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Strategies for the prevention of anastomotic dehiscence in colorectal surgery: a narrative review

Estratégias para prevenção de deiscência anastomótica em cirurgia colorretal: uma revisão narrativa

Estrategias para prevenir la dehiscencia anastomótica en cirugía colorrectal: una revisión narrativa

Sara Biavati – Medical student at Centro Universitário São Camilo.
Matheus Biavati – Medical student at Universidade Federal de Santa Maria (UFSM).
Anna Paula Tonelo Ziliotto – Medical student at Universidade Federal de Santa Maria (UFSM).
Gabriel Muradás – Medical student at Universidade de Santa Cruz do Sul (UNISC).
Julia Simon Manzke – Medical student at Universidade de Santa Cruz do Sul (UNISC).

Abstract:
Introduction: Anastomotic leakage is one of the most serious complications of colorectal surgery, associated with increased morbidity and mortality, the need for reinterventions, and prolonged hospital stay. Its multifactorial etiology makes prevention a significant challenge in surgical practice. Objective: To analyze the main risk factors associated with anastomotic leakage in colorectal surgery and the available evidence regarding preventive strategies. Methods: This narrative literature review was conducted using the PubMed database, including publications from 2021 to 2026. The search terms “anastomotic leak”, “colorectal surgery”, and “prevention” were combined using Boolean operators. The search was restricted to publications in English and Portuguese and to randomized controlled trials, systematic reviews, and meta-analyses. Fifteen studies were selected for descriptive and critical analysis. Results and discussion: Mechanical bowel preparation combined with oral antibiotics showed consistent evidence of reduced anastomotic leakage compared with mechanical bowel preparation alone. Intraoperative perfusion assessment using indocyanine green fluorescence imaging yielded promising results, although discrepancies remain between randomized clinical trials and meta-analyses. Other interventions, including transanal drainage, anastomotic reinforcement, and modifications of surgical techniques, showed heterogeneous or insufficient evidence to establish preventive benefits. Conclusion: Prevention of anastomotic leakage requires an individualized approach based on risk assessment and the best available scientific evidence. Further studies are needed to clarify the effectiveness of strategies for which evidence remains inconclusive.

Keywords: Anastomotic Leak; Colorectal Surgery; Prevention; Surgical Anastomosis; Postoperative Complications.

Resumo:
Introdução: A deiscência anastomótica representa uma das complicações mais graves da cirurgia colorretal, associada ao aumento da morbimortalidade, à necessidade de reintervenções e ao prolongamento da internação hospitalar. Sua etiologia multifatorial torna a prevenção um desafio na prática cirúrgica. Objetivo: Analisar os principais fatores de risco associados à deiscência anastomótica em cirurgia colorretal e as evidências disponíveis sobre estratégias para sua prevenção. Metodologia: Trata-se de uma revisão narrativa da literatura, realizada na base de dados PubMed, com publicações entre 2021 e 2026. Foram utilizados os termos “anastomotic leak”, “colorectal surgery” e “prevention”, combinados por operadores

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booleanos. A busca foi delimitada aos idiomas inglês e português e aos tipos de estudo ensaio clínico randomizado, revisão sistemática e metanálise. Foram selecionados 15 estudos para análise descritiva e crítica. Resultados e discussão: A associação do preparo intestinal mecânico à antibioticoterapia oral apresentou evidências consistentes de redução da deiscência anastomótica em comparação ao preparo mecânico isolado. A avaliação intraoperatória da perfusão com indocianina verde demonstrou resultados promissores, embora persistam divergências entre ensaios clínicos e metanálises. Outras intervenções, como drenagem transanal, reforço anastomótico e modificações técnicas cirúrgicas, apresentaram resultados heterogêneos ou insuficientes para comprovar benefício preventivo. Conclusão: A prevenção da deiscência anastomótica exige abordagem individualizada, fundamentada na avaliação dos fatores de risco e nas evidências científicas disponíveis. Estudos adicionais são necessários para esclarecer a eficácia das estratégias ainda controversas.

Palavras-chave: Deiscência anastomótica; Cirurgia colorretal; Prevenção; Anastomose cirúrgica; Complicações pós-operatórias.

Resumen:
Introducción: La dehiscencia anastomótica es una de las complicaciones más graves de la cirugía colorrectal y se asocia con mayor morbimortalidad, necesidad de reintervenciones y hospitalización prolongada. Su etiología multifactorial dificulta la prevención. Objetivo: Analizar los principales factores de riesgo asociados a la dehiscencia anastomótica en cirugía colorrectal y la evidencia disponible sobre estrategias preventivas. Metodología: Revisión narrativa realizada en PubMed con publicaciones de 2021 a 2026. Se combinaron los términos “anastomotic leak”, “colorectal surgery” y “prevention” mediante operadores booleanos. La búsqueda se limitó a inglés y portugués y a ensayos clínicos aleatorizados, revisiones sistemáticas y metaanálisis. Se seleccionaron 15 estudios para análisis descriptivo y crítico. Resultados y discusión: La preparación intestinal mecánica combinada con antibióticos orales mostró evidencia consistente de reducción de la dehiscencia frente a la preparación mecánica aislada. La evaluación intraoperatoria de la perfusión con verde de indocianina presentó resultados prometedores, aunque persisten divergencias entre ensayos y metaanálisis. Otras intervenciones, como drenaje transanal, refuerzo anastomótico y modificaciones técnicas, mostraron resultados heterogéneos o insuficientes para demostrar beneficios preventivos. Conclusión: La prevención exige un enfoque individualizado basado en la evaluación de riesgos y la evidencia científica disponible. Se necesitan estudios adicionales para esclarecer la eficacia de las estrategias aún controvertidas.

Palabras clave: Dehiscencia anastomótica; Cirugía colorrectal; Prevención; Anastomosis quirúrgica; Complicaciones posoperatorias.

1. Introduction

Anastomotic leakage is one of the most serious complications of colorectal surgery and is associated with increased postoperative morbidity and mortality, the need for surgical reinterventions, and prolonged hospital stay. Its occurrence poses a significant challenge to surgical practice because it can compromise patient recovery, increase healthcare costs, and impair long-term functional and oncological outcomes. Despite advances in surgical techniques

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and perioperative care, preventing this complication remains an important concern in colorectal surgery [1,2].

The etiology of anastomotic leakage is multifactorial, involving patient clinical characteristics, local tissue conditions, and aspects of the surgical procedure. Associated factors include impaired blood perfusion, excessive tension along the anastomotic line, technical difficulties, and conditions that impair tissue healing. Anastomotic location is also relevant, particularly in procedures involving the rectum, in which anatomical and operative characteristics may contribute to a higher risk of complications [3,4].

Against this background, different strategies have been investigated to reduce the incidence of anastomotic leakage. These include optimization of preoperative conditions, bowel preparation combined with oral antibiotics, intraoperative perfusion assessment using indocyanine green fluorescence, improvements in anastomotic techniques, and the use of reinforcement or protective devices. However, although some interventions show favorable results, others remain controversial, with heterogeneous evidence regarding effectiveness [5,6].

The diversity of factors involved in anastomotic leakage and the lack of consistent results across the interventions studied reinforce the importance of critically analyzing the available evidence. Understanding the mechanisms associated with anastomotic failure and identifying strategies with demonstrated clinical benefits are essential to guide surgical decisions and contribute to patient safety. In this context, this study aims to identify the main risk factors associated with anastomotic leakage in colorectal surgery and critically analyze the available scientific evidence on preventive strategies, seeking to identify those that demonstrate a benefit in reducing this complication.

2. Methods

This is a descriptive and analytical narrative literature review designed to identify the main risk factors associated with anastomotic leakage in colorectal surgery and analyze the available evidence on strategies to prevent this complication. The study was guided by the following question: “What are the main risk factors for anastomotic leakage in colorectal surgery, and which preventive strategies show evidence of benefit in reducing this complication?”

The literature search was performed in PubMed, considering publications between 2021 and 2026. The terms “anastomotic leak”, “colorectal surgery”, and “prevention” were combined using Boolean operators. Language filters restricted the search to English and Portuguese

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publications, and study-type filters included randomized clinical trials, systematic reviews, and meta-analyses.

Studies addressing factors associated with anastomotic leakage and preoperative, intraoperative, or postoperative interventions to prevent this complication in patients undergoing colorectal surgery were eligible. Publications without a direct relationship to the review objective, those exclusively addressing diagnosis or treatment of established leaks, or those without results relevant to the research question were excluded.

Study selection initially involved reading titles and abstracts, followed by assessment of full texts for thematic relevance. The search identified 24 articles, of which 10 were excluded for failing to meet eligibility criteria, leaving 14 selected studies. One additional study relevant to the review objective was subsequently incorporated, yielding 15 publications.

The studies were analyzed descriptively and critically, considering methodological designs, study populations, preventive strategies evaluated, and main results concerning anastomotic leakage. Findings were organized by thematic areas to identify convergence, divergence, and limitations of the available evidence, as well as implications for surgical practice.

3. Development and discussion

3.1. Preoperative optimization and bowel preparation

Prevention of anastomotic leakage in colorectal surgery involves measures adopted at different stages of perioperative care. Preoperative strategies include optimization of nutritional status and bowel preparation, whose effectiveness has been investigated in clinical studies and systematic reviews. Although these interventions have different pathophysiological foundations, both seek to reduce conditions potentially unfavorable to postoperative recovery and anastomotic healing.

Mechanical bowel preparation combined with oral antibiotics is one of the most extensively studied strategies. In a systematic review published in 2023, Willis et al. analyzed randomized clinical trials comparing different bowel preparation modalities in elective colorectal surgery. Compared with mechanical preparation alone, mechanical preparation combined with oral antibiotics significantly reduced anastomotic leakage (RR = 0.60; 95% CI: 0.36–0.99) and surgical site infection (RR = 0.56; 95% CI: 0.42–0.74). The authors rated the certainty of this evidence as moderate [4].

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Similar results were reported in a meta-analysis published in 2025, which included nine randomized clinical trials and 3,046 patients undergoing colorectal cancer surgery. Adding oral antibiotics to mechanical preparation was associated with significantly reduced anastomotic leakage (OR = 0.45; 95% CI: 0.32–0.65), as well as surgical site infections. The benefit was also observed in the specific analysis of patients undergoing rectal cancer surgery [1].

Agreement between these reviews suggests that combining mechanical preparation and oral antibiotics offers advantages over mechanical preparation alone. However, the findings do not necessarily demonstrate superiority over oral antibiotics alone, a comparison for which uncertainty persists.

Another intervention investigated is preoperative enteral immunonutrition. In a systematic review and meta-analysis involving ten studies, McKechnie et al. (2025) evaluated immunonutritional supplementation compared with conventional nutritional protocols. Although the estimated leakage risk was lower in the intervention group (RR = 0.56; 95% CI: 0.28–1.10), the difference did not reach statistical significance. Evidence certainty was rated as low or very low [8].

These results indicate that immunonutrition is a potentially promising strategy, but its specific effectiveness in preventing anastomotic leakage has not been conclusively demonstrated. Assessment and optimization of nutritional status should therefore be distinguished from routine use of immunonutritional formulas solely to reduce this complication.

3.2. Intraoperative assessment of anastomotic perfusion

Adequate blood perfusion is a fundamental element of intestinal healing. Indocyanine green fluorescence angiography has therefore been investigated as a complement to visual assessment of vascularization, allowing identification of potentially hypoperfused areas during construction of the anastomosis.

Despite its pathophysiological rationale, clinical findings remain inconsistent. In the AVOID randomized clinical trial, Faber et al. (2024) evaluated indocyanine green during minimally invasive colorectal surgery. The study did not demonstrate a statistically significant reduction in the overall incidence of anastomotic leakage with routine use of the technology [3].

Similarly, in the multicenter ICG-COLORAL trial, Rinne et al. (2025) evaluated 1,136 patients undergoing laparoscopic colorectal resections, excluding low anterior resections.

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Leakage occurred in 5.8% of patients assessed using fluorescence and 7.9% of those assessed conventionally, without a statistically significant difference (OR = 0.73; 95% CI: 0.48–1.13; p = 0.16). Analysis of left-sided colon surgery showed a trend toward fewer complications, also without statistical significance [2].

The IntAct trial, published by Jayne et al. (2025), specifically investigated patients undergoing rectal cancer surgery. Among the 698 participants included in the primary analysis, clinical leakage occurred in 10% of patients assessed using indocyanine green and 15% of those assessed conventionally. Despite the numerical difference, the result did not reach statistical significance (adjusted OR = 0.667; 95% CI: 0.419–1.060; p = 0.087) [6].

In contrast, systematic reviews and meta-analyses reported more favorable results for the technology. Lucarini et al. (2024) identified a potential benefit of indocyanine green angiography in reducing leakage after rectal cancer surgery [9]. Subsequently, a meta-analysis published in 2025, pooling eight randomized clinical trials and 3,999 patients, found an association between fluorescence assessment and reduced anastomotic leakage (OR = 0.64; 95% CI: 0.39–0.98) [5].

Lack of statistical significance in individual trials does not, by itself, demonstrate absence of benefit. Likewise, favorable meta-analysis results do not ensure consistent effectiveness across all colorectal procedures. Indocyanine green is therefore a promising tool, particularly for perfusion assessment in left-sided and rectal anastomoses, although questions remain about standardized use and identification of patients most likely to benefit.

3.3. Surgical techniques and anastomotic integrity

Construction of a safe anastomosis depends on technical integrity, adequate vascularization, and absence of excessive tension between intestinal segments. Different modifications of surgical techniques have therefore been investigated to determine their influence on leakage incidence.

One issue concerns the level of inferior mesenteric artery ligation during anterior resection for rectal cancer. A randomized clinical trial published in 2026 compared high and low ligation in patients undergoing minimally invasive procedures. Among the 293 patients analyzed, symptomatic leakage occurred in 4.9% of the low-ligation group and 6.0% of the high-ligation group, without a statistically significant difference (p = 0.68) [7].

These findings show that preserving the left colic artery through low ligation did not demonstrably reduce leakage in the study population. Technique selection should therefore

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consider other anatomical, oncological, and operative aspects; preventive superiority cannot be established from these results.

Splenic flexure mobilization is another strategy related to obtaining sufficient bowel length to construct tension-free anastomoses. In a systematic review and meta-analysis of 19 studies involving 81,116 patients, Emile et al. (2024) observed an association between splenic flexure mobilization and increased anastomotic leakage (OR = 1.19; 95% CI: 1.06–1.33) [15].

Although this result may appear contrary to the principle of avoiding anastomotic tension, it does not establish that mobilization causes increased complications. The decision to mobilize the flexure may reflect procedural complexity and the need to achieve a technically feasible anastomosis, producing preexisting differences between comparison groups. Interpretation therefore requires caution because of possible confounding by surgical indication.

Another aspect investigated is development of staplers with different mechanical suture configurations. The THREESTAPLER trial compared two-row and three-row circular staplers for low colorectal anastomoses after total mesorectal excision. Among 154 patients, leakage occurred in 16.9% of the three-row group and 15.6% of the two-row group, without a statistically significant difference (p = 0.80) [13].

The results did not demonstrate an advantage of three-row technology in preventing leakage. Furthermore, limitations related to sample size and the noninferiority design restrict definitive conclusions about device equivalence.

Together, these studies indicate that technical modifications potentially favorable to anastomotic construction do not necessarily produce measurable reductions in leakage. Anastomotic quality should be understood as the result of interactions between anatomical, vascular, and operative factors, rather than merely selection of a specific device or technique.

3.4. Anastomotic reinforcement and local protective strategies

Materials for anastomotic reinforcement or sealing have been investigated as a way to increase strength and reduce intestinal leakage. Among the technologies evaluated are surgical adhesives applied directly to the anastomotic line.

The multicenter randomized ReAL trial, published in 2024, evaluated reinforcement using modified cyanoacrylate in patients undergoing surgery for middle or upper rectal cancer. Among the 133 patients who completed follow-up, leakage occurred in 6.6% of the intervention group and 12.5% of the control group, without a statistically significant difference (p = 0.36).

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However, postoperative complications above Clavien-Dindo grade II were less frequent in the reinforcement group [11].

Although the numerical reduction in leakage suggests a possible benefit, these results do not establish cyanoacrylate application as an effective preventive measure. The relatively small sample and lack of statistical significance for the primary outcome limit interpretation.

Use of these materials should therefore be considered investigational. Larger studies with standardized assessment criteria and adequate follow-up are needed to determine effectiveness and safety before routine adoption can be recommended.

3.5. Transanal drainage after low anterior resection

Transanal drainage has been proposed to reduce intraluminal pressure and promote decompression proximal to the anastomosis, particularly after low anterior rectal resection. However, its use remains controversial because of inconsistent findings in the literature.

Zhao et al. (2021) conducted a multicenter randomized clinical trial involving 560 patients undergoing laparoscopic low anterior resection for rectal cancer. Leakage incidence was similar in patients with and without transanal drainage, at 6.4% and 6.8%, respectively (RR = 0.947; 95% CI: 0.508–1.766; p = 0.87). No significant differences in leakage severity were observed either [14].

In a meta-analysis published in 2024, which included three randomized clinical trials and 18 observational studies, findings differed by methodological design. In randomized trials, transanal drainage did not significantly reduce leakage (RR = 0.69; 95% CI: 0.42–1.15). Observational studies, however, identified an association favoring the intervention (OR = 0.45; 95% CI: 0.31–0.64) [10].

In subgroup analyses without a diverting stoma, the meta-analysis identified a possible reduction in leakage with transanal tube use, including in randomized trials. However, interpretation should account for smaller patient numbers and limitations inherent to subgroup analyses.

The divergence between randomized and observational studies may relate to differences in patient characteristics, concomitant use of diverting stomas, and selection of individuals for drainage. Thus, despite suggested benefits under certain conditions, evidence does not consistently support routine transanal drainage as a universal measure to prevent anastomotic leakage.

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3.6. Experimental strategies to protect healing

Beyond traditional interventions, new approaches have sought to modify physiological conditions related to anastomotic healing. Among these, remote ischemic preconditioning has been investigated for its potential to attenuate tissue ischemia-reperfusion injury.

In the randomized RIPAL pilot trial, Hardt et al. (2024) evaluated this intervention in patients undergoing anterior resection for rectal cancer. Of 54 randomized patients, 51 were included in the primary outcome analysis. Leakage incidence was similar in the remote ischemic preconditioning and control groups, at 16.0% and 15.4%, respectively ($p = 1.00$) [12].

Although the proposal has a plausible pathophysiological basis, results did not demonstrate a preventive effect on leakage. Furthermore, as a pilot study, its small sample limits statistical power to identify clinically relevant differences.

Remote ischemic preconditioning therefore remains an experimental strategy whose use in preventing anastomotic leakage requires confirmation in larger clinical trials.

3.7. Critical synthesis of the evidence

Joint analysis of the selected studies shows that prevention of anastomotic leakage in colorectal surgery remains a multifactorial challenge for which different strategies have different levels of evidence.

Among preoperative interventions, mechanical bowel preparation combined with oral antibiotics showed favorable and relatively consistent results in reducing leakage compared with mechanical preparation alone. In contrast, despite estimates suggesting benefit, immunonutrition has not yet demonstrated a statistically significant reduction in this complication.

Intraoperatively, perfusion assessment using indocyanine green stands out for the number of available studies. Although meta-analyses indicate reduced leakage, large multicenter clinical trials reported nonsignificant results, suggesting that benefits may vary by intestinal segment, procedure type, and study population characteristics.

The technical modifications evaluated, including inferior mesenteric artery ligation level, splenic flexure mobilization, and staplers with different configurations, likewise failed to demonstrate universal preventive superiority. These findings reinforce the need to individualize technical decisions according to anatomical and operative conditions.

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Complementary strategies, such as transanal drainage, cyanoacrylate reinforcement, and remote ischemic preconditioning, show heterogeneous or still insufficient results to justify routine preventive use.

Interpretation of the evidence should consider differences between studies in anastomotic location, presence of diverting stomas, methods used to diagnose leakage, and postoperative follow-up duration. Simultaneous inclusion of clinical trials and systematic reviews with potentially overlapping studies also requires caution to avoid treating evidence from the same populations as independent.

Furthermore, absence of a statistically significant difference should not automatically be interpreted as proof of equivalence between interventions. In small-sample studies, wide confidence intervals may indicate substantial uncertainty about the true effect magnitude.

These review findings therefore suggest that prevention of anastomotic leakage should rely on an integrated perioperative approach. Among the measures evaluated, mechanical bowel preparation combined with oral antibiotics has the most consistent favorable evidence compared with mechanical preparation alone. Indocyanine green perfusion assessment also shows potential benefit, particularly in certain colorectal procedures, although disagreement between studies persists.

The other interventions analyzed require further investigation before their preventive effectiveness can be established conclusively.

4. Final considerations

Prevention of anastomotic leakage in colorectal surgery remains a multifactorial challenge related to patient clinical conditions and technical and perioperative aspects. Among the strategies analyzed, mechanical bowel preparation combined with oral antibiotics showed the most consistent evidence of benefit in reducing this complication compared with mechanical preparation alone.

Anastomotic perfusion assessment using indocyanine green showed promising results, although discrepancies remain between clinical trials and meta-analyses. Conversely, interventions such as transanal drainage, anastomotic reinforcement, and surgical technique modifications did not show uniformly proven benefits.

These findings reinforce the importance of individualized prevention based on risk-factor assessment and the best available evidence. Further studies are needed to clarify the

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effectiveness of strategies that remain controversial and contribute to safer colorectal procedures.

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