Journal of Crohn's and Colitis, 2020, 1378–1384
doi:10.1093/ecco-jcc/jjaa066
Advance Access publication March 30, 2020
Original Article

Original Article

Short- and Long-term Outcomes Following Side-to-side Strictureplasty and its Modification Over the Ileocaecal Valve for Extensive Crohn's Ileitis

G. Bislenghi,[a] M. Ferrante,[b] J. Sabino,[b] B. Verstockt,[b] B. Martin-Perez,[a] S. Fieuws,[c] A. Wolthuis,[a] S. Vermeire,[b] A. D'Hoore[a]

[a]Department of Abdominal Surgery, University Hospitals Leuven, KU Leuven, Leuven, Belgium [b]Department of Gastroenterology and Hepatology, University Hospitals Leuven, KU Leuven, Leuven, Belgium [c]Interuniversity Center for Biostatistics and Statistical Bioinformatics, University of Leuven and University of Hasselt, Leuven, Belgium

Corresponding author: Gabriele Bislenghi, MD, UZ Leuven, Herestraat 49, 3000 Leuven, Belgium. Tel.: + 32 016 341838; email: gabriele.bislenghi@uzleuven.be

Abstract

Background and Aims: Postoperative recurrence remains a challenging problem in patients with Crohn's disease [CD]. To avoid development of short bowel syndrome, strictureplasty techniques have therefore been proposed. We evaluated short- and long-term outcomes of atypical strictureplasties in CD patients with extensive bowel involvement.

Methods: Side-to-side isoperistaltic strictureplasty [SSIS] was performed according to the Michelassi technique or modification of this over the ileocaecal valve [mSSIS]. Ninety-day postoperative morbidity was assessed using the comprehensive complication index [CCI]. Clinical recurrence was defined as symptomatic, endoscopically or radiologically confirmed, stricture/inflammatory lesion requiring medical treatment or surgery. Surgical recurrence was defined as the need for any surgical intervention. Endoscopic remission was defined as ≤i1, according to the modified Rutgeerts score. Deep remission was defined as the combination of endoscopic remission and absence of clinical symptoms. Perioperative factors related to clinical recurrence were evaluated.

Results: A total of 52 CD patients [SSIS $n = 12$; mSSIS $n = 40$] were included. No mortality occurred. Mean CCI was 10.3 [range 0–33.7]. Median follow-up was 5.9 years [range 0.8–9.9]. Clinical recurrence [19 patients] was 29.7% and 39.6% after 3 and 5 years, respectively. Surgical recurrence [seven patients] was 2% and 14.1% after 3 and 5 years, respectively. At the end of the follow-up, 92% of patients kept the original strictureplasty and deep remission was observed in 25.7% of the mSSIS patients. None of the perioperative variables considered showed a significant association with clinical recurrence.

Conclusions: SSIS is safe, effective, and provides durable disease control in patients with extensive CD ileitis.

Key Words: Crohn's disease; surgery; strictureplasty; long-term recurrence

1. Introduction

Given the nature of Crohn's disease [CD], surgical treatment is not curative. About 50% of patients will have an early endoscopic recurrence (modified Rutgeerts score [MRS] ≥ i2b]) at 4–6 months. The rate of clinical and surgical recurrence after 10 years can reach 50% and 20%, respectively.[1] Moreover, ileal location and extensive terminal ileitis are established risks factor for early recurrence and second surgery.[2] One of the potential drawbacks of resectional surgery is the danger of a short bowel syndrome. In attempting to preserve bowel length and reduce the risk of intestinal failure,

strictureplasties are a valid alternative to bowel resections.[3] Over the past 30 years, the indication for strictureplasty has further expanded and techniques were developed for long strictures [>20 cm].[4] However, it remains unclear how strictureplasties affect the course of CD. Follow-up data reveal a low site-specific recurrence and remodelling of the abdominal wall at the strictureplasty sites.[5,6]

The aim of this study was to evaluate the short- and long-term outcomes of CD patients with extensive disease of the small bowel [ileum], who received long unconventional side-to-side isoperistaltic strictureplasties [SSIS], with regard to mortality, morbidity, disease recurrence and location, failure, and possible perioperative recurrence-related factors.

2. Materials and Methods

All CD patients with extensive ileitis were considered eligible for this retrospective study. Patients' data were retrieved from a prospectively maintained database. All patients had consented for their data to be analysed through the VLECC Biobank [Vlaamse Erfelijkheidsstudie Crohn's en Colitis Ulcerosa, of Flemish Study for Genetics Research on Crohn's Disease and Ulcerative Colitis]. Decision for surgery was taken in a multidisciplinary team. Patients with a long stenotic small bowel segment ≥20 cm, in absence of fistula, abscess, or phlegmon at imaging (computed tomography [CT] or magnetic resonance enterography [MRE]) were proposed for unconventional side-to-side isoperistaltic strictureplasties. The ultimate feasibility of the strictureplasty was assessed at surgical exploration. Side-to-side isoperistaltic strictureplasty [SSIS] was performed according to the technique described by Michelassi *et al.* in 1996.[7] A modification over the ileocaecal valve [mSSIS] has been described in detail in previous publications.[5,8] After laparoscopic mobilisation of the right colon, the terminal ileum and proximal part of the ascending colon are exteriorised through an umbilical incision. The length of the diseased segment is measured and a suitable point to divide the bowel and mesentery is selected in the middle of the loop. The bowel and part of the mesentery are divided to enable mobilisation of the proximal part over the ileocaecal valve. The most proximal loop is opened longitudinally, and the strictureplasty is started at the outlet, using interrupted sutures for the posterior suture line. The more distal loop is then opened longitudinally to include the ileocaecal valve and the anterior suture line is performed [Figure 1]. When needed, a resection of the most severe part of the diseased bowel was coupled with performance of an SSIS. A relative stricture at the inlet of the SSIS was observed during follow-up in the first 10 patients. Therefore, a HeinekeMikulicz [HM] strictureplasty [Sasaki modification] at the inlet of the mSISS, in order to obtain a wider inlet, was performed in the subsequent cases.[9] Medical therapy was continued postoperatively if: a] active disease outside the site of the strictureplasty was present at the time of surgery; or b] active disease was limited to the site of strictureplasty in patients with a high-risk profile for recurrence.[2]

Patients were assessed clinically at 1 and 6 months postoperatively. An ileocolonoscopy and magnetic resonance enterography [MRE] were done 6 months after surgery. Based on clinical, endoscopic, and radiological findings, medical treatment was initiated and further follow-up was scheduled.

Endoscopic disease activity was assessed according to the modified Rutgeerts score [MRS].[10] Clinical recurrence was defined as symptomatic endoscopically [MRS ≥ i2b] or radiologically confirmed stricture/inflammatory disease requiring initiation/escalation of the medical treatment or surgery. Surgical recurrence was defined as the need for any surgical intervention. Endoscopic remission was defined as MRS ≤ i1.[11] Deep remission was defined as the combination of endoscopic remission and absence of clinical symptoms.[12]

All postoperative complications within 90 postoperative days were taken into consideration. Postoperative morbidity was scored using the comprehensive complication index [CCI][13] based on the Clavien-Dindo classification[14] by using the online CCI calculator [www.assessurgery.com]. A nasogastric tube [NGT] was routinely left in place after surgery until recovery of the gastrointestinal function [defined as passage of flatus or defaecation]. Prolonged postoperative ileus [POI] was defined as the need for NGT reinsertion due to nausea/vomit.

Perioperative factors related to disease recurrence [gender, age at surgery, disease location, disease behaviour, active smoking habits, anaemia [defined as haemoglobin less than 12 or 13 or haematocrit less than 35% or 45%, according to female or male gender respectively], malnutrition (defined as body mass index [BMI] less than 18.5 kg/m^2 or 21 kg/m^2, or weight loss more than 10%, or albumin less than 3.5 g/L), previous CD-related surgery, preoperative (corticosteroids and/or immunomodulators within 4 weeks of surgery, and anti-tumour necrosis factor [TNF], vedolizumab, or ustekinumab within 12 weeks of surgery) and postoperative medical therapy, length of the affected bowel segment, concomitant CD-related surgical procedures, overall postoperative complications, and anastomotic leak were evaluated.

2.1. Statistics

Descriptive statistics were performed on all data. Values are expressed as median and range or mean and standard deviation [SD]. Clinical and surgical recurrence were estimated using KaplanMeier analysis. The common data closure date [November 16, 2019] was used to calculate the time until recurrence for censored patients. Univariable Cox regressions were performed for categorical and continuous variables to evaluate the relation with clinical recurrence. SAS system for Windows, version 9.4, was used for statistical analysis.

3. Results

Between June 2009 and December 2018, 52 consecutive patients (male 24/52, median age 39 years [range 16–73]) underwent [m]SSIS. Twelve patients [23.1%] underwent SSIS and 40 patients [76.9%] underwent mSSIS over the ileocaecal valve. Median duration of disease was 6.3 [0–34] years. A total of 43 cases were approached laparoscopically: among these, six patients [11.5%] underwent a full SILS [single incision laparoscopic surgery] mobilisation of the right colon. One patient [1.9%] needed conversion to open surgery. Thirteen patients [25%] already had previous surgery for CD. In five patients [12.5%], an mSSIS was performed over an ileocolic anastomosis after previous ileocaecal resection. The median length of the affected bowel segment was 53 cm [20–110 cm]; 21 patients [40.4%] had concomitant surgery related to CD. Four patients underwent resection of the middle portion of the affected loop of bowel before using the proximal and distal ends for the SSIS. Three patients in which a conventional SSIS was performed for small bowel strictures underwent a concomitant ileocaecal resection. In the remaining cases, a resection of a portion of jejunum/ileum not suitable for strictureplasty [fistula] was done. Patients' characteristics, surgical details, and postoperative outcomes are listed in Table 1 and 2.

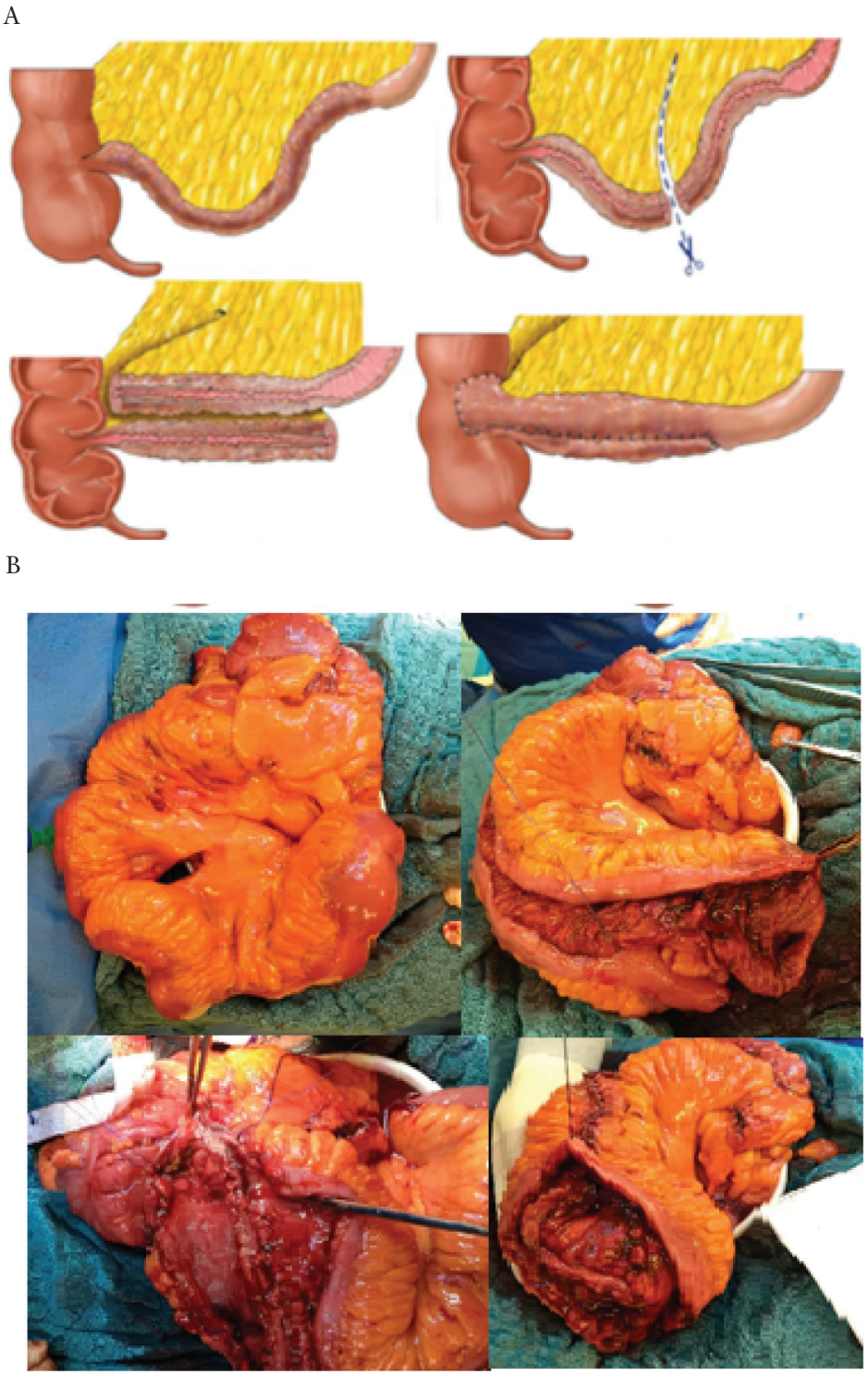

Figure 1. a] Schematic view + b] intra-operative view. The stenotic ileum is divided in the middle. The proximal segment is slid over the distal segment, including the ileocaecal valve when needed. A side to-side isoperistaltic strictureplasty is than performed.

3.1. Short-term outcomes

No mortality occurred. The median length of hospital stay was 9 [517] days. First bowel movement occurred after 5 [212] days. Median number of complications per patient was 1.3 [range 0–4]. Clavien-Dindo classification of postoperative complications is reported in Table 3. Mean CCI for SSIS was 10.3 [range 0–33.7]. Four patients developed an anastomotic leak [7.7%] in the early postoperative period. The first case was a small suction lesion created by the drain left against the suture line. The other cases presented with a small leak [one at the inlet of the strictureplasty, the others at the strictureplasty body] created by too much traction on the stitches. In all cases of anastomotic

Table 1. Study population characteristics; *n* [%].

Male	24 [46.1%]
Median age at surgery, years [range]	32.7 [16–73]
Disease duration, years [range]	6.3 [0–34]
Family history	11 [21.1%]
Montreal classification [age, years]	
A1 [<17]	10 [19.2%]
A2 [17–40]	31 [59.6%]
A3 [>40]	11 [21.2%]
Location	
L1 [terminal ileum]	34 [65.4%]
L2 [colonic]	0 [0.0%]
L3 [ileocolic]	18 [34.6%]
Behaviour	
B1 [non-stricturing, non-penetrating]	7 [13.5%]
B2 [stricturing]	36 [69.2%]
B3 [penetrating]	9 [17.3%]
P [anal involvement]	16 [30.8%]
Preoperative Crohn's medication	45 [86.5%]
Biologics [within 6 weeks of surgery]	29 [55.7%]
Corticosteroids [within 4 weeks of surgery]	13 [25%]
Immunomodulators [within 4 weeks of surgery]	11 [21.1%]
Other	2 [3.8%]
Active smoking	16 [30.8%]
Anaemia	19 [36.5%]
Malnutrition	8 [15.4%]
Extra-intestinal manifestation	4 [7.7%]
Previous surgery	14 [26.9%]
Previous surgery for stricturing CD	13 [25%]
Small bowel resection	2
Ileocaecal resection	5
Colonic resection	2
Strictureplasty	2
Strictureplasty + ileocaecal resection	1
Strictureplasty + small bowel resection	1

CD, Crohn's disease.

Table 2. Surgical characteristics.

Conventional mSSIS	12 [23.1%]
Modified SSIS over the valve	40 [76.9%]
Surgical approach	
Laparotomy	9 [17.3%]
Laparoscopy	36 [69.2%]
SILS	6 [11.5%]
Conversion to laparotomy	1 [1.9%]
Median length of the treated segment, cm [range]	40 [20–110]
Concomitant CD-related surgery	21 [40.4%]
Small bowel resection	10
Segmental colectomy	4
HM or Finney strictureplasty	7

CD, Crohn's disease; mSSIS, modified side-to-side isoperistaltic strictureplasty; SILS, single incision laparoscopic surgery; HM, HeinekeMikulicz.

leak, re-intervention consisted of re-suturing of the perforation without resection of the strictureplasty. Two patients had a re-look laparoscopy to exclude a leak, because of high inflammation parameters. No leak was found and the patients were further treated with antibiotics. Two patients had gastrointestinal bleeding treated conservatively. Prolonged postoperative ileus occurred in 10 patients [19.2%]. Ileus resolution was observed after a median time of 5 days [range 2–12].

Table 3. Postoperative outcomes.

Postoperative hospital stay, days [range]	9[5–17]
Time to recovery of the gastro-intestinal function,[a] days [range]	5[2–12]
Postoperative morbidity [Clavien-Dindo]	
0	27 [51.9%]
1	6 [11.5%]
2	13 [25.0%]
3a	0 [0.0%]
3b	6 [11.6%]
4	0 [0.0%]
Comprehensive complication index [CCI] [mean, range]	10.3 [0–33.7]
Postoperative medication [initiated or continued within 4 weeks after surgery]	28 [53.9%]
Anti-TNF	14
Vedolizumab	6
Ustekinumab	3
Immunosuppressives	3
Anti TNF + immunosuppressives	2
Clinical recurrence	19 [36.5%]
Surgical recurrence	7 [13.5%]
Modified Rutgeerts Score [6 months after surgery]	*n* = 40 [100%]
I0 [*n* patients with no postoperative medical therapy]	3 [7.5%] [1]
i1	3 [7.5%] [1]
i2a	11 [27.5%] [6]
i2b	12 [30%] [7]
i3	5 [12.5%] [3]
i4	4 [10%] [3]
Not available	2 [5%] [2]
Follow- up, years [range]	5.9 [0.8–9.9]

TNF, tumour necrosis factor.
[a]Defined as passage of flatus or defaecation.

3.2. Long-term outcomes

A total of 28 patients [53.9%] continued medical therapy after surgery [Table 3]. Median follow-up was 5.9 years [range 0.8–9.9 years]. No patient was lost to follow-up. Clinical recurrence [19 patients] was 29.7% and 39.6% after 3 and 5 years, respectively. Surgical recurrence [seven patients] was 2% and 14.1% after 3 and 5 years, respectively [Figure 2]. The recurrent disease was away from the strictureplasty site in five patients [26.3%], requiring surgery in one patient. In the remaining 14 patients [73.7%], the recurrence was located at the strictureplasty site [inlet *n* = 4, outlet *n* = 1, body *n* = 9, respectively] requiring surgery in six cases. Four patients [7.7%] required resection of the SSIS after a median of 3.6 years [1–4.4 years]. Reasons for resection were recurrent endoluminal bleeding at the SSIS, multiple strictures along the SSIS body, and penetrating disease with fistula formation between the SSIS body and the abdominal wall. Resection of m[SSIS] results in the loss of the same length of bowel as the resection that was performed at the time of the index procedure. In two patients, a HeinekeMikulicz [HM] strictureplasty was performed at the inlet of the SSIS. One patient developed a second surgical recurrence [two short jejunal strictures treated by HM strictureplasties] 5.9 and 1.9 years after the index surgery [mSSIS] and the first surgery for recurrence [HM strictureplasty at the inlet of mSSIS], respectively [Figure 3]. None of the perioperative variables considered, including concomitant

surgery for CD, showed a significant association with clinical recurrence [Supplementary Table 1, available as Supplementary data at *ECCO-JCC* online]. At 6 months after surgery, 29 mSSIS patients [72.5%] showed significant mucosal improvement [MRS ≤ i2b] at the strictureplasty site. Endoscopic remission was observed in six patients [15%] with concomitant regression of the muscular hypertrophy and remodelling of the bowel wall at MRE [Table 3]. At the end of the follow-up, ileocolonoscopy was available in 35 patients who underwent an mSSIS. Deep remission was reached in nine mSSIS patients [25.7%]. No patient was diagnosed with adenocarcinoma at the strictureplasty site.

<<Fig. 2 near here>>

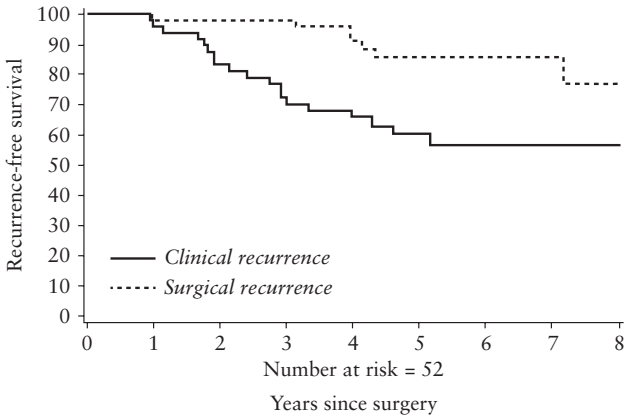

Figure 2. KaplanMeier curves for clinical and surgical recurrence-free survival. Clinical recurrence: symptomatic, endoscopically [MRS ≥ i2b] or radiologically confirmed, stricture/inflammatory lesion requiring initiation/escalation of the medical treatment or surgery. Surgical recurrence: any surgical intervention within or away from the primary strictureplasty.

4. Discussion

Despite the introduction of biologic therapies, CD remains one of the major risk factors related to the development of a short bowel syndrome, especially in those patients who undergo extensive repetitive bowel resections.[15] This highlights the need for bowel sparing surgical options. As recently stated in the ECCO guidelines, long side-to-side isoperistaltic strictureplasty is the preferred technique for the treatment of long stenotic segments or multiple and close strictures of the small bowel.[16]

The safety and feasibility of strictureplasties have been demonstrated well. In a meta-analysis involving 1112 patients and more than 3200 procedures, the overall morbidity rate was 13% and no mortality was reported. Only 4% of patients developed a septic complication [anastomotic leak, abscess, or fistula formation].[3] A more recent meta-analysis showed that SSIS does not confer a higher postoperative morbidity risk when compared with conventional strictureplasties [HM, Finney].[17]

A modified SSIS incorporating the ileocaecal valve for the treatment of extensive terminal ileitis has been introduced in our institution since 2011, with satisfactory postoperative outcomes.[8] In our experience, the presence of any septic complications [mesenteric fistula or abscess not detected on preoperative imaging], an excessive fibrotic bowel wall or thickened mesentery [challenging to transect and to slide over the distal bowel segment without causing excessive traction on the inlet stitches], or marked creeping fat covering the complete serosal surface, are contraindications to performing an SSIS. In those patients, we believe that a segmental small bowel [or ileocaecal] resection has to be preferred over bowel sparing surgery.

In the present series, major complications occurred in 11.5% of the patients. Leak rate was 7.7%. Given the complexity of the surgery, a suspected leak during the first postoperative days led to immediate surgical exploration [re-laparoscopy]. Such an aggressive strategy permitted the detection of early leaks in stable non-compromised patients, with no macroscopic peritonitis and 'good

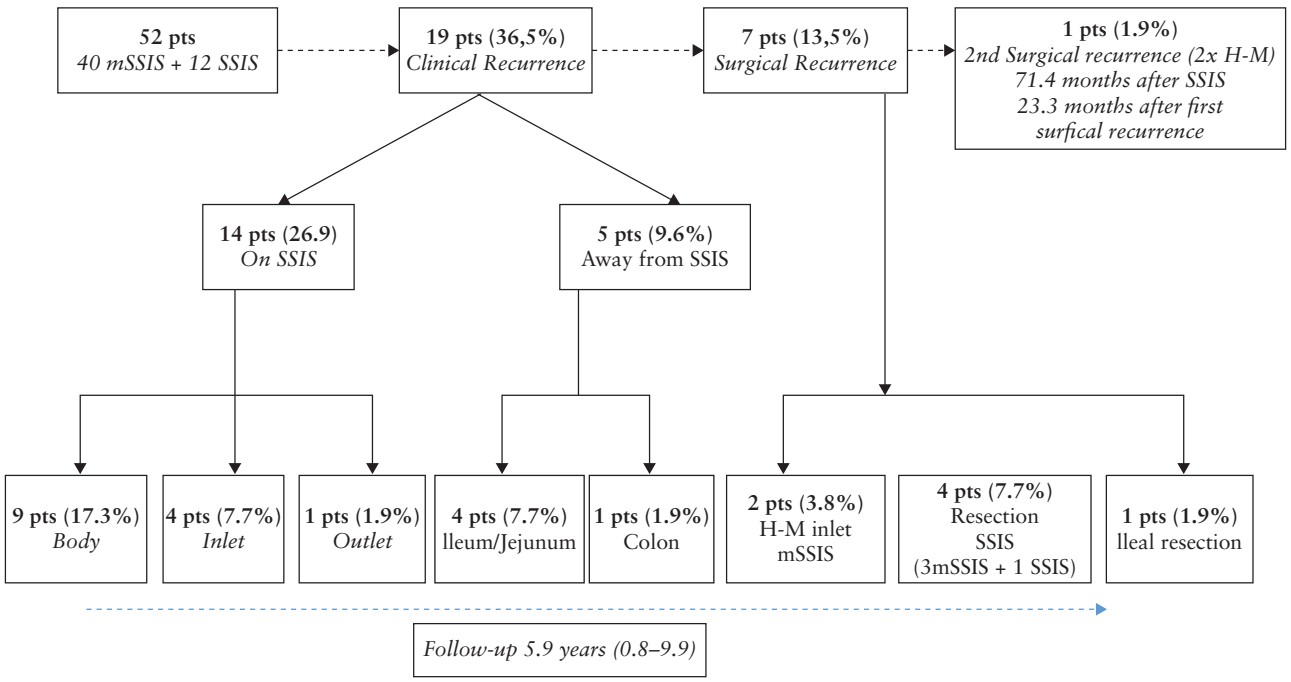

Figure 3. Global response after side to-side isoperistaltic strictureplasty [SSIS]. Overview. Univariable Cox regressions were performed for categorical and continuous variables, to evaluate the relation with clinical recurrence.

Table 4. SSIS published studies. Comparison of long-term outcome.

	Fazi, 2016[6]	Michelassi, 2019[21]	Present study
N	91 pts [complete FU in 83 pts]	60 pts [complete FU in 47 pts]	52 pts
Type	SSIS + modification 22 pts [23%]	SSIS	SSIS + mSSIS 40 pts
Associated procedures	Resection 41 pts [45%] SXPL 41 pts [45%]	Resection 33 pts [55%] SXPL 27 pts [45%]	Resection 14 pts [26.9%] SPXL 7 pts [13.4%]
Preoperative medications	56 pts [61.5%]	Not available	45 pts [86.5%]
Length of spared bowel, cm [range]	55 [10–140]	50 [20–148]	40 [20–110]
Leak	2 pts [2.2%]	0%	4 pts [7.6%]
Follow-up, years[range]	4.6 [0.7–11.6]	11 [1–25] years	5.9 years [0.8–9.9]
Postoperative medications	50 pts [54.9%]	Not available	28 pts [53.9%]
Clinical recurrence	37 pts [44.6%]	36 pts [61%]	19 pts [36.5%]
Surgical recurrence	22 pts [26.5%]	22 pts [37%]	7 pts [13.5%]
Global recurrence at strictureplasty site	24 pts [28.9%]	15 pts [26%]	14 pts [26.9%]
Surgical recurrence at strictureplasty site	15 pts [18.1%]	11 pts [19%]	6 pts [11.5%]
Resection strictureplasty	2 pts [2.4%]	8 pts [13.3%]	4 pts [7.7%]
SSIS maintaned at the end of FU	81 pts [97.6%]	55 pts [86.7%]	48 pts [92.3%]

SSIS, side to-side isoperistaltic strictureplasty; FU, follow-up; SXPL, strictureplasty.

quality' bowel, suitable for re-suturing of the perforation without resection of the strictureplasty. On the other hand, leaks associated with larger bowel defects, bowel ischaemia, and diffuse peritonitis should preclude any attempt to save the SSIS and should lead to immediate resection of the strictureplasty. Prolonged postoperative ileus and delay in recovery of the gastrointestinal function were commonly observed, probably due to extensive tissue manipulation during surgery.[18]

The high-risk recurrence profile of the current study population is highlighted by the short interval between diagnosis and surgery, young age at surgery, the notable proportion of patients with smoking habits, preoperative medications, and previous operations for CD. All of these factors have already been identified as independent risk factors for recurrence after bowel resection.[2] Furthermore, one third of the patients had perianal penetrating disease which indicates a more aggressive phenotype of CD.[19] In patients with extensive small bowel involvement approached with intestinal resections, recurrence tends to mimic the location and the length of the primary disease.[20] In this setting, long strictureplasties avoid the risk of short bowel syndrome. However, the validity of SSIS on the long-term follow-up has been only partially demonstrated. Two studies analysed long-term outcome of SSIS after a median follow-up of 5.5 and 11 years with rates of clinical and surgical recurrence of 4451%, and 2637%, respectively.[6,21] Recurrence at the strictureplasty site occurred in about 27% of the patients. Clinical and surgical recurrence rates of the present study were even lower, being 36.5% and 13.5% at medium follow-up of 6 years, respectively [Table 4]. Strictureplasty site-specific recurrence was 27%, being surgical in 43% of the cases. Overall, the bowel sparing intent of the technique was respected in 92% of the study population and in 57.1% of the surgical recurrences, confirming the durability of SSIS [Figure 2].

Several studies suggest that strictureplasties have the potential to induce regression of the stricturing disease.[22,23] The relief of the intestinal obstruction disrupts the inflammatory process, allows mucosal cytokine production to be down-regulated and promote anatomical and functional recovery of the treated bowel segment.[23,24] The fact that the resolution of the inflammation follows a proximal to distal gradient inside the strictureplasty seems to corroborate this hypothesis. This is particularly relevant considering that endoscopic remission has recently emerged as a key therapeutic goal in the clinical management of CD patients. The establishment of deep remission might be the best way to alter the course of CD, by preventing bowel damage and disability and need for surgical re-interventions.[24,25] Performing a strictureplasty over the ileocaecal valve or ileocolic anastomosis also gives the opportunity for routine flexible endoscopic monitoring. In the present study, 40 patients [76.9%] received an mSSIS over the ileocaecal valve. The remaining 12 patients underwent a conventional SSIS. In these patients, no endoscopic monitoring was possible due to the proximal location of the SSIS [proximal ileum]. At 6 months after surgery, significant mucosal improvement [MRS ≤ i2a] was visible in 17 [44.7%] of 38 mSSIS patients who had an ileocolonoscopy suitable for MRS calculation. Complete mucosal and bowel wall remodelling in absence of any strictures within the treated bowel segment were clearly visible on ileocolonoscopy and MRE in 15.6% of the patients. At the end of the follow-up, 87.5% of the mSSIS patients had an ileocolonoscopy available. Among them, deep remission was achieved in nine patients [25.7%], although only three patients [7.5%] did not receive any postoperative medications.

Limitations of this study are mainly related to its retrospective design, the absence of a control group, and the lack of standardisation with regard to preoperative and postoperative medical treatment. Assessment of mucosal healing was possible only for mSSIS patients.

In the setting of extensive small bowel disease, SSIS emerges as a valid option to classical resections, even when long-term outcomes are considered. It ensures durable results, preserving bowel length and minimising the life-time risk of short bowel syndrome if recurrence occurred.

Furthermore, mSSIS over the valve serves as a good clinical model for research in order to clarify the mechanism at the basis of the mucosal healing and the reversal of fibrosis. Further investigations are

needed to verify if functional recovery is present at the site of the strictureplasty, in terms of motility and absorptive function. This will help the surgeon in a more effective selection of patients in whom strictureplasty would be most appropriate in order to preserve functional bowel.

Funding

This work was not supported by any funding.

Conflict of Interest

BV: receipt of grants/research supports from Pfizer; lecture fees from Abbvie, Ferring, Takeda Pharmaceuticals, Janssen, and R Biopharm; consultancy for Janssen and Sandoz. MF: research grant from Amgen, Biogen, Janssen, Pfizer, Takeda; consultancy for Abbvie, Boehringer-Ingelheim, Janssen, MSD, Pfizer, Sandoz, Takeda,Thermofisher; speakers fee from Abbvie, Amgen, Biogen, Boehringer-Ingelheim, Falk, Ferring, Janssen, Lamepro, MSD, Mylan, Pfizer, Sandoz, Takeda. SV: grants/research supports from MSD, Abbvie, Takeda, Janssen, Pfizer; honoraria or consultation fees from AbbVie, MSD, Takeda, Ferring, Genentech/Roche, Shire, Pfizer Inc., Galapagos, Mundipharma, Hospira, Celgene, Second Genome, Progenity, Lilly, Arena, Gilead, and Janssen; participation in a company-sponsored speaker's bureau for AbbVie, MSD, Takeda, Ferring, Hospira, Pfizer, Janssen, and Tillots. The authors declare no other conflict of interest.

Acknowledgements

None.

Author Contributions

GB, AW ADH, MF, and SV provided the study concept and design; GB and BMP acquired the data; GB and ADH analysed and interpreted the data; SF did the statistical analysis; GB drafted the manuscript; ADH, AW, MF, BV, JS, MP, SV, and SF revised the manuscript critically and contributed important intellectual content.

Supplementary Data

Supplementary data are available at *ECCO-JCC* online.

References

1. de Buck van Overstraeten A, Eshuis EJ, Vermeire S, *et al.* Short- and medium-term outcomes following primary ileocaecal resection for Crohn's disease in two specialist centres. *Br J Surg* 2017;**104**:1713–22.
2. Gklavas A, Dellaportas D, Papaconstantinou I. Risk factors for postoperative recurrence of Crohn's disease with emphasis on surgical predictors. *Ann Gastroenterol* 2017;**30**:598–612.
3. Yamamoto T, Fazio VW, Tekkis PP. Safety and efficacy of strictureplasty for Crohn's disease: a systematic review and meta-analysis. *Dis Colon Rectum* 2007;**50**:1968–86.
4. Michelassi F, Hurst RD, Melis M, *et al.* Side-to-side isoperistaltic strictureplasty in extensive Crohn's disease: a prospective longitudinal study. *Ann Surg* 2000;**232**:401–8.
5. de Buck van Overstraeten A, Vermeire S, Vanbeckevoort D, *et al.* Modified side-to-side isoperistaltic strictureplasty over the ileocaecal valve: an alternative to ileocaecal resection in extensive terminal ileal Crohn's disease. *J Crohns Colitis* 2016;**10**:437–42.
6. Fazi M, Giudici F, Luceri C, Pronestì M, Tonelli F. Long-term results and recurrence-related risk factors for Crohn disease in patients undergoing side-to-side isoperistaltic strictureplasty. *JAMA Surg* 2016;**151**:452–60.
7. Michelassi F. Side-to-side isoperistaltic strictureplasty for multiple Crohn's strictures. *Dis Colon Rectum* 1996;**39**:345–9.
8. de Buck van Overstraeten A, Wolthuis AM, D'Hoore A. Modified side-to-side isoperistaltic strictureplasty over the ileocaecal valve for the surgical treatment of terminal ileal Crohn's disease: the ultimate bowel sparing technique? *Colorectal Dis* 2016;**18**:O311–3.
9. Sasaki I, Shibata C, Funayama Y, *et al.* New reconstructive procedure after intestinal resection for Crohn's disease: modified side-to-side isoperistaltic anastomosis with double Heineke Mikulicz procedure. *Dis Colon Rectum* 2004;**47**:940–3.
10. Riviere P, Vermeire S, Van Assche G, *et al.* The modified postoperative endoscopic recurrence score for Crohn's disease: does it really make a difference in predicting clinical recurrence? *J Crohns Colitis* 2017;**11**:S194 -S.
11. Machiels K, Sabino J, Vandermosten L, *et al.* Specific members of the predominant gut microbiota predict pouchitis following colectomy and IPAA in UC. *Gut* 2017;**66**:79–88.
12. Rogler G, Vavricka S, Schoepfer A, Lakatos PL. Mucosal healing and deep remission: what does it mean? *World J Gastroenterol* 2013;**19**:7552–60.
13. Clavien PA, Vetter D, Staiger RD, *et al.* The Comprehensive Complication Index [CCI®]: added value and clinical perspectives 3 years "Down the Line". *Ann Surg* 2017;**265**:1045–50.
14. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;**240**:205–13.
15. Uchino M, Ikeuchi H, Bando T, *et al.* Risk factors for short bowel syndrome in patients with Crohn's disease. *Surg Today* 2012;**42**:447–52.
16. Bemelman WA, Warusavitarne J, Sampietro GM, *et al.* ECCO-ESCP consensus on surgery for Crohn's disease. *J Crohns Colitis* 2018;**12**:1–16.
17. Campbell L, Ambe R, Weaver J, Marcus SM, Cagir B. Comparison of conventional and nonconventional strictureplasties in Crohn's disease: a systematic review and meta-analysis. *Dis Colon Rectum* 2012;**55**:714–26.
18. Stein K, Hieggelke L, Schneiker B, *et al.* Intestinal manipulation affects mucosal antimicrobial defense in a mouse model of postoperative ileus. *PLoS One* 2018;**13**:e0195516.
19. Beaugerie L, Seksik P, Nion-Larmurier I, Gendre JP, Cosnes J. Predictors of Crohn's disease. *Gastroenterology* 2006;**130**:650–6.
20. D'Haens GR, Gasparaitis AE, Hanauer SB. Duration of recurrent ileitis after ileocolonic resection correlates with presurgical extent of Crohn's disease. *Gut* 1995;**36**:715–7.
21. Michelassi F, Mege D, Rubin M, Hurst RD. Long-term results of the side-to-side isoperistaltic strictureplasty in Crohn disease: 25-year follow-up and outcomes. *Ann Surg* 2019, Jan 31. doi: 10.1097/SLA.0000000000003221. [Epub ahead of print.]
22. Fornasa F, Benassuti C, Benazzato L. Role of magnetic resonance enterography in differentiating between fibrotic and active inflammatory small bowel stenosis in patients with Crohn's disease. *J Clin Imaging Sci* 2011;**1**:35.
23. Maconi G, Sampietro GM, Cristaldi M, *et al.* Preoperative characteristics and postoperative behavior of bowel wall on risk of recurrence after conservative surgery in Crohn's disease: a prospective study. *Ann Surg* 2001;**233**:345–52.
24. Shah SC, Colombel JF, Sands BE, Narula N. Mucosal healing is associated with improved long-term outcomes of patients with ulcerative colitis: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol* 2016;**14**:1245–55 e8.
25. Rutgeerts P, Geboes K, Vantrappen G, Kerremans R, Coenegrachts JL, Coremans G. Natural history of recurrent Crohn's disease at the ileocolonic anastomosis after curative surgery. *Gut* 1984;**25**:665–72.