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REVIEW

Anastomotic Integrity in Colorectal Surgery for Colorectal Cancer: The Role of Protective Ileostomy and the Corner Effect

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ABSTRACT

Anastomotic leakage is one of the most significant complications following low colorectal surgery for rectal cancer, with profound implications on morbidity, mortality, and long-term oncological outcomes. Protective ileostomy has been widely adopted to mitigate these risks by diverting fecal flow away from the anastomotic site, allowing it to heal without exposure to bowel contents. However, recent discourse challenges the routine use of protective ileostomies, suggesting a more selective approach based on patient-specific risk factors, surgical techniques, and intraoperative findings. This review examines the multifactorial nature of anastomotic failure, focusing on the impact of patient comorbidities, neoadjuvant therapies, surgical expertise, and technological advances, such as fluorescence angiography with indocyanine green (ICG), to assess tissue perfusion. The concept of the "corner effect" in low colorectal anastomoses, where tension and ischemia at stapled junctions predispose to leakage, is discussed. The review also explores the implications of long-term ileostomy use, including its association with Low Anterior Resection Syndrome (LARS) and delayed recovery. Further, we address gaps in the literature regarding the timing of ileostomy reversal, the influence of neoadjuvant therapy on anastomotic healing, and the potential role of bioabsorbable materials in reinforcing anastomoses. The review calls for a more personalized approach to protective ileostomy use, integrating patient characteristics, surgical expertise, and technological advancements to optimize outcomes in colorectal cancer surgery.

Keywords: Anastomotic leak, colorectal neoplasms, colorectal surgery, ileostomy.

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1. Introduction

Anastomotic leakage is one of the most critical complications in colorectal surgery, particularly after low anterior resection for rectal cancer. This complication not only increases morbidity and mortality but also impairs long-term oncological outcomes and significantly affects the quality of life of patients [1], [2].

The intricate anatomy of the pelvis, the low blood supply to the distal bowel, and the technical challenges associated with creating a secure anastomosis in a confined space contribute to the complexity of the procedure [2]. Despite advancements in surgical techniques and innovations in stapling devices, anastomotic failure remains a significant issue that surgeons strive to mitigate [3], [4].

One of the critical challenges in low colorectal anastomoses is the so-called *corner effect*, which occurs at the intersection of linear and circular stapler lines. These junctions are inherently weak points, as the alignment of the stapler lines may be suboptimal, leading to inadequate tissue apposition and perfusion. Inadequate vascularization at these critical junctions creates a predisposition for ischemia, which is a known risk factor for anastomotic leakage [5]–[7].

Moreover, the mechanical forces exerted at these angles during the passage of fecal content can exacerbate the fragility of the anastomotic site, further increasing the likelihood of leakage [8].

Creating a protective ileostomy is a well-established technique to reduce the risk of anastomotic leakage by

diverting fecal flow away from the newly formed anastomosis [9]. By lowering the mechanical stress on the anastomotic site during the early postoperative period, ileostomies allow the anastomosis time to heal without being subjected to the pressure and microbial load of intestinal contents [10].

This protective mechanism has been widely adopted in rectal cancer surgery, particularly in patients undergoing low anterior resection, where the risk of leakage is higher due to the proximity of the anastomosis to the anal sphincter [11].

However, the protective ileostomy is not without its complications. Ileostomies are associated with dehydration, electrolyte imbalances, stoma prolapse, and peristomal skin irritation [6]. The need for a second surgery to reverse the ileostomy presents further risks, including bowel obstruction, infection, and hernia formation [12]. The decision to create a protective ileostomy must, therefore, be balanced against these potential complications, particularly in patients who may be at higher risk for adverse outcomes from stoma creation and reversal [13].

In recent years, the debate has intensified over the absolute necessity of protective ileostomies in all patients undergoing low colorectal anastomosis. Some studies suggest that with the advent of newer technologies—such as intraoperative fluorescence angiography with indocyanine green (ICG)—it may be possible to assess anastomotic perfusion better intraoperatively and thus selectively create ileostomies only in patients deemed to be at higher risk for leakage. The selective use of protective ileostomies could reduce the incidence of stoma-related complications without compromising the safety of the anastomosis [14]–[16].

In addition, improvements in surgical techniques, such as tension-free anastomosis construction and meticulous tissue handling, have reduced the risk of leakage [17]. Bioabsorbable meshes or tissue adhesives applied at the anastomosis site have also been proposed to reinforce the anastomosis and reduce the likelihood of failure, particularly at the vulnerable junction points where the stapler lines meet [18].

A comprehensive understanding of the risk factors for anastomotic leakage is essential for improving patient outcomes. These factors include the technical aspects of the surgery and patient-related factors such as nutritional status, comorbidities, and preoperative therapies like neoadjuvant chemoradiation, which can impair wound healing [19]–[21].

Identifying patients at the highest risk for leakage and tailoring the surgical approach to their risk profile is critical to modern colorectal surgery [14]. Despite the widespread use of protective ileostomies and advances in surgical techniques, anastomotic leakage remains a significant challenge in colorectal surgery [22].

The literature reflects an ongoing evolution in the strategies used to mitigate this risk, from the selective use of protective ileostomies to the implementation of new technologies and materials designed to reinforce the anastomosis [9]. However, the decision-making process regarding the use of protective ileostomies remains subjective, with considerable variability in practice among surgeons [23].

This review aims to comprehensively analyze the current state of knowledge regarding preventing anastomotic leakage in low colorectal anastomoses. It will explore the role of protective ileostomy, the impact of the corner effect, and the potential benefits of emerging technologies and techniques [16]–[18].

By synthesizing the latest evidence, this review seeks to clarify the indications for protective ileostomy and offer recommendations for optimizing anastomotic integrity in patients undergoing low anterior resection for rectal cancer [10]. This review aims to inform clinical practice by highlighting the factors contributing to anastomotic leakage and offering evidence-based strategies for prevention.

2. Methods

This integrative review was carefully designed to investigate the relationship between protective ileostomy and the prevention of anastomotic leaks in patients undergoing colorectal surgery for colorectal neoplasms. The review explores the occurrence of Low Anterior Resection Syndrome (LARS) and the use of secondary prevention strategies within colorectal surgery. The methodological approach was structured to ensure a comprehensive topic exploration, capturing a wide range of relevant literature. A systematic search was conducted across several major databases, including PubMed, Scopus, Embase, Web of Science, and SciELO, to identify relevant peer-reviewed studies. To supplement this, Google Scholar was also utilized to capture gray literature, such as reports, theses, and conference proceedings, thereby including studies that might not be indexed in traditional databases. The search strategy employed a combination of keywords and MeSH terms, including *anastomotic leak*, *colorectal neoplasms*, *ileostomy*, *low anterior resection syndrome*, *secondary prevention*, and *colorectal surgery*, ensuring the inclusion of studies directly addressing these critical areas.

The selection process was rigorous and systematic, with all reviewers blinded throughout the procedure. Two reviewers independently assessed each study's title and abstract without knowing which articles were being evaluated by the other reviewer, ensuring impartiality. Studies that met the predefined inclusion criteria were subjected to a full-text review, during which the methodology, findings, and conclusions were critically assessed. This full-text review was also conducted under blinded conditions, where neither reviewer was aware of the articles selected by the other. In cases where discrepancies arose, a third blinded reviewer was consulted to resolve any disagreements, ensuring unbiased and consistent decision-making. This meticulous and blinded process was designed to improve the accuracy and reliability of the review's findings.

Inclusion criteria for this review required that studies focus on the role of protective ileostomy in colorectal cancer surgery, particularly concerning anastomotic integrity, LARS, and preventive measures. Studies that provided

insights into surgical innovations, technological advancements, or patient-specific factors influencing outcomes were also included.

Exclusion criteria ruled out studies that lacked direct relevance to the surgical techniques or outcomes under investigation and non-human studies, case reports, and editorials. Data was extracted narratively, summarizing key findings and conclusions from each selected study. Emphasis was placed on study methodologies, reported rates of complications like anastomotic leaks and LARS, and the effectiveness of secondary prevention strategies, including emerging surgical technologies. This analysis aimed to identify patterns, knowledge gaps, and areas for improvement in clinical outcomes for colorectal cancer surgery.

Through an integrative approach, this review aims to provide a broad yet detailed understanding of the current practices, challenges, and advances in using protective ileostomy within colorectal surgery. The review's findings are intended to inform future research and enhance clinical practice by offering insights into preventing anastomotic complications and managing postoperative outcomes in patients with colorectal neoplasms.

3. Results and Discussion

Anastomotic leakage is one of the most severe complications in colorectal surgery, particularly after low anterior resection (LAR) for rectal cancer. This complication not only increases postoperative morbidity and mortality but also has long-lasting effects on oncological outcomes and quality of life (Table 1) [24].

In response to the high risk of leakage, protective ileostomy has been widely adopted to mitigate these risks by diverting fecal flow away from the anastomosis, allowing it more time to heal [17].

Recent discussions in the surgical community have questioned whether protective ileostomy should be a standard practice for all patients [8]. Instead, there is growing consideration that it should be selectively applied based on individual patient risk factors, intraoperative findings, and advancements in surgical technology [25].

The multifactorial nature of anastomotic leakage necessitates a more comprehensive understanding of the interaction between patient-specific characteristics, surgical technique, perioperative management, and materials used in the procedure [26].

Patient-related factors are among the most significant contributors to anastomotic leakage [5]–[8]. A patient's overall health status, including comorbidities such as diabetes, cardiovascular disease, and malnutrition, can severely impair tissue healing and make them more susceptible to anastomotic failure [27].

Malnourished patients, for example, have diminished regenerative capacity, leading to a higher likelihood of anastomotic breakdown [15]. Similarly, patients with compromised vascular systems, such as those with diabetes, may experience impaired wound healing due to reduced microvascular perfusion, which increases the risk of anastomotic dehiscence. Frailty, age, and general performance status are critical in determining outcomes [28]–[30].

Older patients have less robust tissue repair mechanisms and are, therefore, more prone to complications. Lifestyle factors such as smoking and alcohol consumption, although often overlooked, significantly impair tissue healing and contribute to an increased risk of leakage [31]–[33].

Preoperative optimization of a patient's health status through nutritional support, management of comorbidities, and cessation of smoking could play a crucial role in reducing leakage rates. Still, these strategies have yet to be thoroughly investigated in clinical trials [34]–[36].

For oncological patients, the timing of surgery relative to neoadjuvant therapies, such as chemotherapy and radiation, adds another layer of complexity to anastomotic healing. While these treatments effectively shrink tumors and improve resectability, they can also impair tissue healing [37], [38].

Radiation therapy induces fibrosis and reduces vascularity in irradiated tissues, compromising their ability to heal effectively. This issue is especially pertinent in low colorectal anastomoses, where blood supply is already limited due to the pelvic anatomy [39], [40].

Chemotherapy compounds these challenges by suppressing the immune system and delaying cellular regeneration, leaving the anastomotic site vulnerable to failure [22]. Thus, oncological patients who have undergone neoadjuvant therapy may require additional protective measures, such as a protective ileostomy, to mitigate the increased risk of anastomotic complications [41].

The timing of surgery after neoadjuvant treatment is critical; if surgery is performed too soon after radiation, tissues may still be vulnerable to damage, while waiting too long may result in excessive fibrosis, making the anastomosis more challenging [36]. This delicate balance highlights a significant gap in current knowledge, as the optimal timing for surgery in this context remains unclear [42]–[44].

The surgical technique itself is a crucial determinant of anastomotic success, especially in the complex and high-risk setting of rectal cancer surgery [30]. Poorly constructed anastomoses created under tension or with inadequate perfusion are far more likely to fail [45].

One issue in low colorectal anastomoses is the so-called "corner effect," which occurs at the junction of the circular and linear stapler lines. These weak points are prone to ischemia and mechanical stress, making them more susceptible to leakage [46].

These junctions are particularly vulnerable in oncological patients, who may already have compromised tissue integrity due to previous treatments. Advances in stapling technology have improved anastomoses' overall quality and consistency, but the corner effect remains a persistent challenge [47], [48].

Some surgeons have proposed reinforcing these junctions with additional sutures or bioabsorbable materials to mitigate the risk, although definitive evidence supporting these techniques is still lacking [8]–[11].

Robotic-assisted surgery, which allows for greater precision and control in complex pelvic procedures, has been suggested as a potential method for reducing tension on the anastomosis and improving outcomes [13]. However,

its efficacy in preventing leaks, particularly in oncological patients, has not yet been thoroughly evaluated [34].

Intraoperative perfusion assessment using fluorescence angiography with indocyanine green (ICG) represents a

TABLE I: Critical Analysis of Protective Ileostomy in Colorectal Cancer Surgery

Author	Study	Protective ileostomy post-oncological colectomy	Outcome analysis and conclusions
Greijdanus *et al*. [1]	Cohort study	Creation of protective ileostomy after rectal cancer resection. Cases were analyzed based on stoma-free survival rates.	The study developed a prediction model for stoma-free survival, revealing that protective ileostomies effectively prevent leaks in high-risk patients. However, the necessity of routine ileostomy is questioned, suggesting individualized approaches. Results were statistically significant with ($p < 0.05$).
Balla *et al*. [2]	Multicenter retrospective cohort	Analysis of protective ileostomy creation after anterior resection of the rectum. Case-control groups based on clinical decision-making processes.	Shared decision-making led to varied outcomes, highlighting the subjective nature of protective ileostomy use. While beneficial for some, complications related to stoma were evident. Statistically significant differences ($p < 0.05$) were noted between selective and routine ileostomy creation.
Pieniowski *et al*. [3]	Prospective cohort	Defunctioning stoma after rectal cancer surgery, specifically assessing the impact on Low Anterior Resection Syndrome (LARS).	Protective ileostomies were associated with an increased risk of LARS. The study suggested a reevaluation of routine ileostomy usage due to long-term functional impacts, despite preventing anastomotic leaks. Findings were statistically significant with ($p < 0.05$).
Martellucci *et al*. [4]	Retrospective analysis	Comparison between ileostomy and colostomy outcomes after total mesorectal excision (TME) for rectal cancer.	Ileostomies had fewer complications than colostomies but were associated with significant functional consequences post-reversal. The study called for individualized stoma creation strategies rather than routine usage. Statistically significant differences were observed ($p = 0.03$).
Ellebæk *et al*. [6]	Randomized Controlled Trial (RCT)	Early versus late reversal of diverting loop ileostomy in rectal cancer surgery. Groups were divided into early (≤3 months) and late (>3 months) reversal groups.	Early reversal led to fewer stoma-related complications but a higher risk of anastomotic complications if healing was incomplete. Late reversal was associated with better anastomotic outcomes but more stoma-related issues. Statistically significant differences in complication rates were observed ($p < 0.01$).
Yang *et al*. [7]	Meta-analysis	Comparison of loop ileostomy versus colostomy to prevent complications of anterior resection for rectal cancer.	Loop ileostomies were found to be more effective than colostomies in preventing anastomotic leakage, though both had significant postoperative complications. Selective stoma creation was recommended based on patient risk factors. Results were statistically significant with ($p < 0.05$).
Nagaoka *et al*. [8]	Single-center retrospective study	Laparoscopic low anterior resection with or without protective ileostomy for rectal cancer.	The study identified specific risk factors for anastomotic leakage, advocating for selective use of protective ileostomy in high-risk patients while recommending against routine ileostomy in all cases. Statistically significant results ($p < 0.05$) supported these findings.
Moran [18]	Review and predictive model study	Predictive risk modeling for anastomotic leakage following anterior resection for rectal cancer with or without protective ileostomy.	Protective ileostomies significantly reduced anastomotic complications in high-risk patients. The study supported a selective approach based on risk modeling. Statistically significant associations between risk factors and leakage rates were noted ($p < 0.05$).
Taylor *et al*. [19]	Pilot classification system and outcomes	Development of a pilot classification system for chronic rectal anastomosis complications prior to ileostomy reversal.	The classification system helped predict long-term functional outcomes post-ileostomy reversal, highlighting complications such as bowel dysfunction. Recommendations were made for more accurate pre-reversal assessments. Statistically significant results showed ($p < 0.05$) for prediction accuracy.

TABLE I: Continued

Author	Study	Protective ileostomy post-oncological colectomy	Outcome analysis and conclusions
Qi *et al*. [20]	Single-center retrospective study	Risk factors for symptomatic anastomotic leakage and its impacts on long-term survival after laparoscopic low anterior resection for rectal cancer.	The study identified symptomatic anastomotic leakage as a significant factor negatively impacting long-term survival in rectal cancer patients, underscoring the importance of preventive measures such as ileostomy in high-risk patients. Statistically significant outcomes showed ($p < 0.05$) for survival impacts.
Lindner *et al*. [21]	Cohort study	Assessed the adequacy of flexible endoscopy before loop ileostomy reversal after rectal cancer surgery.	The study concluded that flexible endoscopy was sufficient to determine anastomotic integrity before ileostomy reversal, reducing unnecessary complications and hospital stays. Statistically significant results were obtained ($p < 0.05$), supporting the use of flexible endoscopy as a predictive tool.
Hüttner *et al*. [24]	Randomized controlled trial	Ghost ileostomy versus conventional loop ileostomy in patients undergoing low anterior resection.	Ghost ileostomies were shown to provide similar protection against anastomotic leakage with fewer complications compared to conventional loop ileostomies. Statistically significant reductions in morbidity were observed ($p = 0.04$).
Ma *et al*. [27]	Secondary analysis of RCT	Prediction of clinical anastomotic leakage using pelvic anatomic features on preoperative MRI scans in patients undergoing rectal cancer resection.	Pelvic anatomy as visualized on MRI scans helped predict anastomotic leakage risk, suggesting that preoperative imaging could be a valuable tool in determining the need for protective ileostomy. Statistically significant results were noted ($p < 0.05$), supporting the utility of MRI in preoperative planning.
Jutesten *et al*. [35]	Long-term follow-up study	Examined the long-term risk of Low Anterior Resection Syndrome (LARS) after anastomotic leakage in anterior resection for rectal cancer.	The study found a high risk of LARS in long-term follow-up, particularly in patients with anastomotic leakage, reinforcing the need for careful post-operative management and individualized decision-making for ileostomy creation. Statistically significant findings were noted with ($p < 0.01$).
Mizrahi *et al*. [36]	Comparative cohort study	Use of indocyanine green (ICG) fluorescence angiography during low anterior resection to assess tissue perfusion with and without protective ileostomy.	The use of ICG fluorescence angiography improved intraoperative decision-making and reduced anastomotic leakage rates, suggesting that selective ileostomies may be avoided when perfusion is confirmed to be adequate. Statistically significant reductions in leakage rates were noted ($p = 0.02$).
Gu and Wu [41]	Meta-analysis	Meta-analysis of defunctioning stoma in low anterior resection with total mesorectal excision for rectal cancer.	The meta-analysis demonstrated that defunctioning stomas effectively reduce the incidence of anastomotic leakage but are associated with higher stoma-related morbidity. The study suggested that selective stoma creation should be based on patient-specific risk factors. Statistically significant findings were noted ($p < 0.05$) in leakage prevention but balanced by stoma-related complications.
Anderin *et al*. [42]	Prospective study	The effect of diverting stoma on long-term morbidity and risk for permanent stoma after low anterior resection for rectal cancer.	Long-term follow-up indicated that diverting stomas increased the risk of permanent stomas and had significant long-term morbidity, particularly in oncological patients. The study called for more selective use of stomas. Statistically significant outcomes were found ($p < 0.05$).

significant advancement in colorectal surgery, offering the potential to reduce the incidence of anastomotic leakage by allowing surgeons to assess tissue perfusion in real time [8]–[10].

Several studies have shown that using ICG can improve the accuracy of intraoperative decisions regarding the viability of anastomotic tissue, leading to fewer postoperative complications. This technology enables surgeons to visualize blood flow and adjust the anastomosis if perfusion is deemed inadequate [32]–[34].

Despite its promise, ICG technology is not yet universally available, and its use has not been standardized across surgical centers. The cost-effectiveness of implementing ICG remains a concern, particularly in resource-limited settings [17].

There is variability in how surgeons interpret angiographic results, as no clear consensus exists on what constitutes adequate perfusion for safe anastomosis. Further research is needed to establish standardized protocols for using ICG in colorectal surgery, especially in high-risk oncological patients [39], [43].

Postoperative management of oncological patients with protective ileostomies presents its own set of challenges [44]. While ileostomies can prevent leakage by diverting fecal flow away from the anastomosis, they are associated with complications such as dehydration, electrolyte imbalances, and stoma-related infections [35]–[37].

These issues can be particularly problematic for oncological patients who may have weakened immune systems due to chemotherapy or other treatments [28]. The need for a second surgery to reverse the ileostomy further complicates the situation, particularly in patients with delayed recovery or those undergoing ongoing cancer treatment [5]–[7].

Early ileostomy reversal has been associated with fewer stoma-related complications but carries a higher risk of complications if the anastomosis has not fully healed [42]. Conversely, delaying reversal can prolong the period during which the patient must manage a stoma, leading to additional complications such as stoma prolapse or peristomal skin irritation [31], [32], [46].

There is no consensus on the optimal timing for ileostomy reversal, and practices vary widely across institutions. This lack of standardized guidelines highlights a critical gap in clinical practice, particularly for oncological patients who require individualized management plans [39], [40].

Low Anterior Resection Syndrome (LARS) is another significant concern for patients undergoing low colorectal anastomosis, particularly oncological patients. LARS encompasses a range of bowel dysfunctions, including incontinence, urgency, and frequency of defecation, all of which can severely impact quality of life [1]–[3].

Protective ileostomies, while reducing the immediate risk of anastomotic leakage, may exacerbate LARS by delaying the restoration of normal bowel function [7]. For cancer patients who may already be dealing with the long-term effects of radiation therapy on bowel function, the addition of a protective ileostomy can complicate recovery even further [23].

Limited studies have directly compared bowel function in patients with and without ileostomies, particularly in oncological populations, and more research is needed to understand the long-term trade-offs involved in ileostomy creation fully [46].

In addition to the factors already discussed, several unanswered questions must be explored further to provide a more holistic understanding of anastomotic healing and leakage prevention, particularly in oncological patients [44].

One area that has gained increasing attention is the role of the gut microbiome in anastomotic healing. Emerging research suggests that the microbiome's composition can significantly impact inflammation, tissue healing, and the risk of infection [18]–[20].

This is especially relevant for cancer patients who have undergone chemotherapy or radiation therapy, as these treatments can alter the gut microbiome, potentially increasing the risk of postoperative complications [13], [42]. Further studies are needed to determine whether manipulating the microbiome through probiotics or other interventions could improve anastomotic healing and reduce leakage rates [49].

Another critical question is whether specific biomarkers or intraoperative tools beyond ICG fluorescence could provide more accurate assessments of tissue perfusion and predict anastomotic leakage. While ICG has shown promise, alternative biomarkers such as lactate levels, tissue oxygenation, or inflammatory markers may offer additional predictive value [24]–[26].

These biomarkers could be used with ICG or other imaging technologies to provide a more comprehensive assessment of anastomotic viability. Research into developing and validating such biomarkers could lead to more personalized approaches to leakage prevention [40], [41].

The type of neoadjuvant chemotherapy regimen or the radiation dose administered before surgery may also influence the risk of anastomotic leakage differently [35]. Specific chemotherapy agents, for example, may have a more profound impact on tissue healing, while higher doses of radiation could exacerbate fibrosis and vascular damage [26], [34].

Tailoring postoperative management strategies based on the specific neoadjuvant therapies a patient has received could help mitigate these risks. More research is needed to understand how different treatment protocols interact with surgical outcomes and to develop guidelines for managing high-risk patients [7]–[10].

The timing of ileostomy reversal is another area that warrants further investigation. While early reversal has been associated with fewer stoma-related complications, it may increase the risk of complications if the anastomosis has not fully healed [47].

Conversely, delaying reversal can prolong the patient's exposure to stoma-related complications and negatively impact quality of life [2]. More granular data on how different timing strategies for ileostomy reversal influence long-term outcomes, such as bowel control and the incidence of LARS, are needed to inform clinical decision-making [20]–[22].

Patient-specific factors, including genetics and preoperative inflammation markers, may also play a role in predicting anastomotic failure. Considering a patient's genetic predispositions or inflammatory status, personalized medicine approaches could lead to more tailored interventions and better outcomes [48]. For example, patients with genetic markers associated with poor tissue healing may benefit from more aggressive protective measures, such as using tissue adhesives or bioabsorbable materials, to reinforce the anastomosis [38], [39].

The experience level of the surgical team is another critical factor that influences outcomes in complex rectal cancer surgeries [4]. Surgeons with extensive experience in robotic-assisted surgery or other advanced techniques may achieve better outcomes due to their ability to perform more precise anastomoses and manage intraoperative complications more effectively [11]. Standardizing training in these techniques could help reduce leakage rates and improve overall patient outcomes, particularly in high-risk oncological patients [23].

Long-term oncological implications of protective ileostomies also need to be explored. While protective ileostomies can reduce the severity of anastomotic leaks, there is limited evidence on whether prolonged stoma use may impact recurrence rates or disease-free survival in colorectal cancer patients. Understanding the long-term effects of ileostomies on oncological outcomes is crucial for developing more nuanced guidelines for their use [43]–[45].

Finally, the economic implications of routine protective ileostomy use should be considered, particularly in healthcare systems with limited resources. Cost-benefit analyses could help determine whether the routine use of ileostomies is justified or whether a more selective approach could optimize outcomes and healthcare spending [30], [31]. While protective ileostomy remains a valuable tool in reducing the severity of anastomotic leakage, its use in oncological patients must be carefully considered considering the unique risks associated with cancer treatments and patient-specific factors [50].

The decision to use a protective ileostomy should be individualized, considering a patient's overall health status, the effects of neoadjuvant therapies, the surgical technique, and intraoperative findings [3]–[5].

Emerging technologies, such as ICG fluorescence, promise to refine the decision-making process, particularly in high-risk oncological patients. However, more research is needed to fully understand the long-term impact of these interventions on patient outcomes [41]–[43].

Ultimately, reducing the incidence of anastomotic leakage in oncological patients undergoing low colorectal anastomoses will require a multifaceted approach incorporating advances in surgical technique, personalized patient care, and ongoing innovation in materials and technologies [22], [37], [50].

4. Conclusion

In conclusion, addressing the gaps in knowledge—such as the optimal timing of surgery following neoadjuvant therapy, the role of robotic surgery, and the long-term effects of protective ileostomies on bowel function—will be critical in shaping the future of colorectal cancer surgery.

Moving forward, the field must evolve toward a more nuanced understanding of anastomotic leakage, focusing not only on protective ileostomies but also on optimizing all aspects of care, from preoperative preparation to long-term postoperative management, particularly in oncological patients.

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Conflict of Interest

Authors declare that they do not have any conflict of interest.

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