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Overview of Pediatric Short Bowel Syndrome

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ABSTRACT

Short bowel syndrome (SBS) is a malabsorptive state occuring as a result of surgical resection or congenital disease of a significant portion of the small intestine (1). The amount of resection or remaining bowel generally dictates the degree of malabsorption and consequentely the need for specialized enteral nutrition or parenteral nutrition (PN). Intestinal failure in the context of SBS is defined as a dependence on PN to maintain minimal energy and fluid requirement for growth in children. Common causes of SBS in infants and children include necrotizing enterocolitis, midgut volvulus, intestinal atresia, and gastroschisis. Early identification of patients at risk for long-term PN dependency is the first step toward avoiding severe complications. Close monitoring of nutritional status, steady and early introduction of enteral nutrition, and aggressive prevention, diagnosis, and treatment of infections such as central venous catheter sepsis and bacterial overgrowth can significantly improve the prognosis. Intestinal transplantation is an emerging treatment that may be considered when intestinal failure is irreversible and children are experiencing serious complications related to TPN administration. ***JPGN 47:S33–S36, 2008.*** **Key Words:** Short bowel syndrome—Intestinal failure—Parenteral nutrition. © 2008 by European Society for Pediatric Gastroenterology, Hepatology, and Nutrition and North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition

ETIOLOGY AND RISK FACTORS FOR INTESTINAL FAILURE

Short bowel syndrome (SBS) is a malabsorptive state occuring as a result of surgical resection or congenital disease of a significant portion of the small intestine (1). The amount of resection or remaining bowel generally dictates the degree of malabsorption and consequentely the need for specialized enteral nutrition or parenteral nutrition (PN) (1). Intestinal failure (IF) in the context of SBS is defined as a dependence on PN to maintain minimal energy and fluid requirement for growth in children. Common causes of SBS in infants and children include necrotizing enterocolitis, midgut volvulus, intestinal atresia, and gastroschisis (2).

Successful adaptation refers to the capacity for structural and physiological alterations that allow patients with SBS and IF to grow and remain healthy while receiving oral or enteral nutrition. Predictors of successful adaptation include patient age, underlying diagnosis leading to SBS, the length and portion of small and/or large bowel resected, the presence or absence of the ileocecal valve and/or colon, intrinsic adaptive potential of remaining bowel, the health of other organs that assist with digestion and absorption, and the presence of bacterial overgrowth of the small intestine (3,4). The rates at which enteral feedings are provided postoperatively, and the types of enteral feedings, have also been associated with SBS outcomes (4,5).

INCIDENCE AND REPORTED SURVIVAL RATES

Although the overall incidence of SBS is only 1200/100,000 live births, the mortality rate of the condition is high (6). Reported survival rates in pediatric SBS range from 73% to 89%, making pediatric SBS one of the most lethal conditions in infancy and childhood (4,7–9). A multidiscplinary treatment program has been associated with better survival (10).

COMPLICATIONS AND OVERALL MANAGEMENT

The most important SBS complications relate to the need to administer central venous PN (11). Liver disease

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may develop and is characterized by steatosis, cholestasis, and even cirrhosis. Central venous catheter complications may occur, such as catheter breakage, central venous thrombosis, and catheter-related bacterial or fungal sepsis. Other common complications depend on the length, nature, and surgical anatomy of the remaining small bowel. Malabsorptive diarrhea, fluid and electrolyte abnormalities, micronutrient deficiencies, gastric hypersecretion, anastomotic ulcers, and bacterial overgrowth (3) can occur in children with SBS. These children require careful ongoing monitoring and treatment even when there is normal somatic growth or a history of limited bowel resection (12).

Medical management ought to focus on nutrition, which includes monitoring the provision of calories, micronutrients, fluid, and electrolytes. Usually patients require PN for a period of time. Most can successfully undergo transition to full enteral nutrition (5). The gold standard for success is growth once PN has been completely discontinued, and the maintenance of normal vitamin nutriture and liver function (13).

Children with SBS often require medications to optimize treatment. Gastric acid hypersecretion can impair the absorption of nutrients and precipitate diarrhea; acid blockade with proton pump inhibitors can be useful in this regard. Loperamide, fiber, octreotide, and cholestyramine may prove useful for the control of voluminous and watery stool or ostomy output. In patients with prolonged exposure to PN, ursodeoxycholic acid may hasten improvement in the biochemical cholestasis. Bacterial overgrowth of the small intestine can be treated with rotating courses of enteral antibiotics. Supplementation of vitamins and minerals, especially the fat-soluble vitamins A, D, E, and K, is fundamental for the preservation of nutritional status in children with SBS.

The most important therapy for children with SBS and IF is the early introduction of enteral nutrition. Direct access to the gastrointestinal tract allows the continuous delivery of appropriate formulas that maximize the opportunity for absorption.

PARENTERAL NUTRITION–ASSOCIATED LIVER DISEASE

The management of pediatric SBS was revolutized with the publication in 1968 of the first successful case report of an infant whose growth and development was maintained with PN administered through a central venous catheter (14). Since then, PN has become widely accepted as the primary supportive therapy in infants with IF from SBS, and mortality due to dehydration and malnutrion has been essentially eliminated (15). However, this life-saving therapy has brought with it a set of serious and sometimes life-threatening acute and chronic complications, including PN-associated liver disease (PNALD). PNALD occurs in 40% to 60% of infants receiving prolonged courses of PN (16,17). Infants with PNALD can have progressive changes in liver histology, including fibrosis and eventually cirrhosis. Recent data have confirmed that liver disease in patients receiving PN is strongly associated with survival; in a cohort study of 78 children with SBS, the survival rate among those with cholestasis (direct bilirubin concentration >2 mg/dL), was close to 20%, compared with 80% in those without cholestasis (8). These data confirmed a very high mortality rate in infants with SBS and cholestatic liver disease unable to be weaned from PN (5).

RISK FACTORS PREDISPOSING TO PNALD AND MANAGEMENT

Multiple risk factors for the development of PNALD have been identified. They include premature birth, disruption of the enterohepatic circulation of bile acids, intestinal stasis with subsequent bacterial overgrowth, early and/or recurrent catheter-related sepsis, excessive glucose intake leading to hyperinsulinism and subsequent steatosis, and high parenteral protein, fat, and/or energy intake (3,5,18–20). The diagnosis of PNALD has historically been established by routine biochemical tests of hepatic function, including hepatic transaminases, conjugated bilirubin, albumin, and prothrombin time. The gold standard test remains liver histopathology, but the young age, small size, and precarious medical status of many infants with SBS and suspected PNALD makes routine and serial liver biopsies difficult to perform.

No unifying theory has been put forward to explain all of the features of PNALD, and this lack of clarity with respect to pathophysiology has hampered treatment efforts. Management strategies for the prevention and treatment of PNALD include early enteral feeding, reducing the frequency and/or duration of PN infusions, and aseptic catheter techniques to reduce sepsis. Oral administration of ursodeoxycholic acid may improve bile flow and reduce gallbladder stasis. With advanced liver disease in the setting of prolonged dependence on PN, liver and intestinal transplantation is sometimes required (2). Inasmuch as PNALD has been associated with a poor prognosis among SBS patients, early identification of infants with a high likelihood of progressive disease would be ideal. Provision of intensive medical, nutritional, and surgical rehabilitation would then be expected to improve the chances for full adaptation while avoiding end-stage liver disease and its life-threatening complicatons. Recent data suggest that the provision of parenteral fats enriched with omega-3 fatty acids may benefit children with PNALD (21), and trials in this area are ongoing.

SURGICAL CONSIDERATIONS

Often surgery is the most appropriate therapy to achieve full enteral nutrition. A common surgical therapy

is the placement of feeding devices directly into the gastrointestinal tract. Typically this is a gastrostomy tube, but gastrojejunal or jejunostomy tubes also play a role for patients with abnormal gastric and/or duodenal motility. The primary purpose of such tubes is the continuous administration of enteral nutrition. Continuous, steady administration of enteral nutrition is more likely to be tolerated than bolus feeding in children with SBS (22).

Often children with SBS have proximal small intestinal ostomies even though distal small intestine or colon may also be present but not in continuity (ie, chyme does not pass through the distal segments of intestine). As soon as it is surgically and medically appropriate, such segments should be used by taking down ostomies and allowing the intestinal contents to have maximum contact time with small and large intestine. This gives the gastrointestinal tract the best chance to absorb nutrients, fluid, and electrolytes.

Intestinal lengthening procedures take advantage of the bowel dilation that often occurs in the foreshortened remaining small intestine. Longitudinal intestinal lengthening and tailoring was described in 1980 (23) and has now been used widely. This procedure divides symmetrically dilated segments of small bowel in half longitudinally, blood flow being preserved by separation of the leaves of mesentery with either limb. The lumen is re-created by the formation of 2 narrower channels, which are then reapproximated one to the other in series, effectively doubling the length of the intestinal lumen. Results have been favorable (24).

The serial transverse enteroplasty procedure (STEP) was more recently described (25). Its advantages are that it is simpler, requires no enterotomies, preserves the natural intestinal vasculature, and can be applied to asymmetrically dilated segments of bowel. The procedure consists of applying a surgical stapler at right angles to the bowel successively, alternating sides so as to create a zig-zag longer and narrower channel. A recently created STEP registry (26) reported that enteral tolerance increased by 116% in 38 patients, and nearly half had been weaned from TPN after a median follow-up of 12.6 months.

INTESTINAL TRANSPLANTATION

Intestinal transplantation is indicated when IF is considered permanent and the administration of TPN is resulting in life-threatening complications. This has been operationally defined as significant liver injury with portal hypertension and synthetic dysfunction, multiple central line infections, thrombosis of at least 2 central veins, and/or frequent severe episodes of dehydration (27).

The most common intestinal transplant operations can be categorized as follows: isolated intestine, or transplantation of the small intestine with or without the large intestine; en bloc liver-intestine, or inclusion of the duodenum, pancreas, liver, and small intestine in 1 piece so as not to disrupt the biliary tract; and multivisceral, or removal and replacement of the native foregut and midgut. Graft choice often depends on the size of the recipient, the presence or absence of significant liver disease, and whether there are significant pathological changes extending beyond the small intestine (eg, pseudoobstruction affecting stomach and small bowel).

Since the entry of intestinal transplantation into clinical use in the 1980s (28), outcomes after this procedure have dramatically improved. The average 1-year survival after intestinal transplantation is 80% (29), and at some centers this value exceeds 90%. Because chronic PN is costly and burdensome (30), and the average 5-year survival may be as low as 60% (29), some have argued that transplantation ought to be the preferred treatment for select patients with permanent IF (27,29,30) Nevertheless, transplantation still carries significant morbidity and mortality, patients must receive lifelong immune suppression, and the 5-year survival rates (on average 50%) are still suboptimal (27). If transplant outcomes continue to improve, indications for transplantation will remain an actively debated topic for the IF and transplantation communities.

SUMMARY

Short bowel syndrome is at once a surgical and a medical disorder, with potential for life-threatening complications and for eventual independence from artificial nutrition. Navigating through the diagnostic and therapeutic decisions is ideally accomplished by a multidisciplinary team that includes dedicated staff from nutrition, pharmacy, social work, gastroenterology, and surgery. Early identification of patients at risk for long-term PN dependency is the first step toward avoiding severe complications. Close monitoring of nutritional status, steady and early introduction of enteral nutrition, and aggressive prevention, diagnosis, and treatment of infections such as central venous catheter sepsis and bacterial overgrowth can significantly improve the prognosis. Intestinal transplantation is an emerging treatment that may be considered when IF is irreversible and children are experiencing serious complications related to TPN administration.

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