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RESEARCH ARTICLE

FACTORS INFLUENCING THE OUTCOME OF INTESTINAL ANASTOMOS

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Abstract: ***Background and Objective:*** Anastomotic leak is a major complication after bowel resection. This study estimated the leak rate and evaluated clinical, operative, and laboratory factors associated with leak in a prospective surgical cohort. ***Methods:*** In this single-centre prospective study, 82 consecutive adults undergoing intestinal resection with anastomosis were analyzed. Preoperative features, operative details, and laboratory parameters were recorded. The primary outcome was clinically confirmed anastomotic leak during the immediate postoperative period. Associations were tested using chi-square, Fisher's exact, or t-tests ($p < 0.05$). *Results:* Anastomotic leak occurred in 4 of 82 patients (4.9%), with no mortality among affected cases. Constipation at presentation was significantly associated with leak (11.1% vs 0%, $p = 0.034$). No significant associations were found for age ($p = 0.209$), sex ($p = 0.555$), urgency ($p = 1.000$), anastomotic type or site ($p > 0.05$), or laboratory parameters such as hemoglobin (12.58 ± 2.31 vs 11.08 ± 1.60 g/dL, $p = 0.079$). Use of blood products and total parenteral nutrition did not influence outcomes (all $p > 0.05$). ***Conclusion:*** The anastomotic leak rate was 4.9%, with no mortality in leak cases. Constipation at presentation emerged as a potential bedside indicator of increased risk, whereas demographic, operative, and laboratory factors showed no association. Larger multicentre studies with multivariable analysis are needed to validate these findings.

Keywords: Anastomotic leak, intestinal resection, constipation, surgical outcomes, risk factors.

INTRODUCTION

Anastomotic leak remains one of the most consequential complications after intestinal resection, driving reintervention, prolonged hospitalization, and mortality [1,2]. Large clinical series and multivariable analyses have consistently identified a multifactorial risk profile that spans patient factors (e.g., comorbidity, nutrition), disease acuity, and operative variables [1,2]. Accurate characterization of leak is further complicated by heterogeneity in definitions and diagnostic thresholds across studies, which affects reported incidence and hampers comparability [3].

Historical and contemporary data suggest that early postoperative complications after gastrointestinal anastomosis are influenced by both technical and physiologic factors, including tissue perfusion, tension, contamination, and host response [4,5]. Methodological variability and differing surveillance strategies also shape observed timing: although some leaks declare within the early postoperative window, a substantial proportion present later than commonly assumed, underscoring the need for vigilant postoperative monitoring and clinically pragmatic risk stratification [6].

Against this background—and the persistent uncertainty around which bedside signals are most informative in routine practice—this study aimed to estimate the anastomotic leak rate in a prospective surgical cohort and to evaluate preoperative, operative, and baseline laboratory factors associated with leak, using standardized clinical definitions and transparent statistical reporting.

MATERIAL AND METHODS

Study design and setting
This was a prospective observational cohort conducted over a 12-month period in the Department of General Surgery, Parul Institute of Medical Sciences & Research (PIMSR), Limda–Waghodia, Vadodara (Gujarat, India). Consecutive eligible patients were enrolled after institutional ethics approval.

Participants: inclusion and exclusion criteria
Inclusion criteria
- Adults ≥18 years of age.
- Undergoing intestinal resection with anastomosis (small or large bowel).
- Hand-sewn or stapled anastomosis permitted.

Exclusion criteria
- Age <18 years.
- Immunocompromised patients (e.g., receiving cytotoxic/immunosuppressive therapy or with known immunodeficiency).
- Gastrojejunostomy procedures (excluded by protocol).
- Prior completed end-to-end gastrointestinal bypass without resection at the indexed

operation (not meeting the study's "resection + anastomosis" definition).

Recruitment and sample size
A convenience sample of 82 consecutive eligible cases was accrued within the study window. No formal a priori sample size calculation was performed; the cohort size reflects service volume and prospective case capture during the period.

Perioperative care and surgical technique
Perioperative optimization, anaesthesia, antibiotic prophylaxis, and postoperative care followed unit protocols. Anastomoses were performed at the operating surgeon's discretion (hand-sewn or stapled; end-to-end, side-to-side, or end-to-side configuration), with single- or double-layer suture techniques as per intraoperative judgement. Creation of a proximal diverting stoma (when used) was recorded.

Variables and data collection
Data were prospectively recorded on standardized forms and cross-checked against operative notes and inpatient records.

- Demographics & presentation: age, sex, symptom duration (<4 days, 4–6 days, >6 days), presenting features (abdominal pain, visible peristalsis, abdominal distension, tenderness, vomiting, constipation, tachycardia, ballooning per rectum, rigidity, palpable lump).
- Operative details: urgency (elective vs emergency), anastomosis type (end-to-end / side-to-side / end-to-side), site (e.g., ileo-ileal, ileo-colic, ileo-jejunal), suture layers (single vs double), proximal diverting stoma (yes/no).
- Peri-/postoperative supports: packed red cell transfusion (PCV), fresh frozen plasma (FFP), and total parenteral nutrition (TPN) (yes/no).
- Baseline laboratory parameters: hemoglobin, total leukocyte count (WBC), platelets (reported as lakh/mm³), random blood sugar (RBS), serum bilirubin, creatinine, urea, and albumin.
- Outcome (primary): Clinically diagnosed anastomotic leak in the immediate postoperative period, as determined by the treating team based on clinical findings and adjunct imaging/laboratory corroboration per unit protocol (e.g., feculent/enteric drainage, systemic signs with radiologic evidence, or need for re-intervention). Timing of detection, in-hospital management (conservative vs surgical), and mortality were recorded.

Handling of missing data
The dataset was reviewed for completeness at discharge. Analyses were conducted on available cases (complete-case approach). The number of leak events was 4, which constrained modelling to univariate tests.

Statistical analysis
Analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequency and percentage (n, %). Comparisons between groups were carried out using independent-samples t-tests for continuous variables and chi-square or Fisher's exact tests for categorical variables, as appropriate. A two-sided p-value < 0.05 was considered statistically significant. Given the limited number of anastomotic leak events, no multivariable modelling was performed, and the findings were interpreted with particular attention to precision and statistical power.

Ethics
The study received institutional ethics committee approval prior to enrollment. All procedures conformed to the Declaration of Helsinki and local regulatory requirements. Identifiable patient information was protected; data were analyzed in de-identified form.

RESULTS AND OBSERVATIONS:

Cohort profile (baseline characteristics)
Eighty-two patients were included (mean age 47.4 ± 16.8 years; 61% male). Over half presented within 6 days of symptom onset. Abdominal pain and visible peristalsis were universal, with abdominal distension, tenderness, and vomiting also common (Table 1).

2. Operative details
Most procedures were performed electively, and the end-to-end configuration was the dominant anastomotic technique. The ileum was the commonest site of reconstruction, and surgeons largely favoured a double-layer closure. Peri-operative support (blood products and, when indicated, parenteral nutrition) was used according to clinical need. The full distribution of operative variables and supports is shown in Table 2.

3. Primary outcome — anastomotic leak
Anastomotic leak occurred in 4/82 (4.9%) in the immediate postoperative period; no deaths were recorded among leak cases. On univariate testing, constipation at presentation was the only factor significantly associated with leak ($p = 0.034$). Age group, sex, symptom duration, other symptoms, etiology, urgency, anastomosis configuration, site, suture layers, and post-operative support (PCV/FFP/TPN) showed no significant associations (all $p > 0.05$) .

Table 1. Baseline characteristics (n = 82)

Variable	Category	n	%
Age (years)	Mean ± SD	**47.4 ± 16.8**	—
Age group	< 30	16	19.5
	31–40	13	15.9
	41–50	23	28.1
	51–60	9	11.0
	61–71	13	15.9
	> 70	8	9.8
Sex	Male	50	61.0
	Female	32	39.0
Symptom duration	< 4 days	36	43.9
	4–6 days	42	51.2
	> 6 days	4	4.9
Presenting symptoms	Abdominal pain	82	100.0
	Visible peristalsis	82	100.0
	Abdominal distension	69	84.1
	Tenderness	66	80.5
	Vomiting	60	73.2
	Tachycardia	53	64.6
	Ballooning per rectum	39	47.6
	Constipation	36	43.9
	Rigidity	19	23.2
	Palpable lump	15	18.3

Table 2. Operative and peri-operative details (n = 82)

Variable	Category	n	%
Urgency	Elective	47	57.3
	Emergency	35	42.7
Anastomosis type	End-to-end	53	64.6
	Side-to-side	23	28.1
	End-to-side	6	7.3
Site	Ileo-ileal	78	95.1
	Ileo-colic	3	3.7
	Ileo-jejunal	1	1.2
Suture layers	Double-layer	79	96.3
	Single-layer	3	3.7
Post-operative supports	Packed cells (PCV)	47	57.3
	Fresh frozen plasma (FFP)	24	29.3
	Total parenteral nutrition (TPN)	7	8.5

Part 4. Laboratory comparisons by leak status

Baseline laboratory values did not differ significantly between patients with and without an anastomotic leak. Representative comparisons showed no statistical differences for hemoglobin (12.58 ± 2.31 vs 11.08 ± 1.60 g/dL; $p = 0.079$) or total leukocyte count (9632 ± 2142 vs 10 336 ± 3490 /mm³; $p = 0.692$). Platelet counts were also similar (3.36 ± 1.52 vs 3.17 ± 1.49 lakh/mm³; $p = 0.802$). Other routinely measured parameters—RBS, serum bilirubin, creatinine, urea, and albumin—showed no significant differences (*all* $p > 0.05$).

Table 3. Anastomotic leak and univariate associations (n = 82)

Factor	Levels	Leak present (n)	Leak absent (n)	p-value
Overall	—	4	78	—
Age group	<30	0	16	
	31–40	2	11	
	41–50	0	23	
	51–60	1	8	
	61–71	1	12	
	>70	0	8	0.209
Sex	Male	3	47	
	Female	1	31	0.555
Symptom duration	<4 days	2	34	
	4–6 days	2	40	
	>6 days	0	4	1.000
Symptoms	Abdominal pain	4	78	—
	Visible peristalsis	4	78	—
	Abdominal distension	3	66	1.000
	Vomiting	2	58	0.621
	Constipation	4	32	0.034
	Tachycardia	2	51	0.927
	Past surgery	2	22	0.711
	Tenderness	4	62	0.717
	Rigidity	2	17	0.486
	Palpable lump	2	13	0.308
	Ballooning PR	2	37	1.000
Etiology	Bowel obstruction	1	25	
	Perforation	2	7	
	Stricture	1	4	
	Adhesions	0	14	
	Appendicitis	0	8	
	Abdominal Koch's	0	3	
	Hernia	0	7	
	Other	0	10	0.139
Urgency	Elective	2	45	
	Emergency	2	33	1.000
Anastomosis type	End-to-end	2	51	
	Side-to-side	2	21	
	End-to-side	0	6	0.693
Site	Ileo-ileal	4	74	
	Ileo-colic	0	3	
	Ileo-jejunal	0	1	1.000
Suture layers	Double-layer	4	75	
	Single-layer	0	3	1.000
Post-operative supports	Packed cells (PCV)	3	44	0.830
	FFP	1	23	0.847
	TPN	1	6	0.227

Statistical tests were chi-square or Fisher's exact as appropriate in the source analyses.

Figure 1. Anastomotic leak (%) by constipation at presentation (p = 0.034)

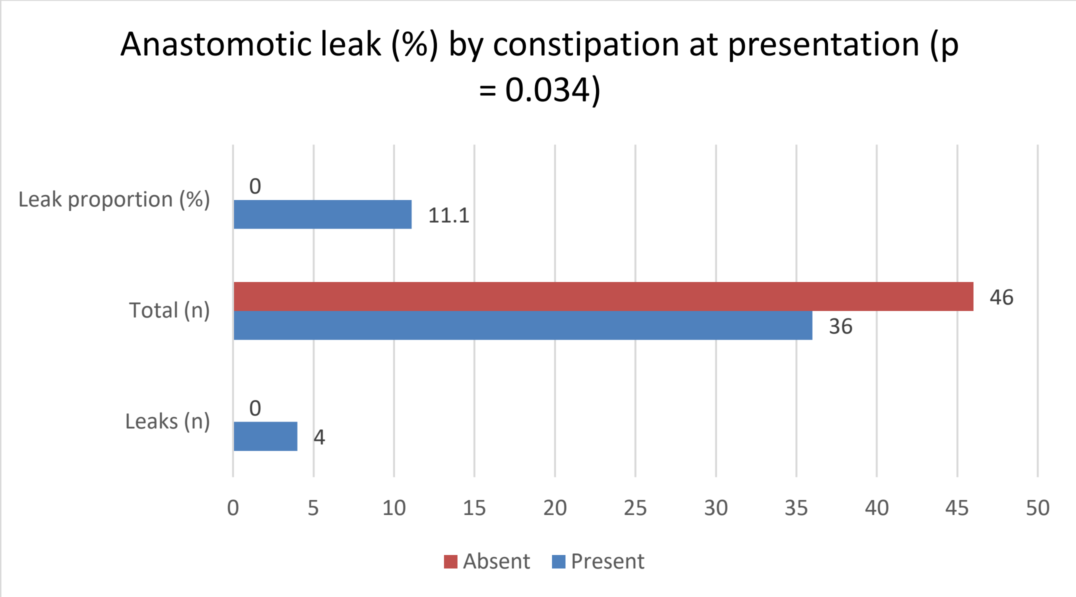

Table 4. Laboratory parameters (mean ± SD) by leak status

Parameter	Leak (mean ± SD)	No-leak (mean ± SD)	p-value	Test
Hemoglobin (g/dL)	12.58 ± 2.31	11.08 ± 1.60	0.079	Independent samples t-test
WBC (/mm³)	9632 ± 2142	10 336 ± 3490	0.692	Independent samples t-test
Platelets (lakh/mm³)	3.36 ± 1.52	3.17 ± 1.49	0.802	Independent samples t-test

Note: RBS, serum bilirubin, creatinine, urea, and albumin were also compared between groups and were not significantly different (*all p* > 0.05); values are not displayed to avoid redundancy.

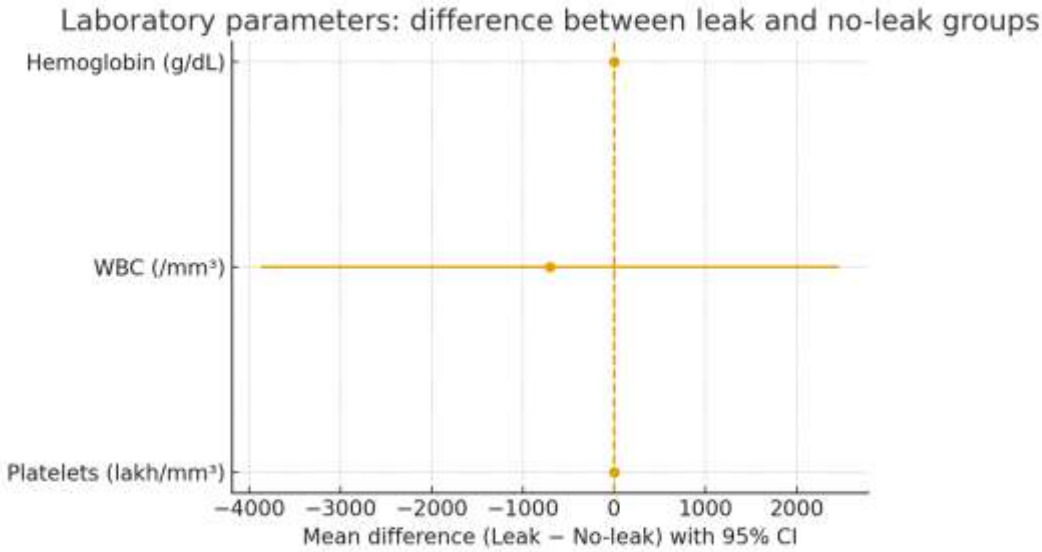

Figure 2. *Forest plot showing the mean difference (Leak − No-leak) with 95% CIs for hemoglobin, WBC, and platelets (n=4 leak; n=78 no-leak). The vertical line at 0 denotes no between-group difference. All confidence intervals cross zero, indicating no significant differences in these laboratory parameters between patients with and without anastomotic leak (Welch t-tests).*

5. Adverse Events and Robustness of Findings

Robustness of findings

Anastomotic leak occurred in 4/82 (4.9%) and all events were identified in the immediate postoperative period. There was no mortality among patients with leak. Given the small number of events, only univariate analyses were performed; therefore, null findings for most predictors should be interpreted cautiously because of limited statistical power. The single significant signal—constipation at presentation (11.1% vs 0%; p = 0.034)—is internally consistent, but confirmation in larger, adequately powered cohorts is warranted.

Adverse events and supportive care

Leak patients required additional imaging and interventions, and qualitatively experienced longer hospitalization; however, length-of-stay was not systematically recorded. Supportive measures among leak cases included packed cell transfusion (3 patients), fresh frozen plasma (1), and total parenteral nutrition (1); none of these supports showed a statistical association with leak in the overall cohort (all $p > 0.05$).

Sensitivity considerations

Several potentially relevant peri-operative variables (e.g., drain use, operative time, blood loss, ERAS elements) were not collected as independent variables, precluding adjusted analyses or sensitivity checks for these factors. Overall, the results should be viewed as directional and hypothesis-generating, with the constipation signal meriting prospective validation.

In summary, anastomotic leak occurred in 4.9% of patients, with constipation at presentation the only factor associated with leak on univariate analysis, while demographics, operative variables, and laboratory parameters showed no significant differences.

DISCUSSION

Our observed leak rate of 4.9% sits toward the lower end of what large bowel literature would consider typical, and is plausible for small-bowel anastomoses performed under standardized care pathways. In a 17,518-patient colorectal cohort, Parthasarathy et al. reported clinically important leak rates clustering around mid-single digits, with risk concentrated in higher-acuity and nutritionally depleted subsets [7]. That broader context helps anchor our figure: although our cohort is predominantly small-bowel, a leak rate near 5% is numerically consistent with lower-risk segments of large multicentre series [7].

Focusing specifically on small intestine and colon, Sakr et al. identified multivariable predictors that routinely emerge in surgical practice—emergency setting, contamination, hemodynamic stress, and nutritional compromise—as independent signals for anastomotic failure [8]. In contrast, our univariate screen detected constipation at presentation (11.1% vs 0%) but not emergency status or other peri-operative factors, which likely reflects limited statistical power rather than true absence of effect; nonetheless, the directionality (obstructive physiology at admission) is biologically coherent with the determinants summarized by Sakr et al. [8].

Consistent with that interpretation, El-Badawy's review of gastrointestinal leaks emphasized that obstructive burden, stasis, and intraluminal pressure changes can worsen tissue perfusion and impair healing, translating into higher leak risk when multiple stressors co-exist [9]. Our constipation signal can be read as a pragmatic bedside marker of obstructive physiology rather than a causal factor per se, aligning with the pathophysiologic framing in that review [9].

Emergency surgery often confers additional risk; Skovsen et al. recently highlighted that small-bowel anastomoses performed emergently carry higher complication profiles than elective cases, in part due to contamination, oedema, and hemodynamic instability [10]. We did not observe an emergency–elective separation (2 vs 2 leaks), which is numerically compatible with a small-event series; the lack of separation here should be interpreted as inconclusive rather than contradictory to the pattern reported by Skovsen et al. [10].

Technique comparisons in the literature also offer perspective. Slesser et al. showed, across colorectal RCTs, that compression, stapled, and hand-sewn configurations yield broadly similar leak risks once case-mix is accounted for [11]. In our data, anastomosis configuration (end-to-end vs side-to-side vs end-to-side) did not associate with leak, a finding that tracks with the "no clear winner" conclusion in methodologically balanced trials and meta-analyses [11]. Likewise, a randomized trial by Aniruthan et al. found no clinically meaningful difference in leak between single- and double-layer intestinal anastomoses under controlled conditions [12]. Our observation that all four leaks occurred in the double-layer group is numerically unsurprising given that >95% of procedures used double-layer closure; with only three single-layer cases, any comparison is underpowered and consistent with the RCT's equivalence signal [12].

Site-specific outcomes are also instructive. Sánchez-Guillén et al. reported leak rates in ileocolic anastomoses typically in the low single digits, with complications influenced more by case mix and peri-operative status than by anastomotic technique per se [13]. Although our cohort was predominantly ileo-ileal, a 4–5% leak rate is numerically compatible with those ileocolic benchmarks under routine practice, and our lack of technique-based signal mirrors their adjusted comparisons [13].

Nutritional status remains a recurrent risk theme. Anandan et al. reported that pre-operative hypoalbuminemia substantially increased leak risk in emergency gastrointestinal resections [14]. Our leak vs no-leak groups did not differ in albumin on univariate testing, which is best interpreted as underpowered rather than contrary to the weight of evidence; with only four events, even a moderate albumin effect would be difficult to resolve statistically [14]. A similar caution applies to transfusion-related risks. Cortina et al. found that longer operative time and intraoperative transfusion were associated with higher leak rates in lower-GI surgery [15]. We observed no association for PCV/FFP in univariate tests—again a plausible small-number result rather than a refutation of the linkage between physiologic stress, transfusion exposure, and anastomotic failure [15].

Pathways of care may also modulate risk. Behera et al., synthesizing ERAS-style early feeding in pediatric anastomosis, reported safety signals and shorter recovery metrics when protocols were adhered to [16]. While pediatric data are not directly transferable to adults, the directionality—structured pathways mitigating stress and accelerating recovery—supports the idea that standardized peri-operative care can compress risk in small-bowel anastomosis populations; our low mortality and prompt identification of leaks fit that broader narrative [16,17]. In line with this, Girard et al. emphasized early recognition and tailored management as central to preventing escalation of leak-related morbidity and mortality—principles consistent with our zero-mortality observation [17].
Finally, the constipation association in our cohort warrants clinical nuance. Yang et al. linked constipation and obstructive dynamics to early postoperative bowel dysfunction after colorectal surgery, underscoring how baseline motility and obstruction phenotypes shape downstream complications [18]. Our finding—leak enrichment among patients presenting with constipation—likely captures a related physiologic substrate (higher intraluminal pressure, stasis, mucosal ischemia) rather than a singular causal pathway [18]. Regionally, variation in case-mix (obstruction vs inflammatory vs neoplastic), emergency load, and resource availability can shift absolute rates and which predictors declare in small datasets; methodologically, univariate screens in low-event cohorts will down-weight subtle effects but still allow clinically coherent signals, as seen here with constipation [7–18].
Overall, the literature suggests that risk in small-bowel anastomosis is multifactorial—driven by acuity, contamination, perfusion, nutrition, and operative stress—while technique differences are often neutralized once case-mix is balanced [7–13,15–17]. Within that framework, our cohort's 4.9% leak rate, absence of mortality, and a single significant pre-operative signal (constipation) are numerically credible and align with the directionality reported across contemporary series, albeit with the important caveat that larger, adjusted studies are needed to refine effect sizes and confirm the constipation finding [7–18].

Limitations
This single-centre observational cohort had few leak events (n=4/82), limiting statistical power and restricting analyses to univariate tests. Several potentially relevant peri-operative variables (e.g., drain use, operative time, blood loss, ERAS elements) and length-of-stay were not systematically captured, precluding adjusted or sensitivity analyses. Findings may therefore have limited generalizability and should be interpreted as hypothesis-generating.

Conclusion

In this cohort, the anastomotic leak rate was 4.9%, with no mortality among leak cases. On univariate analysis, constipation at presentation was the only factor associated with leak (11.1% vs 0%; p=0.034), while demographics, operative variables, and baseline laboratories showed no significant associations. These results are directionally consistent with contemporary literature and suggest that obstructive physiology at admission may flag higher risk; larger, multicentre studies with multivariable adjustment are warranted to refine effect sizes and validate this signal.

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