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Reconstructive Surgery for Intestinal Failure

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Keywords

Surgery · Intestinal failure · Short bowel · Crohn's disease · Mesenteric ischemia

Abstract

Background: Intestinal failure (IF) in the adult is the result of a wide spectrum of disease. Acute mesenteric ischemia, postoperative short bowel due to a complicative course, and Crohn's disease are major causes of IF. Reconstructive surgery in the context of IF comprises a spectrum of procedures including stoma takedown, reversal of laparostomies, and closure of enteric fistulas. ***Methods:*** This article is based on a PubMed-based literature search and personal experience in adult patients with IF. ***Results:*** This review summarizes therapeutic options of reconstructive surgery in adult patients focusing on the main reasons of IF such as mesenteric ischemia, complicative previous surgery, and Crohn's disease. Indications and contraindications are discussed as well as the optimal time point of reconstructive surgery. ***Conclusion:*** This overview summarizes surgical aspects in a special cohort of patients with a rare disease entity necessitating an interdisciplinary approach.

Introduction

Intestinal failure (IF) is the inability of the bowel to provide the body with sufficient nutrients, fluid, and supplements. In 2015 the ESPEN group redefined IF as "the reduction of the gut function below the minimum necessary for the absorption of macronutrients and/or water and electrolytes, such as intravenous supplementation is required to maintain health and or growth" [1]. This group elaborated a functional classification of IF allowing the stratification of patients according to a time- and prognostic-based pattern. Causes of IF are diverse and can be categorized as shown in a simplified manner in Table 1. Reconstructive surgery in the context of IF is not a defined surgical procedure. In most cases it includes stoma reversal or closure of bowel fistulas in the presence or absence of a laparostomy. When planning reconstructive surgery in IF patients, it is essential to keep the primary cause which led to this situation in mind. It is helpful to stratify the case according to the index surgery as "one hit" versus "multiple hit" category (Fig. 1). IF with short bowel due to intestinal ischemia is most often a "one hit" abdomen, meaning that the procedure resulting in short bowel is extensive resection in a single surgical step. Short bowel due to Crohn's disease is in most cases the result of repeated and complicated procedures in the same patient. This aspect is relevant for planning reconstructive surgery in view of the expected fragility of the abdomen, difficulty in getting access to the abdominal cavity, and length of the operation.

The focus of this review lies in personal experience with reconstructive surgery in *adult* IF patients, omitting surgical techniques of bowel lengthening procedures or intestinal transit modifying operations which have been summarized elsewhere [2].

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Table 1. Causes of intestinal failure

Medical	Ischemic	Infiltrative	Obstructive	Functional
Trauma Surgical complication	arterial venous	desmoid carcinoid amyloidosis tumor	adhesions internal hernia volvulus	pseudo-obstruction Crohn's disease colitis radiation enteritis

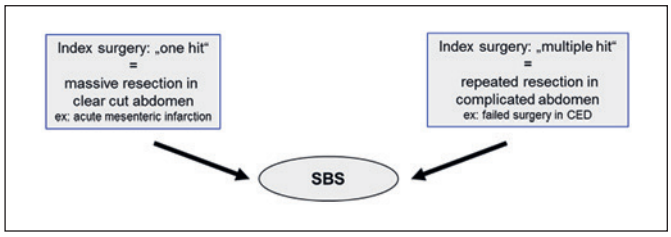

Fig. 1. Role of the index surgery.

Indication for Reconstructive Surgery

The indication for reconstructive surgery should be clearly defined (Table 2). The most relevant indication for reconstructive surgery is gain in bowel length. This can be reached either via pure lengthening procedures such as serial transverse enteroplasty (STEP) or the Bianchi procedure [3–5], which are mainly performed in pediatric patients optimizing rather volume-to-surface ratio than pure lengthening or via recruitment of bowel segments that are excluded from chyme passage as a result of previous surgery or a complication thereof. In this latter case a stoma is present and the wish of the patient to take down the stoma is one reason for reconstructive surgery. A well-designed stoma can, however, result in better quality of life than short bowel with colorectum in continuity but multiple uncontrolled bowel movements per day and night. A high enterostomy can harbor many problems such a skin irritation due to aggressive small bowel output. All efforts to "control" local problems such as high-dose intravenous proton pump inhibitors, medical treatment to lower stoma output (loperamide, opioids, or octreotide) [6], and professional stoma care should be undertaken to minimize local problems [7].

A clear indication for reconstructive surgery is the presence of a laparostomy with one or multiple enteric fistulas. This "abdominal catastrophe" is often the result of previous failed surgery for simple indications such as hernia repair or Crohn's disease. Previous publications estimated postoperative short bowel in up to 30% as the reason for IF and need for total parenteral nutrition (TPN) [8–10]. Once an entero-atmospheric fistula has developed spontaneous resolution is extremely rare [11]. Enteric fistulas are difficult to treat and almost impossible to treat in an ambulatory setting [12, 13]. Nevertheless, stabilization of these fistulas in the same manner as mentioned above for difficult-to-manage enterostomies is crucial and needs time. Patients' patience is often stressed, and sometimes psychological help is needed until the reconstructive surgical procedure can be performed.

A rare indication for reconstructive surgery is lowering or preventing catheter-related blood stream infection (CRBSI). The presence of a stoma or a laparostomy necessitating regular changes in wound dressing might harbor an increased risk of CRBSI. When venous access is already limited and pathophysiology suggests infection due to stoma, stoma takedown may be indicated since the presence of stoma is a risk factor for CRBSI [14].

Furthermore, a secondary deterioration of liver function known as IF-associated liver disease (IFALD), measured as elevated liver enzymes, can result from intrabdominal pathology such as blind loops or dilated bowel segments with bacterial overgrowth [15]. These indications are rare, and the success of reconstructive surgery cannot be guaranteed.

Contraindication for Reconstructive Surgery

When the risks of anesthesia and surgery outweigh the anticipated benefits, reconstructive surgery should better be denied. Detailed knowledge about the anatomy, the expected outcome, and the risk of surgery are mandatory to decide whether the operation is reasonable. In view of quality of life, the shorter the small bowel and the older the patient, the stricter the indication for reconstructive surgery should be. However, anastomosing very short small bowel segments to a segment of colon has been shown to improve quality of life by reducing the need for TPN [16]. A special situation is IF due to intestinal ischemia with subtotal loss of the small and large intestine including the right and transverse colon. In this case, reconstructive surgery with jejuno-colostomy results in frequent bowel passages. The compliance and the age of the patient in this case determines the subjective outcome.

Table 2. Indications for reconstructive surgery in intestinal failure patients

Indication	Intention
Stoma takedown	
Gain of bowel length	Better intestinal absorption of macro- and micronutrients Better intestinal absorption of fluid and electrolytes
Catheter infection	Stoma may be associated with increased risk for catheter infection
Worsening liver function	Latent septic source from – blind loop – colonic reservoir
Patient wish	Difficult to care for stoma Skin irritation/ulceration Quality of life improvement
Laparostomy reversal	Catheter infection Difficult to care for laparostomy Health care costs Patient wish

High risk of anastomotic failure is a major contraindication for reconstructive surgery, although in most cases only a single anastomosis is necessary. So far, there are no data indicating that the risk of anastomotic dehiscence is significantly higher in IF patients on TPN provided that malnutrition and hypalbuminemia have successfully been (re)compensated. This is in contrast to a recent study in patients with left colectomy for colon cancer, which showed preoperative TPN as a major risk factor for anastomotic dehiscence [17]. Risk factors for anastomotic dehiscence are otherwise the same as in the "normal" surgical population [18]. Renal insufficiency with dialysis and generalized atherosclerosis are major risk factors [19, 20]. A contrast-enhanced CT scan best rules out compromised perfusion [21]. Risk calculators for anastomotic failure have been established mainly for colorectal surgery [22, 23]. An online module for calculating perioperative risks by the American College of Surgeons can be used (https://riskcalculator.facs.org/RiskCalculator/Outcome.jsp).

Reconstructive Surgery for:

Short Bowel

Short bowel syndrome is classified as Type I, II, or III depending on which anatomical situation is present (Fig. 2). Defining the underlying anatomic type of short bowel helps since it predicts outcome [9, 24]. When type I short bowel syndrome can be converted to Type II or III, prognosis both in terms of survival as well as for oral autonomy improves. Pathophysiology of such conversion lies not only in gaining bowel length but enhancing adaptation via distinct pathways such as endocrine signaling (GLP-2, aldosterone), hyperphagia, and probably the microbiome [25–27]. The clue is to know preoperatively how much bowel can be recuperated in view of length, quality, and anatomical origin. It is standard to measure bowel length at the end of the procedure when operating on patients with Crohn's disease, especially in redo procedures. However, this is not the standard of care yet in "abdominal catastrophes" as mentioned above. When dealing with such patients operating reports are often hard to get. Therefore, the remaining bowel length is often unknown. Imaging studies such as MRI, CT scan, or small bowel follow-through can be helpful in estimating bowel length [21]. The shorter the bowel the easier it is! Clinically judging bowel length by asking the patient when an orally taken meal passes through can also be helpful, especially in patients with enteric fistulas. When the colon length has to be determined a colon contrast enema shows it very precisely. It further has the advantage of ruling out colonic stenosis which could later impair bowel passage. Pathology reports help in evaluating the length of resected bowel but naturally make no statements on the remaining bowel length. Endoscopy plays no role in evaluating the remaining bowel length.

Mesenteric Ischemia – Arterial and Venous – and Dissection

Arterial mesenteric ischemia is still one of the main reasons for massive bowel loss. In larger publications, mesenteric ischemia accounted for 10–40% of short bowel syndrome [8–10]. The clinical outcome of mesenteric ischemia was poor over many years and has improved only little over decades [28–31]. However, due to the widespread availability of angio-CT, increased awareness, and the establishment of "intestinal stroke units" [32], the outcome of mesenteric ischemia has improved

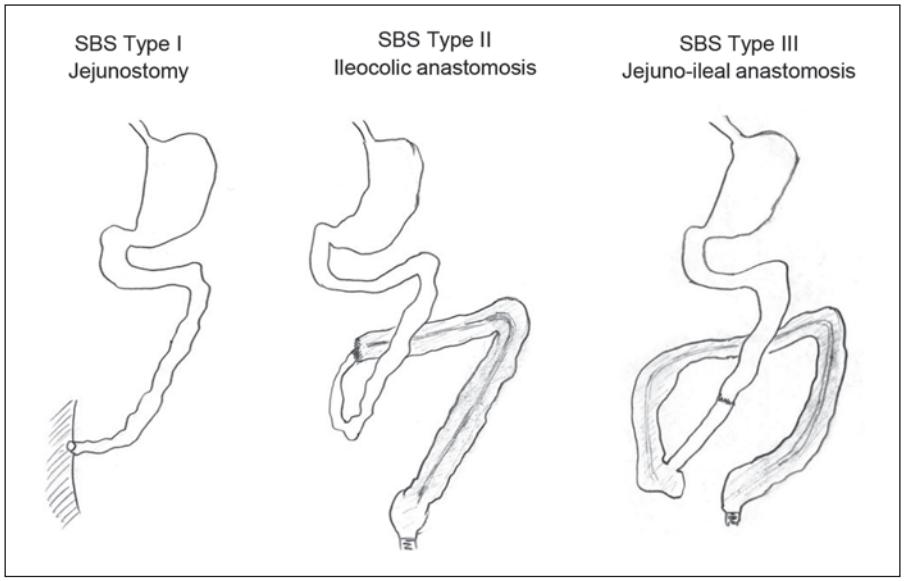

Fig. 2. Types of short bowel syndrome.

recently. Reestablishing arterial perfusion via embolectomy of the arterial thrombus or stenting of mesenteric vessels alone or in combination with bowel resection is crucial and strictly time dependent [33]. However, it is still a matter of debate whether bowel continuity should be restored early or late after revascularization [34]. Older guidelines [35] do not specify whether bowel resection should be followed by early or late anastomosis. The more recent European guideline from the Society of Vascular Surgery [36] and the World Society of Emergency Surgery [37] suggests that bowel continuity should be restored early during second- or third-look laparotomy. The reason for either leaving both ends blind or performing a stoma was the increased risk of anastomotic dehiscence when a primary anastomosis was performed directly after bowel revascularization and resection. Although experimental data suggest that acute ischemia impairs healing [38, 39] and can be improved by postponing anastomosis [40], there is no data on how often anastomotic dehiscence occurs after early reconstruction of bowel continuity following mesenteric ischemia in humans [41]. In my personal experience, anastomotic dehiscence can be reduced significantly (from 32% to 8%) if the bowel anastomosis is postponed from the first to the second or third laparotomy. Restoring bowel continuity can be easily postponed up to 10 days after the initial hit if necessary. An unstable clinical status, especially an ongoing septic process, forbids bowel reconstruction at any time point. Establishing an "intestinal stroke center" for patients with arterial mesenteric ischemia significantly lowers mortality and long-term IF. Therefore, improving interdisciplinary treatment for patients with arterial mesenteric ischemia is probably one of the best preventions [24, 42] for later reconstructive procedures.

Crohn's Disease

IF in patients with Crohn's disease is mainly due to complicated surgery, and seldom due to repeated non-complicated surgical procedures [43, 44]. When IF in Crohn's patients is due to short bowel, a reconstructive surgical procedure is not an option and bowel transplantation can be considered. However, if IF in this patient population is due to an abdominal catastrophe and the expected gain of bowel length is sufficient, reconstructive surgery can be considered. In these cases, patients often present with an open abdomen or multiple fistulas (Fig. 3). The following aspects should be addressed preoperatively: (1) what kind of medical treatment for Crohn's disease is the patient taking and does it have to be tapered or intensified preoperatively? and (2) is there bowel with "active" Crohn's disease left which may become reactivated after bowel continuity and stool passage have been restored? Of note, preoperative endoscopy is often not helpful and can be misleading in judging Crohn's activity in excluded bowel segments [45]. In my personal experience, the decision about resecting Crohn's-affected bowel segment at the time of reconstructive surgery depends on the medical therapeutic options left. Otherwise, simultaneous resection is a good choice.

Certain mutations in the NOD2 (nucleotide-binding oligomerization domain 2) gene are associated with Crohn's disease [46]. Patients with NOD2 deficiency exhibit worse outcomes compared to NOD2 wild type in Crohn's disease and in short bowel syndrome even in the absence of Crohn's [47–50]. Whether the NOD2 status of a Crohn patient should be determined preoperatively and whether it has an influence on the choice of reconstructive surgery is unclear. Currently, it is not yet routine to determine NOD2 status as a prognostic marker. In a NOD2 knock-out mouse model, mice with a resectional

Fig. 3. Laparostomies with small bowel fistulas.

short bowel syndrome have a worse outcome with regard to adaptation compared to wild-type mice [Berlin et al., in press].

Time Point of Reconstruction

There is no randomized study evaluating the best time point of reconstructive surgery after the last surgical intervention in patients with IF or short bowel. Most data are extrapolated from reversal of Hartman procedures done for perforated sigmoid diverticulitis and these data are controversial [51, 52]. Apart from the fact that many patients never undergo reversal and although early takedown of ileostomies as well as Hartmann reversal have been judged safe procedures [53, 54], most surgeons choose 6 months after the last procedure as the best time point. Resolution of the postinflammatory state and of adhesions are arguments in favor of waiting for this comparatively long period of time. In a French multicenter prospective trial in young patients with ileocecal resections due to Crohn's disease who received an end ileostomy, stoma reversal was safely done after 2–5 months [55]. A recent systematic review of timing of surgery in IF patients showed that a longer time interval between the last surgery resulted in fewer complications and in a lower recurrence rate of enteral fistulas [11].

The following aspects argue in favor of an early time point of reconstructive surgery: the index surgery was a single surgical procedure with no programmed lavage and no peritonitis, the patient is well reconstituted with a closed wound, and finally, the patient is well nourished. Patients with comorbidities often need more time to recover after the last surgery. Ideally, they should have recuperated to their preoperative functional status. However, a high enteric fistula can impair full recovery. The term of "prehabilitation" has come up and could be a method to improve outcome in this very special patient group [56].

When no information about the patient's history including intrabdominal anatomy with anastomosis, bowel length, and number of previous laparotomies is available, then it is safe to postpone reconstructive surgery for at least 6 months after the last procedure [21]. In my own experience, reconstructive surgery on 28 patients was safely performed at a median of 10 months after the last procedure. The more complex and complicated previous surgery was, the longer the time interval to reconstructive surgery should be. Waiting up to 12 months is safe. A close interdisciplinary discussion with the gastroenterologist about the ideal time point of surgery for a patient on TPN is mandatory.

Abdominal Approach and Abdominal Wall Closure

Abdominal wall access can be challenging in this patient cohort. Getting into the abdomen can take much time and is a matter of patience. A laparoscopic approach should not be undertaken in this situation and is contraindicated in most cases due to the risk of bowel perforation. Usually, the old scar from median laparotomy is excised and the upper abdomen is used as the first approach. When a skin graft was done on an open abdomen, the "pinch test" helps to evaluate whether the laparostomy is "ready to get into." When the skin graft can be pinched and lifted from the underlying bowel, it can easily be dissected from the bowel.

When performing reconstructive surgery in IF patients, there is at least one anastomosis performed, resulting in contamination of the abdominal cavity. Nonresorbable mesh grafts for closure should not be used in the same setting. In our opinion bio-meshes play no role. It is preferable to close the abdominal wall by single interrupted or less often by continuous suture even when the tissue sutured is rather a "low quality" scar than fascia, since closure with autologous tissue prevents fistula formation. There are few data as to whether these patients need further hernia surgery [11] and how safely this can be done. Restricting abdominal pressure to lift no more than 5 kg for at least 6 weeks seems reasonable postoperatively.

Conclusion

Reconstructive surgery in adult patients with IF includes stoma takedown, closure of entero-atmospheric fistulas, and reanastomosing bowel segments with the goal to gain bowel length, improve short bowel syndrome, and ameliorate patient status in view of parenteral nutrition. The indication for such operations is rare. Although the surgical technique to perform these operations is not difficult, it is one of the most important steps in the multidisciplinary team work, leading, hopefully, to recovery from IF. Therefore, patients who need these complex reconstructive procedures should be referred to specialized centers.

Disclosure Statement

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