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Nutritional Issues in the Short Bowel Syndrome – Total Parenteral Nutrition, Enteral Nutrition and the Role of Transplantation

Stephen J.D. O'Keefe

Division of Gastroenterology, University of Pittsburgh, Pittsburgh, PA, USA

Abstract

In this review, I focus on the extreme of the short bowel syndrome where the loss of intestine is so great that patients cannot survive without intravenous feeding. This condition is termed short bowel intestinal failure. The review outlines the principles behind diagnosis, assessing prognosis and management. The advent of intravenous feeding (parenteral nutrition) in the 1970s enabled patients with massive (>90%) bowel resection to survive for the first time and to be rehabilitated back into normal life. To achieve this, central venous catheters were inserted preferably into the superior vena cava and intravenous infusions were given overnight so that the catheter could be sealed by day in order to maximize ambulation and social integration. However, quality of life has suffered by the association of serious complications related to permanent catheterization – mostly in the form of septicemias, thrombosis, metabolic intolerance and liver failure – from the unphysiological route of nutrient delivery. This has led to intense research into restoring gut function. In addition to dietary modifications and therapeutic suppression of motility, novel approaches have been aimed at enhancing the natural adaptation process, first with recombinant growth hormone and more recently with gut-specific glucagon-like peptide-2 analogues, e.g. teduglutide. These approaches have met with some success, reducing the intravenous caloric needs by approximately 500 kcal/day. In controlled clinical trials, teduglutide has been shown to permit >20% reductions in intravenous requirements in over 60% of patients after 6 months of treatment. Some patients have been weaned, but more have been able to drop infusion days. The only approach that

predictably can get patients with massive intestinal loss completely off parenteral nutrition is small bowel transplantation, which, if successful (1-year survival for graft and host >90%) is accompanied by dramatic improvements in quality of life.

Introduction

It should be noted that the severity of the short bowel syndrome (SBS) varies from mild to severe, and that the degree of severity is directly related to the loss of absorption capacity. For example, the management of *mild disease* is easy and based on increased oral supplementation to overcome the reduced efficiency of absorption, for example oral B_{12} supplementation in patients with ileal resection, whilst the management of *severe disease* includes intravenous supplementation of water, electrolytes and nutrients.

Definition of Severe Short Bowel Syndrome or Short Bowel Syndrome and Intestinal Failure

SBS and intestinal failure (SB-IF) is the most severe form of the syndrome and can only be managed with long-term use of intravenous nutrition, i.e. home (HPN) or total parenteral nutrition (TPN). It is this condition that we will focus on in this article. It has been defined as a condition that results from surgical resection, congenital defects or disease-associated loss of absorption, and is characterized by the inability to maintain protein energy when on a conventionally accepted normal diet [1].

Prediction of Short Bowel Syndrome and Intestinal Failure

Studies performed by Messing et al. [2] in France have indicated that patients with massive intestinal resection or loss can be categorized into those who are likely to become permanently dependent on parenteral nutrition (PN) and those who are not. Measurements suggest that patients with <80 cm of small intestine plus colon are likely to become independent of parenteral support (PS). However, those who have lost their colons as well, i.e. those with end-jejunostomies, will likely need >200 cm of small intestine to remain independent of PS. Of course, this assumes that the remaining small intestine is functionally normal. If it is diseased, as in Crohn's disease, then greater lengths of small intestine will be required.

Clinical Determination of Short Bowel and Intestinal Failure

The best practical way of assessing whether a patient has SB-IF is to measure 24-hour urine output volumes plus sodium content when they are off all intravenous infusions and eating normally. If the 24-hour urine volume is greater than 1 liter and if urinary sodium is greater than 20 mEq/day, then it is not present. These measurements are also very useful in gauging intravenous fluid and electrolyte requirements in patients requiring TPN or HPN.

Adaptation

The remarkable thing about the intestine is its ability to adapt to the loss of length. Consequently, it is important to reassess absorption in the months following intestinal loss to reassess PS requirements. Some patients might well become independent of intravenous infusions in the 2 years following resection. The process of adaptation begins almost immediately following resection or loss, and can continue for over 2 years [3, 4]. Adaptation is characterized by villous hyperplasia, which increases the absorptive surface 200-fold. In the days before the advent of intravenous feeding, this process allowed some patients to survive with only 15 cm of small intestine [5]. Villous hyperplasia is far more evident in studies in experimental animals than in humans. The hyperplasia is associated with increased digestive enzyme secretion, muscular hypertrophy, delayed food transit through changes in motility and increased blood flow. The net result is increased absorption. These features are illustrated in figure 1. Probably the driving force for adaptation is the increased contact between food and the remaining mucosa resulting from the associated hyperphagia. Studies have shown that adapted patients usually consume 1.5–2.0 times the recommended dietary allowance for protein and calories [6]. Studies of ours have revealed that food-induced pancreatic secretion is also twice normal (fig. 2) [6, 7].

General Principles of Management

(1) It must be remembered that most food digestion occurs in the jejunum and proximal jejunum. Consequently, digestion is rarely a problem and there is no indication for pancreatic enzyme supplementation to improve absorption in SB-IF patients.

(2) The reason why we have an extraordinary long small intestine is to allow for the reabsorption of the massive quantities of fluid (>7 liters/day) and elec-

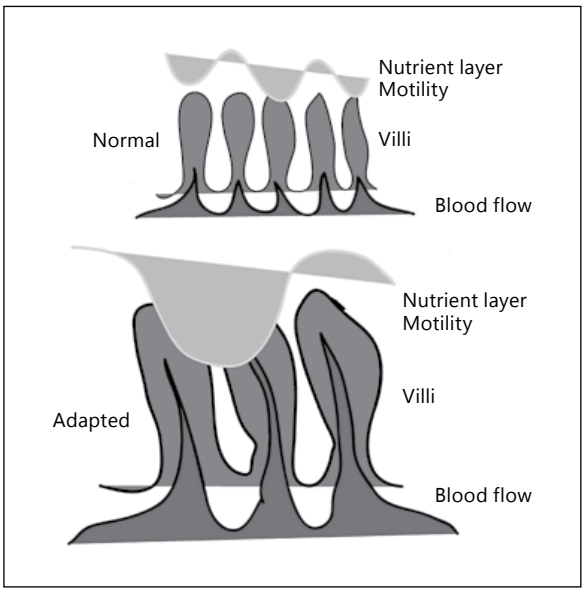

Fig. 1. Key factors in intestinal adaptation.

trolytes that are secreted by the upper gastrointestinal tract to ensure optimal enzymatic digestion. Consequently, fluid and electrolyte depletion is the earliest event in SBS.

(3) As mentioned above, digestive function and absorption improves with time because of adaptation, but absorptive capacity must be rechecked over the course of time to reassess basic needs.

(4) As mentioned above, digestion is not the problem, transit is. Consequently, it is important to tailor management to keep food in contact with the remaining intestinal surface for as long as possible.

Practical Management

(1) Avoid dietary restriction [8]. Remember hyperphagia is part of the adaptation response.

(2) Prolong nutrient-mucosa contact time. Break down normal meals into small frequent meals, supplement with nutrient-dense liquids and use drugs to reduce motility. Patients need to understand that they have to change the way they eat; they must train themselves to 'nibble like rabbits'. This reduces the load on the remaining intestine and ensures a longer contact time between food and the absorptive mucosa. The most effective way is to provide continuous slow enteral feeding. This was beautifully illustrated by Joly et al. [9] in their random-

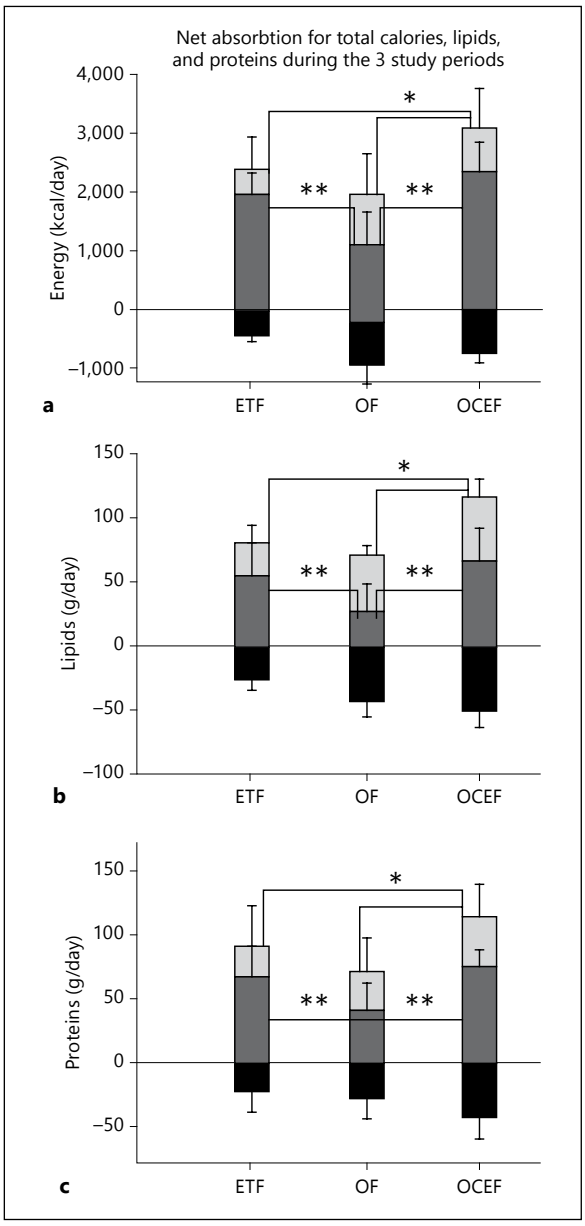

Fig. 2. A randomized crossover study compared absorption between isocaloric tube feeding and OF in 15 SBS patients >3 months after short bowel constitution. An OF period combined with enriched (1,000 kcal/day) tube feeding was also tested. Means ± SD. Net absorption for total calories (**a**), lipids (**b**) and proteins (**c**) during the 3 study periods. In the *histograms*, intakes (light grey) and losses (in black) are above and below the zero line, respectively, the dark grey being the net absorption (intake losses). Total caloric, lipid and protein intakes (light grey bars) were significantly higher with OF combined with tube feeding (OCEF) than with OF and enteral tube feeding (ETF; * p = 0.001). Net absorption for total calories, lipids and proteins (dark grey bars) was significantly higher with ETF and OCEF than with OF (** p 0.001) with permission [9].

ized crossover study of 15 SBS patients; they compared absorption between isocaloric tube feeding and oral feeding (OF), and then a combination of OF and 1,000 kcal/day tube feeding. Figure 2 shows that absorption of calories, lipids and protein was significantly higher with exclusive enteral tube feeding than OF. The combination enhanced absorption further, illustrating the importance of hyperphagia in maximizing absorption in SB-IF patients.

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