



Temporary diverting loop ileostomy in Crohn's disease surgery; indications and outcome

Volkan Doğru^{1,2} · Umut Akova^{2,3} · Eren Esen² · Daniel J. Wong^{2,4} · Andre da Luz Moreira² · Arman Erkan^{2,5} · John Kirat² · Michael J. Grieco² · Feza H. Remzi^{2,5}

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Abstract

Introduction Crohn's disease can present with complex surgical pathologies, posing a significant risk of morbidity and mortality for patients. The implementation of a loop ileostomy for selected patients may help minimize associated risks.

Methods In this retrospective cohort study, we investigated the utilization of temporary fecal diversion through the creation of a loop ileostomy in Crohn's surgery. Closure of all ostomies involved a hand-sewn single-layer technique. We then conducted bivariate analysis on 30-day outcomes for closures, focusing on favorable recovery defined as the restoration of bowel continuity without the occurrence of two challenges in recovery: newly developed organ dysfunction or the necessity for reoperation.

Results In total, 168 patients were included. The median age of the patients was 38 years (IQR 27–51). The most common indication for a loop ostomy was peritonitis (49%). After ileostomy closure, 163 patients (97%) achieved favorable recovery, while five encountered challenges; four (2.4%) underwent abdominal surgery, and one (0.6%) developed acute renal failure requiring dialysis. Two patients (1.2%) had a re-creation of ileostomy. Patients encountering challenges were older (56 [IQR 41–61] vs. 37 [IQR 27–50]; p 0.039) and more often required secondary intention wound healing (40% vs. 6.7%; p 0.049) and postoperative parenteral nutrition following their index surgery (83% vs. 26%; p 0.006).

Conclusion Selectively staging the Crohn's disease operations with a loop ileostomy is a reliable practice with low morbidity and high restoration rates of bowel continuity. Our hand-sewn single-layer technique proves effective in achieving successful surgical recovery.

Keywords Crohn's disease · Gastrointestinal surgical procedure · Ileostomy

Introduction

Complex Crohn's Disease (CD) surgery has a high-risk potential for septic complications. Given the high postoperative mortality in emergency settings (3.6% for CD) [1] the

decision by an inflammatory bowel disease (IBD) surgeon to cool off active inflammation with a diverting ostomy may be driven by more than anecdote. Despite the broadly accepted ability of diversion to provide a good window of opportunity to control a severe penetrating disease [2], correct malnutrition [3] and reduce immune suppression [3, 4], some patients and clinicians still remain adamant about rejecting a stoma or feel uncertain about its indication. A severe aversion or uncertainty of a diverting ostomy might be due to the fear of stigmatization or a disconnect among gastroenterologists, general surgeons and subspecialized IBD surgeons. However, the hazard inherent to the ostomy itself is less devastating than a full-blown surgical site contamination such as generalized peritonitis [5] and the stoma can be reversed in most cases with minimal additional complications [6].

✉ Feza H. Remzi
Fremzi@northwell.edu

¹ Akdeniz University Hospital, Antalya, Türkiye
² Inflammatory Bowel Disease Center, NYU Langone Health, New York, NY, USA
³ Emory University School of Medicine, Atlanta, GA, USA
⁴ Beth Israel Deaconess Medical Center, Boston, MA, USA
⁵ Center for Advanced Inflammatory Bowel Disease Care, Northwell Health, 125 Community Drive, Manhasset, NY 11030, USA

Historically, multiple studies investigated the morbidity following closure of a diverting loop ileostomy (DLI), but it is still unclear what proportion of patients suffer from conditions as a result of their index surgery [7]. Furthermore, from the most straight forward over-and-over stitches to the most advanced staplers, there are many predefined closure techniques for loop ileostomies [8]. The various different treatments of the opposite bowel walls of prospecting anastomotic rim or the selection between continuous and interrupted placement of sutures contribute to this variability [9, 10]. Adding further complexity in the comparisons of outcomes, some surgeons prefer a double-layer anastomosis for closures of loop ileostomy [10–12].

Proven to be successful even in small-diameter bowel anastomosis of infancy [13] or Heineke-Mikulicz strictureplasty of IBD surgery [14], single-layer anastomosis fashioned in an interrupted style is an appropriate alternative technique to perform end-to-end anastomosis in the closures. Despite being widely used and having gained acceptance by some as a gold standard, diversity of suturing techniques still poses significant challenges in comparing and categorizing this method under a single, overarching label of “interrupted single layer anastomosis” [11, 15, 16].

Our focus on single-layered interrupted sutures is driven by Crohn's disease's unique mesenteric and antimesenteric polarization, aimed at mitigating uneven tension distribution across the suture line and reducing the risk of stricture formation. By clarifying the technical distinctions and providing a more nuanced understanding of the treatments of the opposite bowel walls at the anastomotic rim of the closures, we examined our selective use of DLIs in complex surgical situations related to CD and analyzed the outcomes of our hand-sewn single-layer technique for loop ileostomy closures.

Methods

In this retrospective cohort study, we conducted a manual review of operative and clinical notes of patients registered in our institutional review board–approved CD surgery database at New York University Langone Health (IRB no: i22-00112). Eligibility for the study was confined to CD patients who underwent a DLI creation and subsequently underwent a single-layer interrupted handsewn DLI closure between September 2016 and September 2021. Exclusions comprised individuals who were diagnosed with CD following pouch surgery ($n=25$), did not undergo closure within the designated time frame ($n=17$), had their closures performed at external healthcare facilities ($n=2$), or were closed using a different technique ($n=1$). Figure 1 illustrates

the complete patient selection flow diagram, including the Montreal classifications [17] of the selected cohort.

We systematically analyzed all pertinent demographic and clinical factors, including patient demographics, disease characteristics, surgical details, estimated indications for diversion, immunosuppression, complications, and other major perioperative features. By incorporating covariates from both the stoma creation (the index surgery) and its subsequent closure, we conducted bivariate analysis on 30-day outcomes for loop ostomy closures. Our emphasis was on favorable recovery, defined as the restoration of bowel continuity without facing two challenges in recovery—newly developed organ dysfunction or the necessity for reoperation.

We defined ‘initial procedures’ as the primary staged interventions for the treatment of IBD, whereas ‘additional procedures’ comprised subsequent interventions performed after the primary procedure. During both types of procedures, DLIs were surgically created at the index surgery, with closure scheduled for a subsequent session as an integral component of the procedure's culmination stage (e.g., the index surgery was the second stage in a three-stage ileal pouch anal anastomosis [IPAA] procedure).

An anastomotic leak was defined as a discontinuity of tissue apposition in the anastomosis confirmed by a combination of clinical, radiologic, endoscopic and or operative findings. The definition of malnutrition was based on the GLIM 2018 criteria [18]. Biochemical diagnostic tests, such as serum albumin, were not routinely used for malnutrition screening. Both peritonitis and preoperative malnutrition were considered a threat to anastomotic integrity and to preventing sepsis-associated organ failure, serving as rationales for fecal diversion. Severity of the postoperative complications were graded according to the Clavien–Dindo classification (CDC) [19]. Delayed postoperative ileus was defined as obstipation and intolerance of oral intake that persist for more than three days following surgery. Small bowel obstruction (SBO) was defined as the presence of symptoms, signs, and radiographic evidence of mechanical small intestinal obstruction. Short bowel syndrome was describing reduced absorptive surface area for nutrients resulting in dependency to recurrent intravenous hydration episodes or a home parenteral nutrition support. Readmission was defined as an unplanned patient admission to a hospital within 30 days after being discharged.

Surgical technique

The ileostomy is closed by suturing the resultant antimesenteric defect in one layer using 3–0 absorbable braided polyglactin (2–0 if tissues are thick or inflamed) interrupted seromuscular sutures. In the case of poor tissue quality such

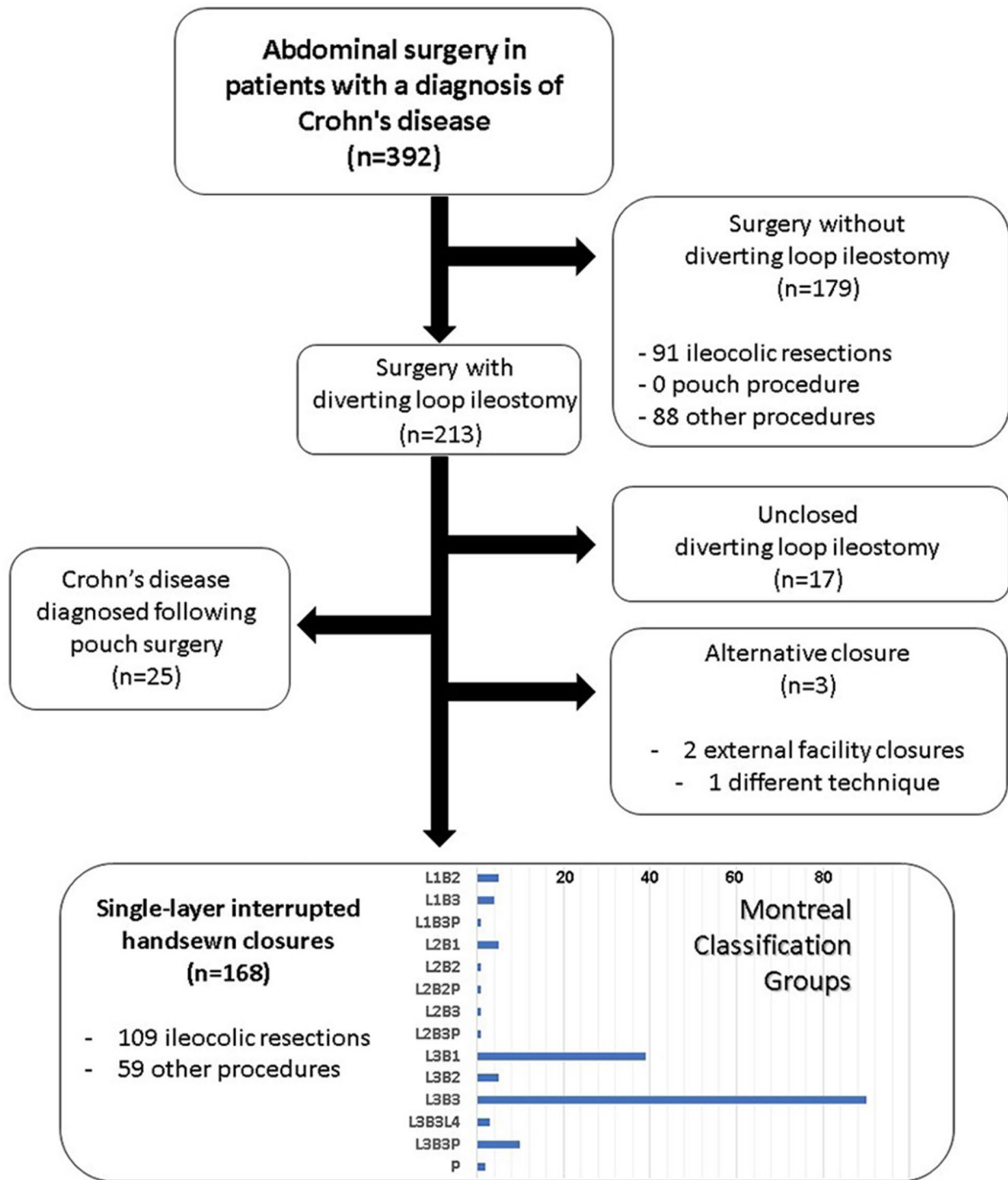


Fig. 1 The flow diagram and the Montreal classifications of the selected cohort

as a large serosal defect, an enterotomy not amenable to repair or an ischemia, segmental small bowel resection is performed first and one layer end-to-end small bowel anastomosis is then performed using 3–0 or 2–0 absorbable braided polyglactin interrupted seromuscular sutures; Turnbull style sutures posteriorly and interrupted seromuscular sutures anteriorly (Fig. 2).

Statistical analyses

The data was analyzed using the Statistical Package for Social Sciences 28.0 software for Windows (SPSS; IBM, Armonk, NY, USA). Sankey diagram was created using the networkD3 and tidyverse packages at R version 4.2.1. The

Kolmogorov-Smirnov test was used to determine the normality of continuous variables. Median (interquartile range [IQR]) was used for the presentation of non-parametric distributions. For categorical variables, χ^2 or Fisher exact test and for continuous variables, Student's *t* test or Mann-Whitney *U* test were used depending on the test assumptions. The comparison of clinical characteristics between patients with favorable recovery and those encountering challenges after a DLI closure involved a bivariate analysis. Only traits with a significance level of $p < 0.5$ were considered for display in the tabular presentations, and results with *p*-values less than 0.05 were deemed statistically significant.

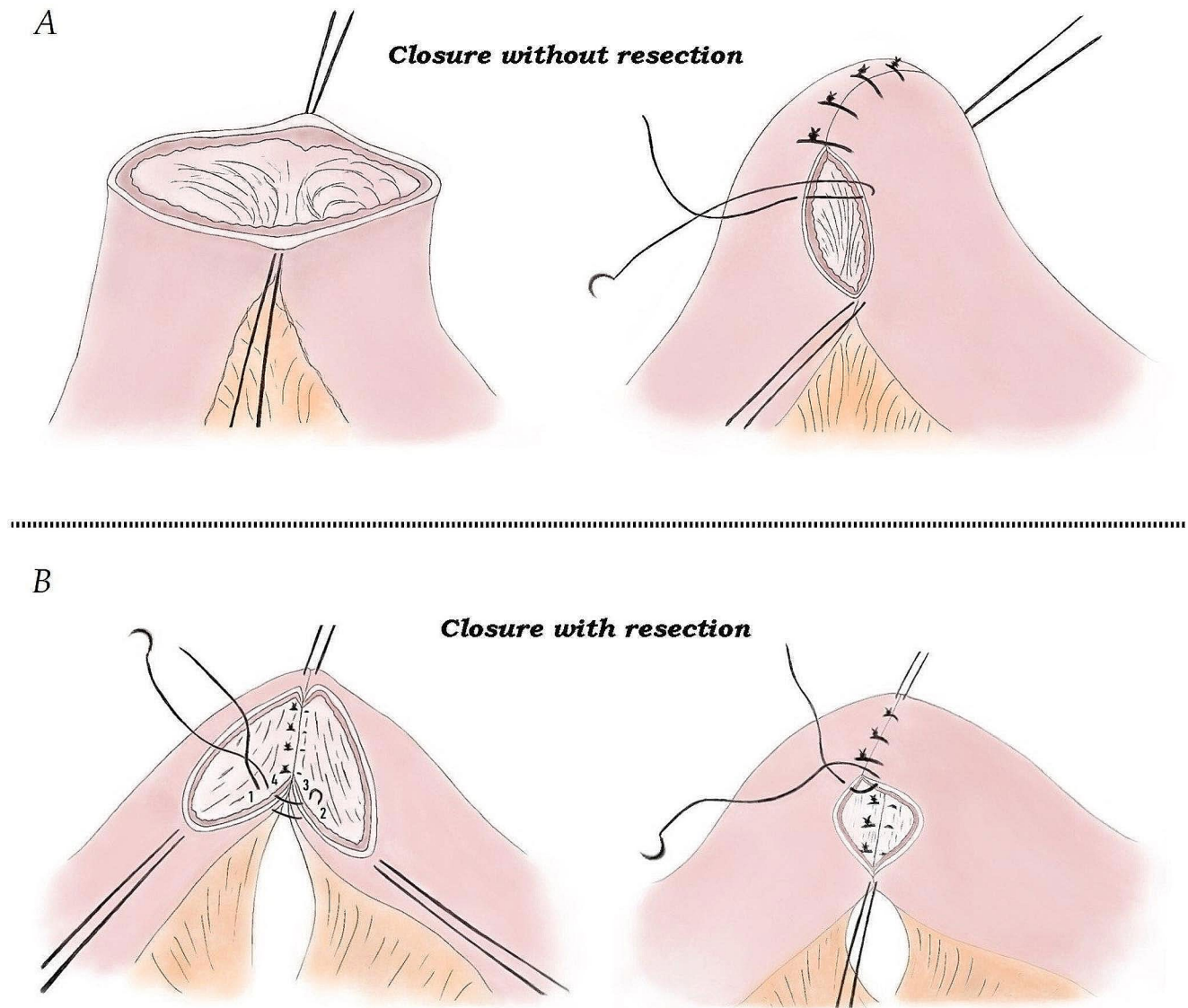


Fig. 2 (A) Handsewn closure without small bowel resection. (B) Handsewn closure after small bowel resection; Turnbull style sutures posteriorly (*Step-by-step description*: (1) inside-out full thickness, (2)

outside-in full thickness, (3) inside-out mucosa, (4) outside-in mucosa) and interrupted seromuscular sutures anteriorly

Table 1 Comparative indications for temporary diverting loop ileostomy in fistulizing and non-fistulizing Crohn's disease

Indications, n (%)	Total n = 168	Fistu- lizing disease 93 (55)	Non- Fistulizing disease 75 (45)	<i>p</i>
Peritonitis	83 (49)	66 (71)	17 (23)	<0.001*
Reoperative IBD surgery†	57 (34)	31 (33)	26 (35)	0.856
Multiple anastomoses	34 (20)	28 (30)	6 (8.0)	<0.001*
Preoperative malnutrition	31 (18)	19 (20)	12 (16)	0.462
Emergency surgery	12 (7.1)	4 (4.3)	8 (11)	0.137
Other indications	38 (23)	10 (11)	28 (37)	<0.001*

IBD, inflammatory bowel disease

† includes procedures for recurrence or complications related to previous surgery for IBD

**p* <0.05

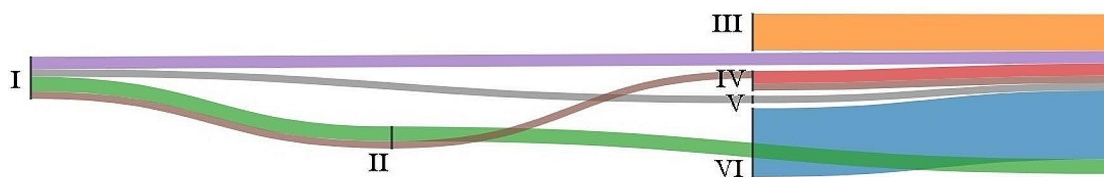
Results

A total of 168 CD patients (64 female and 104 males) underwent handsewn loop ostomy closure and were followed up for a median of 1.6 years (IQR 0.5–2.8). The median patient

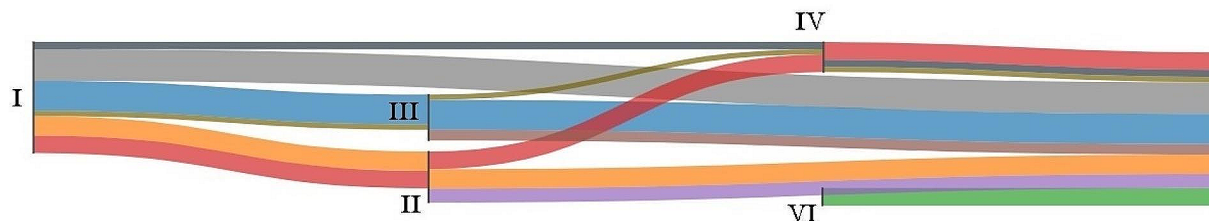
age was 35 years (IQR 26–51). The median patient body mass index (BMI) was 23 kg/m² (IQR 20–26). There were 7 (4.2%) American Society of Anesthesiologists (ASA) class I, 136 (81%) class II and 25 (15%) class III patients. Median time between the index surgery and the closure was 3.0 months (IQR 3.0–4.0). The median duration of inflammatory bowel disease was 9.0 years (IQR 3.0–20). The diagnosis of Crohn's disease was established following the conversion from ulcerative colitis (UC) in 10 patients.

The foremost goal of a DLI in 162 patients (96%) was to safeguard at least one simultaneously anastomosed bowel segment. Of the remaining six patients, ileostomy was dedicated to alleviating inflammation in three cases and addressing strictures in the other three. The most common indication for a DLI creation was peritonitis (49%). The prevalence of multiple indications was 42%. Table 1 delineates the estimated indications for the establishment of a DLI in Crohn's disease. Furthermore, Fig. 3 illustrates the distribution of patients with different indications using a traceable multi-level Sankey chart, specifically highlighting groups comprising 3 or more individuals while excluding less populated groups.

Non-fistulizing disease



Fistulizing disease



- I. Peritonitis
- II. Reoperative IBD surgery
- III. Multiple anastomoses
- IV. Preoperative malnutrition
- V. Emergency surgery
- VI. Other indications

Fig. 3 Indications of a temporary diverting loop ileostomy in complex Crohn's disease surgery—IBD, inflammatory bowel disease

A total of 119 (71%) CD patients had received immunosuppressive treatment at some point during the 12-week period preceding the creation of a DLI. Of these, 97 (58%) patients were prescribed biologics, 61 (36%) patients were receiving corticosteroid treatment, and 39 (23%) patients were receiving a combination of both biologics and corticosteroids. At the time of DLI closure, 84 (50%) CD patients were identified as having undergone a pattern of discontinuation of immunosuppressive agents. Among patients who had been on immunosuppression within 12 weeks prior to DLI creation, the rate of discontinuation, specifically the proportion of patients who had ceased immunosuppressive agents by the time of the closure surgery, was found to be 71% (84/119).

At the index surgery, preoperative malnutrition was present in 31 patients (18%), peritonitis was observed in 83 patients (49%), and at least one fistula takedown was carried out in 93 (55%) procedures; entero-colonic fistula was the most common fistula type (55/93). Of the patients with entero-colonic fistula, 64% (35/55) had aggressive Crohn's disease involvement or complications at the descending colon/sigmoid and underwent anterior resection/left hemicolectomy. Among patients with perianal Crohn's involvement at the index surgery, a perianal complex fistula served as the sole indication for DLI in 27% (3/11) of the cases; one of these three patients underwent a proctectomy. An ileocolic resection was necessary in 68% of patients with fistulizing disease (63/93). One patient underwent IPAA. Baseline clinical characteristics of patients at the DLI closure are shown in Table 2. Complications between the index surgery and the ileostomy closure are presented in Table 3.

At the time of the DLI closure surgery, 8 patients (4.8%) underwent an additional small bowel resection because their ostomies were not suitable for anastomosis after mobilization. The ileostomy was closed without a resection in 160 patients (95%). A regular circumstomal skin incision was enough in 159 patients (95%). One patient (0.6%) needed an extended circumstomal incision and 8 patients (4.8%) needed a circumstomal plus a midline incision.

After the closure, 21 patients (12%) had postoperative complications within thirty days of the operation. Of these patients, 11 patients (6.5%) experienced only minor deviations (e.g. a mild episode of self-limited nausea/vomiting) from the normal postoperative course (CDC-I). Two patients (1.2%) needed medication, blood transfusion or total parenteral nutrition without any interventional procedures or sepsis (CDC-II). Seven patients (4.2%) needed a surgical, endoscopic or radiologic intervention but didn't have sepsis (CDC-III). One patient (0.6%) had sepsis with single organ dysfunction (CDC-IV).

Thirty days after the DLI closure, 163 patients (97.0%) achieved favorable recovery. Restoration of bowel continuity

was possible in 166 patients (98.8%). Five patients encountered challenges; four (2.4%) underwent abdominal surgery, and one (0.6%) developed acute renal failure requiring dialysis. Two of the four patients who underwent abdominal surgery had a re-creation of ileostomy due to anastomotic leak. Postoperative 30-day outcomes after the DLI closures are displayed in Table 4. Patients encountering challenges were older (57 [IQR 43–62] vs. 35 [IQR 26–49]; p 0.040), more often required secondary intention wound healing at the index surgery (40% vs. 6.7%; p 0.049) and more frequently needed postoperative parenteral nutrition within the 30-day period following their index surgery (100% vs. 28%; p 0.002) (Table 5).

Discussion

Specifically tailored for patients confronting the intricacies of CD, our study represents a pivotal exploration into the safety and efficacy of the interrupted single-layer loop ileostomy closure technique. Remarkably, 97% of cases achieved a favorable recovery. This signifies the restoration of bowel continuity without the emergence of newly developed organ dysfunction or the necessity for subsequent reoperation.

Traditionally in CD surgery, a deliberate temporary DLI serves as a bridge to definitive bowel resection, effectively mitigating inflammation and optimizing patient well-being and nutrition [20]. The plan for reversal within 3-to-6 months can prove unattainable in a significant proportion of initially designated transient loop enterostomies [21]. However, recent advancements in CD management and the utilization of sophisticated surgical techniques, incorporating upstream temporary stomas, have resulted in a decrease in the incidence of permanent stomas [22]. The incorporation holds the potential to maintain the integrity of bowel anastomosis distal to the diversion site. This potential aligned significantly with the primary goal of implementing a DLI in our study. Among patients exclusively deemed eligible for closure and who underwent reversal surgery, only 1.2% had their ileostomy recreated.

With the integration of biologics into CD treatment, many aspects of diversion, including stoma reversal rates [22, 23], the psychosocial impacts [24], disease recurrence [20, 25], and stoma-related complications [21], are thoroughly reassessed. However, even in the era of biologics, there exists a significant gap in our understanding of the outcomes precisely related to the intended plan of closing the temporary stoma when patients proceed to surgery for closure. This gap is further enlarged by contemporary medical ethics constraints, preventing the safe conduct of a well-matched controlled study to compare the protective effect size of temporary diversion in the immediate postoperative

Table 2 Baseline clinical characteristics of patients at the diverting loop ileostomy closure in Crohn's disease

Patient characteristics, n (%) or median (IQR)	n = 168
Sex	
Female	64 (38)
Male	104 (62)
Age, years	35 (26-51)
BMI, kg/m ²	23 (20-26)
ASA	
I	7 (4.2)
II	136 (81)
III	25 (15)
Duration of IBD, years	12 (3.0-20)
Type of index surgery	
Initial procedure for Crohn's	111(66)
Ileocolic resection	91 (54)
Strictureplasty	3 (1.8)
Other (e.g. small bowel resection, AR)	20 (12)
Strictureplasty	0 (0)
Additional procedures [†]	57 (34)
Ileocolic resection	18 (11)
Strictureplasty	1 (0.6)
Other (e.g. small bowel resection, AR)	38 (23)
Strictureplasty	1 (0.6)
Emergency index surgery	12 (7.1)
Fistulizing disease at the index surgery	93 (55)
Entero-enteric (confined to small bowel)	48 (29)
Entero-colonic	55 (33)
Entero-vesicular	11 (6.5)
Perianal	8 (4.8)
Other (e.g. fistula to a phlegmon/skin)	18 (11)
Preoperative malnutrition at the index surgery	31 (18)
Conventionally open index surgery	68 (40)
Secondary intention wound healing (at the index surgery)	13 (7.7)
Reconstruction of the abdominal wall (at the index surgery)	8 (4.8)
Preoperative 12-week immunosuppression	
Before the DLI creation (at the index surgery)	119 (71)
Corticosteroids	61 (36)
Before the DLI closure	41 (24)
Corticosteroids	6 (3.6)
Index-to-closure time, months	3.0 (3.0-4.0)

AR, anterior resection; ASA, American Society of Anesthesiologists; BMI, body mass index; DLI, diverting loop ileostomy; IQR, interquartile range

[†] includes procedures for recurrence or complications related to previous surgery for inflammatory bowel surgery

*p<0.05

phase of bowel resections in CD cohorts. Consequently, our study significantly enriches the literature by showcasing the absence of mortality in 168 staged complex CD procedures, coupled with a tangible outcome of 98.8% bowel continuity. This stands as a testament to the safety and preeminence of staging complex CD operations with a DLI.

In our study, anastomotic dehiscence occurred in 2 patients (1.2%), and postoperative bowel obstruction developed in 9 patients (5.4%), with 8 out of 9 responding to conservative treatment. These complication rates were slightly lower than those reported in a recent systematic review of morbidity, which included 2146 ileostomy closures (56.6% handsewn closure, 3.5% CD) [26]. The review, without

specifying the type of anastomosis, noted rates of 2.0% for anastomotic dehiscence and 7.6% for postoperative bowel obstruction after closures.

While various techniques exist for ileostomy closure following IBD surgery [12], the end-to-end handsewn ileostomy closure stands out as one of the most commonly employed methods in loop ileostomy reversal [27]. Its appeal lies in its capacity to preserve bowel anatomy with minimal loss, offering the IBD surgeon the opportunity for reoperative procedures, including potential redo pouch surgeries [28]. This aspect significantly influenced our surgical strategy. The consideration of employing techniques other than end-to-end handsewn ileostomy closure underscores

Table 3 Complications between the index surgery and the diverting loop ileostomy closure

Complications of the index surgery, n (%)	n = 168
Postoperative 30-day complications	113 (67)
Delayed postoperative ileus	21 (12)
Venous thromboembolism/thrombophlebitis	4 (2.4)
Transfusion	23 (14)
Acute kidney injury	5 (3.0)
Foley reinsertion	2 (1.2)
Surgical site infection	26 (15)
Anastomotic leak	2 (1.2)
Wound dehiscence of skin	14 (8.3)
Small bowel obstruction	7 (4.2)
Need for parenteral nutrition	50 (30)
Severity of postoperative 30-day complications [†]	
Any deviation from the normal postoperative course	23 (14)
Need for medication/blood tx/TPN	72 (43)
Interventional procedures	7 (4.2)
Interventional procedures under general anesthesia	7 (4.2)
Single organ dysfunction	4 (2.4)
Multiorgan dysfunction	0 (0)
Mortality	0 (0)
Morbidity at discharge	
Home parenteral nutrition support	29 (17)
Drain at discharge	3 (1.8)
Antibiotics (i.v.) at discharge	3 (1.8)
Interval (beyond 30-day) complications	
Small bowel obstruction	3 (1.8)
Short bowel syndrome	29 (17)
Acute kidney injury	4 (2.4)
Peristomal skin complaints	56 (33)
Stoma retraction	0 (0)
Stoma prolapsus	7 (4.2)
Parastomal hernia	7 (4.2)

[†] in accordance with Clavien-Dindo classification (in order of increasing severity); TPN, total parenteral nutrition; tx, transfusion
*p<0.05

potential challenges, especially in the context of recurrent CD pathology. Notably, a stapled side-to-side anastomosis may entail additional bowel length loss or hinder patients from undergoing advanced procedures, particularly in the setting of reoperations [29]. This consideration gains significance for patients undergoing IPAA, given the observed 20% failure rate for initial pouches at the 10-year mark post-proctocolectomy in individuals with CD [28].

A comprehensive meta-analysis of randomized controlled trials stands out as the main reference point for proponents of stapled closures [8]. By comparing stapled anastomoses to handsewn anastomoses it has demonstrated that stapled closures were reducing the 30-day rate of bowel obstruction; 6.4% with stapler and 12.9% with handsewn. In our study, we observed an overall bowel obstruction rate of 5.4%. This leads us to posit that, with the expertise gained in high-volume centers, the occurrence of bowel obstruction

Table 4 Postoperative 30-day outcomes after the diverting loop ileostomy closures

30-day outcomes, n (%) or median (IQR)	n = 168
Restoration of bowel continuity	166 (98.8)
Anastomotic leak	2 (1.2)
Abdominal reoperations (with indications)	4 (2.4)
- Anastomotic leak	
Re-creation of ileostomy	2 (1.2)
- Adhesive small bowel obstruction	
Lysis of adhesions	1 (0.6)
- Bleeding control	1 (0.6)
Organ dysfunction	
- Acute kidney injury	2 (1.2)
Mortality	0 (0)
Rate of weaning from PN support [†]	20/29 (69)
Small bowel obstruction	9 (5.4)
Surgical site infection	2 (1.2)
Percutaneous drainage procedures	4 (2.4)
First flatus, days	2.0 (1.2-3.0)
Tolerance of fluids, days	1.0 (1.0-2.0)
Tolerance of solid diet, days	2.0 (2.0-3.0)
Early postoperative pain score ^{††}	4.0 (2.0-4.0)
Duration of operation, minutes	148 (123-173)
Estimated Blood Loss, mL	20 (10-40)
Readmissions	16 (9.5)
Length of stay, days	3.0 (2.0-5.0)

IQR, interquartile range; PN, parenteral nutrition

[†] rate of patients with short bowel syndrome that resolved after the loop ostomy closure

^{††} numeric rating scale at which 0 is no pain and 10 is the worst pain imaginable

events can be minimized, potentially approaching the rates seen with stapled anastomoses.

It's important to note that none of the randomized controlled trials [30–33] included in this meta-analysis [8] delved into the specifics of complications at the index surgery, a limitation also found in large retrospective national studies comparing stoma closure techniques [34]. If future comparative studies are designed specifically for CD, a meticulous exploration is warranted, scrutinizing the intricacies of index surgery in the context of CD involvement. Furthermore, it is imperative for upcoming studies to allocate interventions judiciously, avoiding unnecessary risks of additional bowel loss while safeguarding the potential for future ileal pouch creation.

According to one of the largest morbidity and mortality series of loop ileostomy closures from the United Kingdom, a complication occurring after the index surgery was associated with anastomotic leakage at closures [35]. Although the principle was being developed in the context of this UK series, complications were lacking a deep level of granularity but presented as a single risk group. In another RCT, on the other hand, the index complications were granular

Table 5 Comparison of clinical characteristics between patients with favorable recovery and those experiencing challenges after diverting loop ileostomy closure

Patient characteristics, n (%) or median (IQR)	Challenges in Recovery	Favorable Recovery	<i>p</i>
	5 (3)	163 (97)	
Age, years	57 (43-62)	35 (26-49)	0.040*
ASA	3 (60)	133 (82)	0.242
ASA II	2 (40)	23 (14)	0.160
ASA III			
Estimated indication(s) for diversion			
Peritonitis	4 (80)	79 (48)	0.208
Reoperative IBD surgery	3 (60)	54 (33)	0.338
Preoperative malnutrition	2 (40)	29 (18)	0.230
Fistulizing disease	5 (100)	88 (54)	0.066
Fistula to a phlegmon or skin	2 (40)	16 (9.8)	0.089
Conventionally open index surgery	4 (80)	64 (39)	0.159
Secondary intention wound healing at the index surgery	2 (40)	11 (6.7)	0.049*
Reconstruction of the abdominal wall at the index surgery	1 (20)	7 (4.3)	0.219
Index-to-closure time, months	3.0 (3.0-12)	3.0 (3.0-4.0)	0.198
Postoperative 30-day complications after index surgery			
Delayed postoperative ileus	1 (20)	20 (12.3)	0.492
Surgical site infection	2 (40)	24 (15)	0.171
Wound dehiscence of skin	1 (20)	13 (8.0)	0.356
Need for parenteral nutrition	5 (100)	45 (28)	0.002*
Interventional procedures under general anesthesia	1 (20)	6 (3.7)	0.194
Morbidity at discharge after index surgery			
Drain at discharge	1 (20)	2 (1.2)	0.087
Antibiotics (i.v.) at discharge	1 (20)	2 (1.2)	0.087
Interval complications [†]			
Peristomal skin complaints	0 (0)	56 (34)	0.171
Parastomal hernia	1 (20)	6 (3.7)	0.194

AR, anterior resection; ASA, American Society of Anesthesiologists; IBD, inflammatory bowel disease; IQR, interquartile range

[†] complications occurring beyond 30 days from the index surgery and before closure

**p* < 0.05

and scaled similar to our study but it was not designed to address the impact of previous complications on the closure outcomes but to compare early versus late closures [36]. Besides, only patients without clinical or radiological signs of adverse events after the index operation were included and randomized in the trial. Although the complete picture remains to be fully understood, the influence of the role of the index surgery was evident in our findings. Thus, we believe close surveillance of complicated patients from the index CD surgery is the key for an enhanced planning of the following DLI closure surgery. Poor adherence to

surveillance may lead to adverse consequences particularly for elderly patients, those requiring secondary intention wound healing at the index surgery and patients needing postoperative parenteral nutrition within the 30-day period following their index surgery.

In navigating the spectrum of diversion options— from a split stoma to an end stoma with a mucous fistula or a blind stump — IBD surgeons must possess a nuanced understanding, preserving these tools for specialized scenarios, particularly when a patient's tolerance for anastomotic complications is minimal [37]. Yet, it's crucial to recognize that alternatives to a DLI can heighten the risk of stoma complications, like retraction. Employing a DLI with a stoma rod, a fixture routinely embraced by our surgical team, serves as a barrier against the pull of remnant phlegmonous tissues and anticipated postoperative edema, thereby promoting a mesenteric tension around the stoma. Even amidst scenarios favoring end ileostomies for Crohn's, opting for a loop-end ileostomy may present as a clinically prudent course of action, especially when crafting an end ileostomy proves technically demanding. This holds particularly true in scenarios where accessing the mesentery poses challenges, such as restricted reach [38].

We note that this study has several limitations due to its single center setting and retrospective design despite the use of prospectively collected data. The higher proportion of patients with abdominal Crohn's disease undergoing surgical procedures including the creation of a loop ileostomy at our center may be attributed to our role as a quaternary center specializing in IBD. As a result, we often receive referrals for more complex cases requiring surgical intervention. In addition, it's crucial to note that our study exclusively comprises patients deemed eligible for DLI closure and who proceeded to reversal surgery, meaning that the reported bowel restoration rates do not account for those patients who had a fecal diversion but failed to undergo restoration surgery. This limitation underscores the need for further exploration to comprehensively evaluate the outcomes of loop ileostomy in the broader context of stoma management in CD patients. Regarding the shift in IBD diagnosis post-pouch surgery, the majority of IPAA patients experienced a transition to Crohn's disease, emphasizing the inherent complexities of Crohn's disease pathophysiology. However, with advancements in our understanding of the underlying biological pathways, we anticipate that such limitations may gradually attenuate. Additionally, it's important to acknowledge that our study evaluates corticosteroid use as a single group, without distinguishing based on dosages. This limitation restricts our ability to infer the impact of dosage variations on postoperative outcomes.

The detailed DLI creation and closure strategy set forth in the present paper contributes to the evidence on optimal

management of CD patients. The end-to-end, interrupted and single-layer handsewn closures for DLIs created using a liberal and selective approach demonstrated safety and yielded positive outcomes. These included a 98.8% restoration of bowel continuity and a 97.0% recovery without the occurrence of adverse events such as newly developing organ dysfunction or the need for reoperation. In the face of the series of challenges brought on by intense inflammatory conditions encountered at a quaternary IBD referral center, we remain reluctant to consider the liberal use of diversions in CD surgery to be an “overused” practice.

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors declare no competing interests.

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