

Short Bowel Syndrome and Malabsorption – Causes and Prevention

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Keywords

Short bowel syndrome · Crohn's disease · Radiation enteritis

Summary

Background: The short bowel syndrome (SBS) is a condition caused by extensive intestinal resection for a variety of conditions. The etiology varies by age group. Necrotizing enterocolitis is the leading cause in infants. In older children, trauma and malignancies are most common. Postoperative SBS has become most common in adults, followed by mesenteric vascular disease and cancer/irradiation. **Methods:** Systematic literature review. **Results:** Prevention of SBS should be given high priority. Each of the etiologies has been evaluated and strategies to prevent extensive resection have been developed. These include a thoughtful approach to reoperation, early identification of complications, e.g. intestinal ischemia, reducing radiation enteritis, and bowel-conserving therapies in diseases such as Crohn's disease. **Conclusion:** Several operative strategies to prevent SBS are useful. Timing and extent of reoperation need careful consideration. Minimizing intestinal resection, bowel-conserving techniques for complications such as fistula or strictures, and remodeling procedures are important.

Schlüsselwörter

Kurzdarmsyndrom · Morbus Crohn · Radiogene Enteritis

Zusammenfassung

Hintergrund: Das Kurzdarmsyndrom (short bowel syndrome (SBS)) stellt ein Krankheitsbild dar, das durch umfangreiche Darmresektionen aufgrund verschiedener Erkrankungen verursacht wird. Die Ätiologie ist je nach Altersgruppe unterschiedlich. Die nekrotisierende Enterokolitis stellt die häufigste Ursache bei Kleinkindern dar. Bei älteren Kindern treten Trauma und Malignome am häufigsten auf. Das postoperative SBS zeigt sich am häufigsten bei Erwachsenen, gefolgt von mesenterialen Gefäßkrankheiten sowie Karzinomen/Bestrahlung. **Methoden:** Systematische Literaturübersicht. **Ergebnisse:** Der Prävention des SBS sollte eine hohe Priorität eingeräumt werden. Jede der Ätiologien wurde analysiert, und Strategien zur Verhinderung von umfangreichen Resektionen wurden entwickelt. Hierzu gehören eine durchdachte Herangehensweise für eine Reoperation, eine frühzeitige Erkennung von Komplikationen, z.B. intestinale Ischämie, eine Reduktion der radiogenen Enteritis sowie darmerhaltende Verfahren bei Erkrankungen wie Morbus Crohn. **Schlussfolgerung:** Zur Verhinderung des SBS sind mehrere operative Strategien nützlich. Der Zeitpunkt und das Ausmass der Reoperation erfordern ein sorgfältiges Abwägen. Die Minimierung der Darmresektion, darmerhaltende Verfahren bei Komplikationen wie Fisteln oder Strikturen sowie Remodeling-Methoden sind von Bedeutung.

Causes of the Short Bowel Syndrome

A variety of conditions requiring intestinal resection lead to the short bowel syndrome (SBS), defined as a small intestinal remnant less than 180 cm in adults with associated malabsorption. SBS accounts for approximately two thirds of the patients with intestinal failure [1–3]. Usually, SBS results from a single massive resection, but multiple repeated resections are another important mechanism [4]. The causes of SBS vary by age group. Furthermore, the etiology of SBS, particularly in adults, may be changing.

In infants, necrotizing enterocolitis (NEC) is the most common cause of SBS, accounting for 40–50% of the cases [5–9]. This is followed by intestinal atresia, gastroschisis, and midgut volvulus [5–9] (table 1). Congenital SBS also occurs. In older children, trauma, postoperative SBS, and malignancies become important reasons for resection [10]. Motility disorders requiring resection are also potential mechanisms for SBS in both infants and children.

In our experience, postoperative SBS resection performed for complications of a previous abdominal operation has become the most common cause of SBS in adults, accounting for 36% of our patients [11, 12] (table 2). This occurs after both open and laparoscopic procedures and is usually associated with common surgical procedures such as colectomy and hysterectomy [12]. While this complication may be related to infarction secondary to vascular injury, volvulus, or hypotension, it most commonly occurs due to intestinal obstruction. Internal hernia is a particular concern following gastric bypass procedures [13]. Pneumoperitoneum-associated intestinal ischemia and mesenteric vein thrombosis related to laparoscopic procedures are being recognized increasingly [12, 14].

Historically, mesenteric ischemia was the most frequent cause of SBS and remains an important predisposing factor [2, 3, 15, 16]. Mesenteric vascular disease is the common mechanism of intestinal ischemia, accounting for 75% of the cases [17]. This is primarily related to arterial thrombosis or embolism in elderly patients. However, ischemia secondary to drug abuse and hypercoagulable disorders is increasing in incidence [18, 19]. Mesenteric vascular thromboembolism is a potential cause of SBS in patients with inflammatory bowel disease [20]. Non-occlusive mesenteric ischemia is also an important cause of SBS, particularly in critically ill patients. In this group of patients, enteral feeding is a potential contributing factor.

Malignancy with or without radiation treatment also accounts for a significant number of cases, i.e. up to 20% of SBS patients [21–23]. Resection of some malignant tumors, e.g. desmoid tumors, may result in massive resection due to the involvement of mesenteric vessels [22]. Concomitant radiation treatment might result in radiation enteritis with subsequent need for resection. Rectal cancer and gynecologic malignancies are the most frequent tumors associated with radiation injury [23]. Intestinal obstruction is the most common complication requiring resection, but fistulas and perforation

Table 1. Causes of the short bowel syndrome in infants and children [5, 20]

<i>Infants</i>
Necrotizing enterocolitis
Intestinal atresia
Gastroschisis
Midgut volvulus
Congenital
<i>Children</i>
Trauma
Postoperative complication
Cancer
Motility disorders

Table 2. Causes of the short bowel syndrome in adults

Postoperative complications
Irradiation/cancer
Mesenteric vascular disease
Crohn's disease
Trauma
Volvulus
Motility disorders

also occur. One third of the patients with radiation enteritis undergo surgical intervention and 10% of those develop SBS so that the overall incidence of SBS in patients receiving radiation therapy is quite low.

Crohn's disease is also a common cause of SBS, but may be declining in incidence with less aggressive resective therapy [24–27]. Crohn's disease accounts for SBS in approximately 10–20% of the patients [2, 23, 26]. Most cases arise in patients with extensive small intestinal or ileocolonic involvement and penetrating type [25]. Approximately 3% of the patients with Crohn's disease develop SBS [25].

Resection for trauma and other benign conditions, such as volvulus and intestinal pseudo-obstruction, are other potential causes for SBS [28–30]. These causes account for approximately 10% of the patients. As mentioned above, these are common factors in the development of SBS in children as well.

Prevention of the Short Bowel Syndrome

Prevention of the SBS is an important consideration given the morbidity and mortality associated with long-term treatment. Efforts at prevention can be divided into two periods: preoperative and postoperative. Preoperative strategies to prevent SBS are primarily related to the patient's underlying diagnosis and management (table 3).

Several strategies can be employed to prevent postoperative SBS. Since intestinal obstruction is the most common mechanism, efforts to prevent adhesions are important [11]. An example is the use of antiadhesion barriers. Avoiding technical errors, which might lead to devascularization, and

Table 3. Preventive strategies for the short bowel syndrome

Cause	Strategy
Postoperative SBS	prevent adhesions avoid technical errors diagnose intestinal ischemia cautious approach to frozen abdomen
Mesenteric vascular disease	early diagnosis revascularization second-look procedures
Irradiation/cancer	minimize radiation exposure ancillary (e.g. hyperbaric oxygen) appropriate resection
Crohn's disease	improved medical therapy appropriate diagnosis bowel-conserving operations
Trauma	appropriate resuscitation diagnose intestinal ischemia second-look procedures manage open abdomen

diagnosing intestinal ischemia in a timely fashion would also be beneficial, but is not always possible. Approaching the frozen abdomen cautiously may also reduce SBS [11]. Patients undergoing bariatric procedures, in particular, should have mesenteric defects closed to prevent internal hernias, and this diagnosis should always be entertained when these patients experience abdominal pain postoperatively [13, 31]. Unsuspected intestinal ischemia is increasingly recognized as a complication of laparoscopic procedures, and there should be a high index of suspicion to detect this problem [12, 14].

Intestinal ischemia from mesenteric vascular disease and hypercoagulability will have improved the outcome with timely diagnosis and treatment. Early diagnosis may permit attempts at revascularization to reduce the need for resection. However, diagnosis remains challenging [32]. Intestinal viability should be carefully assessed intraoperatively and second-look procedures be used judiciously to avoid extensive resection, particularly if mesenteric revascularization is achieved at the initial procedure [15]. Timely embolectomy or mesenteric reconstruction can often salvage significant segments of intestine [15].

Radiation enteritis can be reduced by minimizing the bowel exposed to radiation and by dosing regimens [21]. Alternative techniques for delivering radiation treatment and other changes, e.g. postoperative versus preoperative radiation for rectal cancer, may have reduced the incidence. Novel strategies such as hyperbaric oxygen therapy, pentoxifylline, and anti-inflammatory agents may be helpful in selected situations [21, 33]. Paradoxically, resection of severely injured intestinal segments may improve overall intestinal absorption as opposed to bypass or nonoperative approaches.

In our experience, errors in diagnosis, aggressive resectional therapy, and postoperative complications contribute to SBS in patients with Crohn's disease [24]. It is not clear if the advent of biologic therapy is decreasing the frequency. Utili-

Table 4. Operative strategies to prevent the short bowel syndrome

Timing and extent of reoperation
Prevention of extensive resection
Minimal resection
Strictureplasty
Serosal patch repair
Tapering and lengthening
Recruiting intestine
Preserving other digestive organs

zation of stricturoplasty rather than resection is important in a bowel-conserving strategy [34]. Initial misdiagnosis of Crohn's colitis as ulcerative colitis with ileal pouch construction is another predisposing factor [25]. This leads to SBS in some patients because of Crohn's disease in the pouch and more proximal intestine.

SBS might be minimized in trauma patients by early diagnosis of vascular injuries, use of second-look procedures, and appropriate resuscitation to avoid hypoperfusion. Most cases are associated with mesenteric vascular injury [28]. Increased recognition of the role of seat belt and air bag injuries to the intestine is important [29]. The use of damage control laparotomy may decrease the incidence of intestinal ischemia, but increases the risk of subsequent enterocutaneous fistula [35]. This situation can lead to the need for further operative procedures requiring intestinal resection.

Bowel-preserving strategies are now being used in infants with NEC which may decrease the incidence of SBS due to this condition [36, 37]. Abdominal drainage rather than aggressive resection is often appropriate and has a similar outcome in the short term [36].

Intestinal malrotation can present at any age and with a variety of symptoms [30]. In neonates, diagnosis and treatment are usually carried out expeditiously. In older children and adults, malrotation may be an incidental finding and the symptoms are more varied. All adults with malrotation should be informed of the risk as well as signs and symptoms of volvulus. The presence of symptoms is a clear indication for operative intervention; however, management of asymptomatic adults is controversial.

There are several operative strategies that can be utilized to prevent SBS (table 4) [38]. Timing and extent of reoperation are important issues. In patients who are known to have had a frozen abdomen at a previous operation or a history of an open abdomen, e.g. with coverage by a skin graft, the timing of reoperation is of great importance [39]. Reoperation may be delayed for up to 12 months to allow inflammation to resolve and adhesions to soften to permit safer reexploration. This is particularly true if enterocutaneous fistulas are present. Avoiding extensive enterolysis and using cautious resection can prevent SBS in patients with extensive adhesions from conditions such as radiation enteritis [21]. This should lower the risk of intestinal injury and the need for resection in these high-risk patients.

Preventing extensive intestinal resection where possible is another important strategy. This is particularly important in patients who have already had a previous resection or at known risk for further intestinal disease, e.g. Crohn's disease. In order to avoid extensive resection, multiple resection and anastomoses may need to be performed. In general, as little as 6-inch segments between anastomoses may be appropriate to preserve intestine with a shortened remnant. A hand-sewn end-to-end anastomosis rather than stapling side to side may also preserve length.

Alternative bowel-conserving techniques for repair of fistulas and strictures are often useful. Use of stricturoplasty in conditions such as Crohn's disease or anastomotic strictures can obviate the need for resection [34]. A variety of techniques can be employed depending on the length and location of the stricture. Serosal patch repair of intestinal perforation or defects will be appropriate in selected circumstances [34, 40].

Dilated intestinal segments due to dysfunction or chronic obstruction can be tapered rather than resected [34]. Tapering alone by either imbrication or longitudinal excision is appropriate if there is not a shortened intestinal remnant. In patients with a shortened remnant, tapering and lengthening can be achieved by either longitudinal or transverse enteroplasty [40, 41].

Recruiting any additional intestine is another important issue. Previously bypassed segments may exist in some patients. Restoring continuity with any distal segments should

always be given consideration [42]. Remodeling of anastomoses can occasionally be helpful.

Preserving other digestive organs would be beneficial in optimizing intestinal function in patients at risk for SBS. The stomach has a reservoir function that permits greater oral intake. Gastric motility might also influence intestinal transit and affect intestinal absorption. Thus, reconstruction of the upper gastrointestinal tract is important in patients with previous bariatric procedures [13]. Preserving pancreatic function is also beneficial when feasible, as this can further impair absorption.

Conclusion

In summary, knowledge of the factors leading to SBS may lead to prevention of extensive intestinal resection. Preventive strategies are, in part, diagnosis-specific. Operative techniques to minimize intestinal resection are also important, particularly in patients who already have a shortened intestinal remnant.

Disclosure Statement

The author does not have any conflicts of interest related to this article.

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