that results in tissue hypoperfusion.31 A meta-analysis demonstrated a 60% increased risk of AL in diabetic patients undergoing colorectal surgery. The role of the perioperative glycemic control is hard to overestimate, and hyperglycemia is a factor that affects neutrophil activity and predisposes patients to infectious complications.

The trend of significant value of emergency surgery was notable (OR 10.00, p=0.064), and the absence of a significant value was probably due to the small sample size rather than to the absence of relationship between the two variables. The procedure of peritonitis, bowel edema, haemodynamic instability, and inadequate patient preparation, with an impact on anastomotic integrity, are often undertaken in an emergency situation, and a number of studies have suggested damage control measures or diversion in emergency situations with high risks.32,33 Among the items that have been discussed is the risk assessment involved in choosing whether to use primary anastomosis in an emergency situation.34

Our study statistically found a significant association between intraoperative blood loss (more than 500 mL) and AL (OR 12.60, p=0.038). Hypotension, a decrease in the splanchnic blood flow, and tissue hypoxia at the anastomotic site are the effects of excessive haemorrhage, which impairs the process of healing.35Also, immunosuppressive effects of transfusion-related immunomodulation have been demonstrated to predispose patients to infectious and anastomotic complications.36

Although there was a higher proportion of sex males in the leak patients (75.0% vs. 61.5%), it was not statistically significant in our cohort (p=1.000). This contrasts some large database studies and meta-analyses that have found male sex to be an independent risk factor of AL.37 In colorectal surgery, there is a technical challenge of the small pelvis in low pelvic dissections and the difference in hormones between males and females with oestrogen protecting wound healing has been hypothesized.38 The lack of significance in our study is likely a consequence of the limited statistical power inherent to the small sample size.

The effects of AL were of clinical importance in our study. The patients in AL experienced an increase of over twofold stays at the hospital (21.8 vs. 9.4 days), and ICU hospitalization and reoperation. The 30-day mortality was more severe in the AL group (25.0% vs. 3.8%), but the response was not statistically significant (p=0.248) and it might have been simply due to insufficient power to emphasize the presence of a significant mortality difference between the two groups with only 4 leak events. These results align with international information that has identified the dire effects of AL on patient outcomes and utilisation of healthcare resources.39

There are a number of significant limitations in this research that need to be mentioned. To begin with, the sample size (n=30) is too small with only 4 leak incidents, which severely undermines the statistical power of the study with broad confidence intervals and does not allow meaningful multivariate analysis. Some of the variables that demonstrated a clinically significant difference between groups including emergency surgery and smoking might have been statistically significant in a larger cohort. Second, the retrospective design is a priori prone to selection bias, recall bias and information bias and the use of medical records could have resulted in an incomplete or incorrect capture of some of the variables. Third, research was done in one tertiary care centre, which is limited in the generalization. Fourth, the records did not record some of the possible confounders including experience of the surgeon, mesenteric vascularity, and tissue oxygenation at the anastomotic site, and they could not be evaluated. Lastly it cannot be ruled out that undetected subclinical (Grade A) leaks that were not documented in the medical charts might have occurred. This should, however, be viewed as preliminary and hypothesis-generating and thus, it is necessary to validate the present findings in larger multicentre studies.

Conclusion

In this retrospective study, anastomotic leak after gastrointestinal resection anastomosis was found in 13.3% (4/30) of patients and was linked to high morbidity. Hypoalbuminemia, diabetes mellitus and excessive intraoperative blood loss were revealed to be obstinately important risk factors on univariate analysis whereas emergency surgery demonstrated an interesting trend. Among them, nutritional condition and glycemic level are the possible modifiable goals of preoperative optimisation. Clinical suspicion, high level of attention in the surgical technique and timely postoperative observation is still crucial to low cases and reduction of the effects of this complication. Due to the limitations inherent in the retrospective design and the small sample size, new large-scale studies with multicentre are required to confirm these initial results and build solid predictive models that can be used in clinical practice.

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