Perspective

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Precision grading of surgical strategies for small bowel Crohn's disease: An R0–R3 individualized framework based on lesion severity and functional preservation

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SUMMARY: Small bowel Crohn's disease (SBCD) presents unique surgical challenges due to segmental lesions and the need to balance radical resection with bowel function preservation. Current guidelines lack standardized surgical classifications, leading to variable outcomes. This study proposes a four-tier surgical strategy (R0-R3) tailored to lesion severity and functional preservation. R0 involves complete resection for localized mild lesions (creeping fat, no fibrosis) with ≥ 3 meters of residual bowel, using wide resection margins and anti-TNF-α therapy postoperatively. R1 preserves mild (non obstructive fibrotic) lesions and resects moderate to severe segments, with imaging surveillance support. R2 combines resection of severe lesions (fibrotic strictures/obstruction) with strictureplasty or partial preservation of moderate lesions to avoid short bowel syndrome. R3 employs temporary stoma creation for extensive complex lesions or high-risk patients, deferring definitive surgery until stabilization. This framework emphasizes individualized decision-making, prioritizing anatomical clearance, bowel conservation, and postoperative biologics to reduce recurrence. Compared to traditional approaches, the R0-R3 system enhances flexibility in managing heterogeneous SBCD, particularly in extensive disease. Future validation through multicenter trials and biomarker-driven predictive models is recommended to optimize long-term outcomes and quality of life. This strategy aligns with personalized surgical trends, addressing gaps in current guidelines by integrating lesion severity, functional prognosis, and staged interventions.

Keywords: Small-bowel Crohn's disease, Surgical stratification strategy, Individualized surgery

1. Introduction

Crohn's Disease (CD) is a chronic inflammatory disease that affects the entire gastrointestinal tract, with typical symptoms including abdominal pain, diarrhea, and internal fistulas, significantly impacting patients' quality of life (*1,2*). Small Bowel Crohn's Disease (SBCD) is characterized by segmental distribution and heterogeneity of lesions (radiologically defined as ≥ 2 non-contiguous lesions on CT/MR enterography) (*3*), posing dual challenges of anatomical complexity and functional preservation during surgical intervention. Unlike colonic Crohn's disease, the surgical strategy for small bowel CD requires a greater emphasis on balancing complete lesion resection and small bowel function preservation (*4*).

In recent years, the widespread use of biologics has significantly improved the medical treatment of CD. However, surgery remains an inevitable therapeutic option for most patients with small bowel CD, especially when medical treatment fails or complications arise. ECCO guidelines recommend ileocecal resection or segmental bowel resection when medical treatment fails or in cases of acute complications (such as bowel obstruction, perforation, or complex fistulas), while stoma surgery is recommended for extensive lesions (*5*). ECCO guidelines also recommend strictureplasty as the preferred option for multiple strictures (evidence level: b), but there is still no consensus on the surgical grading standards for SBCD (*5*). ACG guidelines emphasize surgical conservatism, particularly in young patients and those at high risk for short bowel syndrome, advocating for ileocecal valve preservation and minimal resection (*6*). Although the above guidelines provide directional suggestions for CD surgical strategies, they lack systematic classification and standardization for specific surgical strategies for small bowel CD. Especially in cases of extensive small bowel lesions, the choice of surgical strategy varies greatly among individuals, leading to high

postoperative recurrence rates and difficulty in ensuring quality of life. Moreover, current guidelines often adopt a fixed surgical pathway without individualizing based on lesion severity, presenting considerable limitations in clinical practice.

To address this issue, based on the clinical experience of our Inflammatory Bowel Disease Center, we propose a four-tier surgical strategy (R0-R3) based on lesion characteristics (Figure 1). First, we classify small bowel Crohn's disease lesions into three categories: mild, moderate, and severe, representing creeping fat without fibrosis, fibrotic stenosis without complete obstruction, and severe stenosis with obstruction, respectively. On this basis, we propose this four-level surgical strategy (R0, R1, R2, R3) to achieve a precise balance between complete lesion resection and intestinal function preservation, providing a more individualized surgical intervention plan for patients with different types of lesions. Through this strategy, we aim to address the shortcomings of current guidelines in surgical management of small bowel CD and further optimize surgical outcomes and long-term quality of life. In the future, we will further verify scientific validity and practicality of this strategy through multicenter clinical studies.

2. R0 strategy: Localized lesion, complete resection

2.1. Surgical indications

The R0 strategy is suitable for a single small bowel lesion or a lesion localized to a single segment of the small intestine, as confirmed by CTE/MRE evaluation and postoperative macroscopic examination showing no skip lesions, and without extensive fibrosis or fistula formation; the remaining normal small bowel after resection should exceed 3 meters.

2.2. Surgical approach

Resection range: The proximal and distal resection margins of the affected segment should be at least 2 cm, ensuring the removal of potential lesions.

Anastomosis method: Either antiperistaltic or isoperistaltic side-to-side anastomosis can be used, effectively reducing risk of anastomotic stricture (*7,8*).

Postoperative management: Early use (within 4 weeks after surgery) of anti-TNF-α agents to consolidate therapeutic effects and prevent anastomotic recurrence (*9,10*).

2.3. Strategy advantages

The R0 strategy maximizes lesion clearance, has a lower postoperative recurrence rate, and provides better long-term quality of life compared to other strategies. It is suitable for patients with a short disease course and localized mild lesions.

3. R1 strategy: Extensive lesions, partial resection

3.1. Surgical indications

The R1 strategy is indicated for cases with skip lesions of mild, moderate, or severe severity, such as fibrotic strictures in some intestinal segments without complete obstruction. The mildly affected bowel segment shows creeping fat but retains bowel elasticity.

3.2. Surgical approach

Resection range: Resection is performed on moderate to severe lesions, while mildly affected bowel segments are preserved as much as possible. Localized release can be performed for intestinal segments with creeping fat hypertrophy.

Anastomosis method: Side-to-side anastomosis is used to reduce intestinal tension and minimize risk of stricture.

Postoperative follow-up: Regular imaging monitoring, such as MR enterography or small bowel CTE, is recommended to evaluate the progression of residual lesions.

3.3. Strategy advantages

This strategy preserves intestinal function while minimizing the impact of severe lesions on bowel motility and absorption.

4. R2 strategy: Coexisting moderate and severe lesions, combined resection

4.1. Surgical indications

The R2 strategy is indicated mainly for moderate and severe lesions, where some bowel segments exhibit fibrotic stricture or localized obstruction. Imaging and endoscopic evaluations reveal alternating moderate and severe lesions, making surgical resection challenging.

4.2. Surgical approach

Resection range: Primarily targeting moderate to severe lesion segments while preserving relatively healthy bowel. When resecting moderate lesions in one stage carries a high risk of short bowel syndrome, partial preservation of moderate lesions can be considered. During surgery, bowel clamps can be used to physically expand the fibrotic segment, similar to endoscopic balloon dilation. If the patient's general condition is favorable, strictureplasty can be performed on the moderately stenotic bowel segment.

Anastomosis method: Side-to-side anastomosis

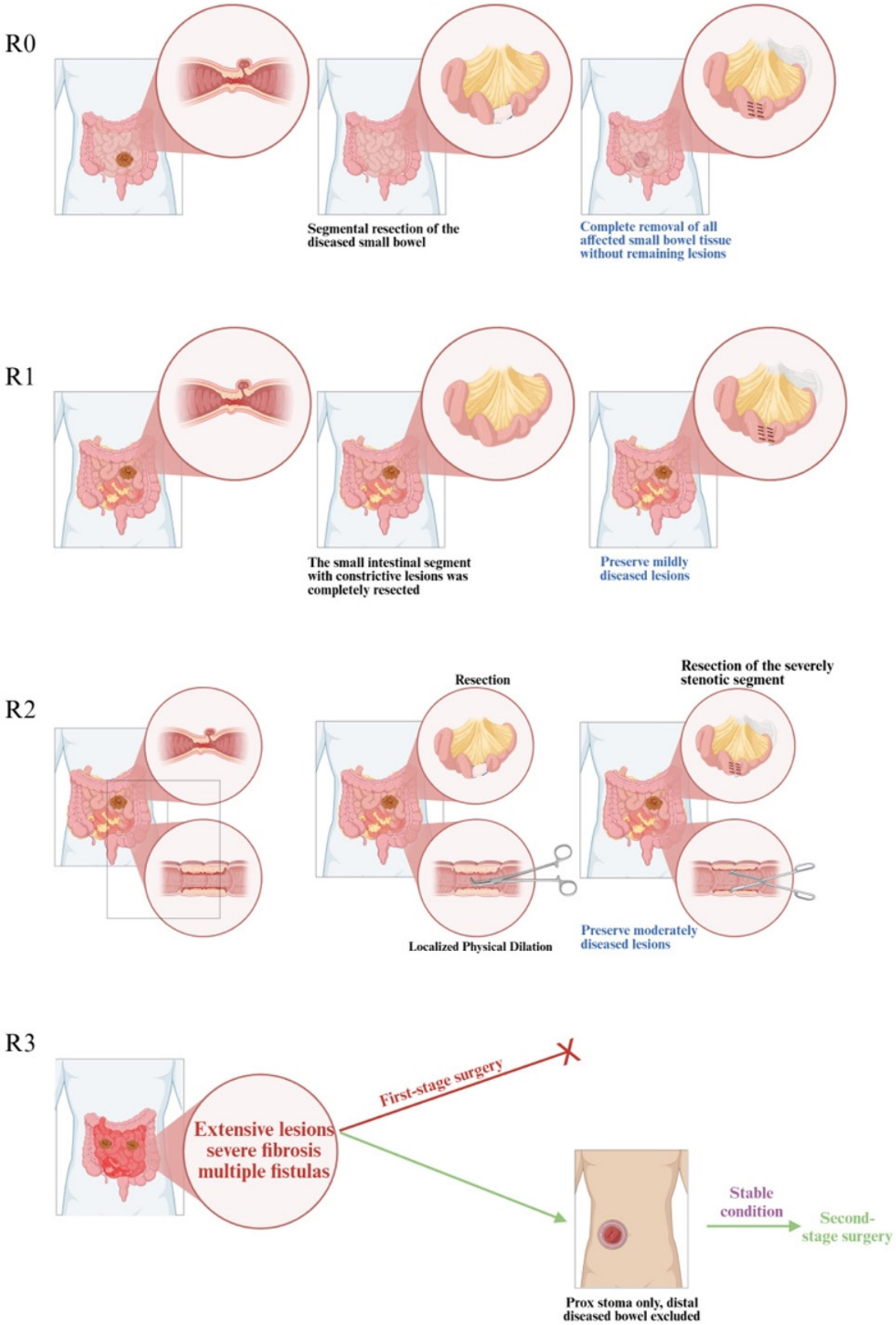

Figure 1. Precise classification of surgical strategies for small bowel Crohn's disease. When the patient's general condition is good, R0 surgery is preferred, followed by R1 and R2 approaches. When the patient's general condition is poor, intestinal surgery should be performed in two stages: first, the R3 strategy is employed to alleviate clinical symptoms and restore enteral nutrition, and after stabilization, an R0/R1/R2 surgery is considered.

is performed during digestive tract reconstruction to prevent postoperative anastomotic stricture. In cases with multiple anastomoses, creating a proximal stoma at an appropriate location can reduce the risk of anastomotic leakage.

Postoperative management: Combined anti-inflammatory and immunomodulatory treatment is used to prevent the progression of residual lesions.

4.3. Strategy advantages

The R2 strategy effectively removes severe lesions while minimizing loss of intestinal function. Postoperative maintenance with biologics can reduce risk of recurrence.

5. R3 strategy: Temporary stoma — Extensive complex lesions

5.1. Surgical indications

The R3 strategy is indicated for extensive and complex lesions with severe fibrosis and multiple fistulas, where resection carries a high risk of short bowel syndrome. It is also appropriate for patients with poor general condition and severe malnutrition, where single-stage resection is poorly tolerated.

5.2. Surgical approach

Surgical method: Perform a proximal stoma, leaving the distal diseased bowel segment unutilized. Once the patient's condition stabilizes, choose an R0, R1, or R2 strategy for second-stage surgery (*11*).

Postoperative management: Focus on nutritional support and stoma care. Resection of the diseased bowel segment can be considered after the patient's general condition stabilizes.

5.3. Strategy advantages

R3 surgery effectively alleviates symptoms caused by acute or extensive lesions and reduces surgery-related mortality. The second-stage surgery is highly flexible and can be adjusted according to the patient's recovery status.

6. Conclusion

For small bowel Crohn's disease, the four-tier surgical strategy (R0, R1, R2, R3) provides a scientific and standardized approach to surgical treatment. The advantage of this strategy lies in its precise selection of surgical methods based on severity of lesions, distribution characteristics, and individual patient differences, thus avoiding the limitations of traditional "one-size-fits-all" surgery. By clearly defining indications and surgical key points of each strategy, surgeons can flexibly address complex lesions in practice, especially in dealing with moderate to severe and extensive complex lesions, demonstrating enhanced practicality and flexibility.

The primary goal of CD intestinal surgery is to alleviate the patient's clinical symptoms. The long-term goal is to maximize duration of disease remission, while the ultimate goal is to achieve lifelong clinical non-recurrence for CD patients. This tiered strategy aligns with the current trend of personalized surgical treatment for CD, standardizing surgical practice and reducing risk of postoperative recurrence and short bowel syndrome caused by inappropriate surgical strategies. Future research should focus on long-term efficacy of different strategies and postoperative quality of life. Multicenter randomized controlled trials are needed to further validate the scientific and practical value of the tiered surgical approach. Leveraging big data and biomarker research to develop preoperative predictive models will facilitate more accurate preoperative surgical planning, advancing CD surgical strategies to a higher level.

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