Management of Patients With a Short Bowel

JEREMY MARK DARBY NIGHTINGALE, MB, BS, MRCP, MD

From the Leicester Royal Infirmary NHS Trust, Leicester, UK

ABSTRACT

Short bowel syndrome most commonly results after bowel resections for Crohn’s disease. The normal human small intestinal length ranges from about 3 to 8 m, thus if the initial small intestinal length is short, a relatively small resection of the intestine may result in the problems of a short bowel. Two types of patient with a short bowel are encountered in clinical practice: those with their jejunum anastomosed to a functioning colon, and those with a jejunostomy. Both types of patient have problems absorbing adequate macronutrients, and both need long-term vitamin B₁₂ therapy. Patients with a jejunostomy also have major problems with large stomal losses of water, sodium, and magnesium. This high-volume jejunostomy output is treated by restricting oral fluids, giving a glucose-saline solution to drink, and using drugs that either reduce gastrointestinal motility (loperamide or codeine phosphate) or secretions (H₂ antagonists, proton pump inhibitors, or octreotide). Patients whose jejunal length is less than 100 cm, and whose stomal output is greater than their oral intake, benefit most from antisecretory drugs. In patients with a retained colon, bacterial fermentation of unabsorbed carbohydrate in the colon results in energy being salvaged. However, they have increased oxalate absorption and a 25% chance of developing calcium oxalate renal stones. Thus patients with a colon are advised to eat a high-energy diet rich in carbohydrate but low in oxalate. Patients with a jejunostomy need a high-energy iso-osmolar diet with added salt. Both patient types have a 45% prevalence of gallstones. With current therapy most patients with a short bowel have a normal body mass index and a good quality of life.

Key words: short bowel syndrome, jejunostomy, parenteral nutrition, renal stones, gallstones, rehydration solutions

SMALL INTESTINAL LENGTH

Intestinal failure occurs when a reduction of absorption creates the need for oral or parenteral nutrient and/or fluid supplements. In the long term, this most commonly results after an intestinal resection leaves a short residual length of bowel; less commonly, it results from extensive small bowel diseases such as scleroderma, visceral myopathy, or neuropathy. The normal human small intestinal length, measured surgically, radiologically, or at autopsy, from the duodenoojunal flexure to the ileocecal valve, varies from 275–850 cm and tends to be shorter in women. Congenital cases of a short bowel have been reported but patients with a short bowel do start with a short intestinal length before any resections. Due to this wide variation in normal small intestinal length, it is more important, after an intestinal resection, to refer to the remaining length of bowel rather than to the length resected. If residual bowel length has not been measured at surgery, it can be measured radiologically from a barium follow-through examination.

ANATOMICAL TYPES OF A SHORT BOWEL

In clinical practice there are two types of patient with a short bowel (Fig. 1). Some patients have had their ileum and some of their jejunum resected, usually leaving a jejunoileocolic anastomosis, though sometimes the ileocecal valve is preserved. Others have had their colon, ileum, and some of their jejunum resected and have a jejunostomy. Both patient types most commonly result from bowel resections for Crohn’s disease (Table I). There are more women than men with a short bowel, possibly because women start with a shorter length of small bowel.

The presence or absence of a colon affects the small intestinal length at which nutrient and/or fluid supplements are needed. In those with a retained colon, long-term parenteral nutrient supplements are likely if less than 50 cm residual jejunum remains. Most patients with a jejunostomy need water and sodium supplements if the jejunal length is less than 200 cm (100–200 cm oral supplements, 0–100 cm parenteral supplements).

PROBLEMS AND TREATMENTS

Water and Mineral Losses

Short bowel patients with a preserved colon. The colon has a large capacity to absorb sodium and water, thus patients with a short bowel and a preserved colon are rarely in negative water and sodium balance and rarely need water or sodium supplements (Table II). Magnesium deficiency is less common than in patients with a jejunostomy, but may be treated by magnesium oxide, vitamin D, or a reduced-fat diet.

Diarrhea may be treated with loperamide given before food. As the enterohepatic circulation, around which loperamide circulates,
is disrupted, higher doses than usual may need to be given. Rarely, bile salt malabsorption contributes to the diarrhea and is helped by cholestyramine, which has the additional advantage of reducing oxalate absorption; however, it may also reduce fat absorption.

Short bowel patients with a jejunostomy. The main problem experienced by a patient with a jejunostomy is of large stomal water, sodium, and magnesium losses; this problem is apparent immediately after the resection. Jejunostomy patients can be either “absorbers” or “secretors.” “Absorbers” tend to have more than 100 cm residual jejunum and absorb more water and sodium from their diet than they take orally (usual daily jejunostomy output about 2 kg). “Secretors” tend to have less than 100 cm jejunum and put out more water and sodium from their stoma than they take in orally (usual daily stomal output about 6 kg). Thus net absorbers can be managed with oral supplements whereas net secretors need parenteral supplements.7 These requirements change very little with time.

Magnesium deficiency is common and may cause fatigue, depression, irritability, muscle weakness, and if very severe, convulsions.9 Potassium problems are unusual and net loss through the stoma occurs only when less than 50 cm jejunum remains.7 A low potassium level may be due to sodium depletion with secondary hyperaldosteronism8 or magnesium depletion.

TABLE I.

<table>
<thead>
<tr>
<th>CAUSES OF SHORT BOWEL 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Jejunum-colon</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Number</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Crohn’s disease</td>
</tr>
<tr>
<td>Ischemia</td>
</tr>
<tr>
<td>Irradiation</td>
</tr>
<tr>
<td>Ulcerative colitis</td>
</tr>
<tr>
<td>Volvulus</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

* Seven have ileocecal valve and 31 a jejunocolic anastomosis.

FIG. 1. The two common types of patients seen in clinical practice with a short bowel.

TABLE II.

<table>
<thead>
<tr>
<th>PROBLEMS OF A SHORT BOWEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Jejunum-colon</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Water and sodium loss, magnesium deficiency</td>
</tr>
<tr>
<td>Nutrient malabsorption</td>
</tr>
<tr>
<td>Renal stones</td>
</tr>
<tr>
<td>Gallstones</td>
</tr>
<tr>
<td>Jejunal adaptation</td>
</tr>
<tr>
<td>Social problems</td>
</tr>
</tbody>
</table>

* Bacterial fermentation of carbohydrate salvages some energy, but d(−) lactic acidosis can occur if the diet is high in mono- and oligosaccharides.

Reasons for the high output from a jejunostomy. The main reason for the large volume of the stomal output is loss of the normal daily intestinal secretions, which are made up of about 0.5 L saliva, 2.0 L gastric, and 1.5 L pancreaticobiliary secretions. High gastrin levels could cause gastric acid hypersecretion and thus contribute to the jejunostomy output.10,11 However, in man gastric acid hypersecretion has been demonstrated only in the immediate postoperative period.12 Rapid liquid gastric emptying may increase the stomal output13 and may be due to low plasma peptide YY levels.11

Treatment of a high output jejunostomy. Treatment for a high output from a jejunostomy (or ileostomy) begins with restricting the amount of hypotonic fluid drunk (e.g., water, tea, coffee, juices, and alcohol). Jejunal mucosa is “leaky” and rapid sodium fluxes occur across it. If water is drunk, there is a net efflux of sodium into the bowel lumen,14 giving rise to a jejunal luminal sodium concentration of 90 mmol/L which is lost in the jejunostomy fluid. It is a common mistake for patients to be encouraged to drink oral hypotonic solutions; this increases stomal sodium losses.

The second treatment is for the patient to sip a glucose-saline solution with a sodium concentration of at least 90 mmol/L throughout the day.15,16 The glucose increases the sodium absorption as there is coupled absorption of glucose and sodium in the jejunum. The World Health Organization cholera solution has a sodium concentration of 90 mmol/L17 and is commonly used (without the potassium chloride). The concentration of sodium in this solution is much higher than needed to treat most infective diarrheas. (Glucose-saline solution composition: 3.5 g sodium chloride, 2.5 g sodium bicarbonate, and 20 g glucose; sodium citrate 2.9 g may be substituted for bicarbonate as some patients find this solution more palatable). Sodium chloride capsules, if tolerated, are as effective as a glucose-saline solution, and a glucose polymer may be substituted for glucose to increase the energy intake.18

If restricting oral fluids and giving a glucose-saline solution to drink are not adequate, drugs may be given. As the intestinal output, especially in net secretors, rises after meals, it is important to give the drugs before food. Drugs used to reduce jejunal output act to reduce either intestinal motility or secretions. Loperamide, often in high dose, and codeine phosphate mainly reduce intestinal motility and patients who are net absorbers respond best to them. Gastrointestinal secretions and thus intestinal output can be reduced in net secretors with drugs that reduce gastric acid secretion (e.g., the H2 antagonists19 or proton pump inhibitors20 or the somatostatin analog octreotide21–25). Octreotide also reduces gastrointestinal motility and other exocrine secretions.
For magnesium deficiency magnesium supplements may be given as magnesium oxide capsules 12 or 24 mmol daily (each containing 4 mmol). If this supplement does not bring the magnesium level into the normal range, oral 1α-hydroxycholecalciferol may be used.

**NUTRITIONAL PROBLEMS**

Most patients who have less than 100 cm small bowel remaining and who are maintained on oral supplements absorb only about 50–60% of their oral energy intake, so they need to consume twice as much energy as before the resection. Most patients can achieve this by eating more food, though some may use a nocturnal nasogastric tube feed, thus utilizing the shortened gut at a time when usually inactive. Both groups of patients have had their terminal ileum removed, and so need long-term vitamin B₁₂ therapy.

**Short Bowel Patients With a Preserved Colon**

Patients who have a short bowel and retained colon are often well immediately after the resection but in the succeeding months may lose weight and present severely malnourished. This presentation is different from that of patients with a jejunostomy, who present immediately after surgery with fluid and electrolyte losses from their stoma. The retention of the colon allows the rate of liquid gastric emptying to be slowed.¹³ This mechanism is probably due to unabsorbed nutrients arriving in the colon and causing high circulating levels of peptide YY.¹¹

Patients with a retained colon need to be given important information about their oral intake of carbohydrate, fat, and oxalate.

**Carbohydrate.** Carbohydrate, unabsorbed by the small bowel, is fermented by colonic bacteria to short-chain fatty acids which are absorbed, and so provide an important mechanism by which energy is salvaged.²⁶–³⁰ 4.2 MJ/d or more can be salvaged in these patients.³⁶ Experimentally this process can be prevented by giving metronidazole which also inhibits adaptation.³¹

Thus a diet high in carbohydrate is beneficial; however, rarely such a diet (especially if rich in mono- and oligosaccharides) can cause d-lactic acidosis.³² Lactic acid produced by man is of the l(+) isomer but abnormal bacterial colonization of the colon can result in a metabolic acidosis due to formation and absorption of the d(−) isomer, which cannot be metabolized. It is more likely if thiamine deficiency coexists. d(−) lactic acidosis can cause a syndrome of ataxia, blurred vision, ophthalmoplegia, and nystagmus. It is suspected when a patient is found to be acidicotic with a large anion gap. Treatment is with broad-spectrum antibiotics (neomycin or vancomycin) and thiamine, and by changing the diet to one high in polysaccharides but low in mono- and oligosaccharides.³³

**Fat.** Although the proportion of dietary fat absorbed remains constant,³⁷,³⁸ unabsorbed long-chain fatty acids may worsen diarrhea by reducing water and sodium absorption³⁵ and increasing the colonic transit rate.³⁶ They are toxic to bacteria, so reducing the amount of carbohydrate fermented,³⁷,³⁸ they also increase stool losses of calcium and magnesium,³⁴ and increase oxalate absorption.

**Oxalate.** Calcium oxalate renal stones occur in a quarter of patients with a retained colon.⁵ After an ileal resection there is increased colonic absorption of dietary oxalate.³⁹ Calcium and oxalate usually form an insoluble complex in the colon, but if free fatty acids are present in the colon they preferentially bind the calcium, so the oxalate becomes soluble and is absorbed, giving rise to hyperoxaluria.⁴⁰–⁴¹ Unabsorbed bile salts in the colon also increase the colonic permeability to oxalate.⁴²

Renal stones oxalate stones are prevented by giving a low-oxalate⁴³ diet without excess fat.⁴¹ Oral calcium supplements,⁴⁴ calcium-containing organic marine hydrocolloid,⁴⁵ and cholestyramine (which binds bile salts)⁴⁶ may be used.

Patients with a short small intestine anastomosed to colon need a large total energy intake with a diet high in carbohydrate (polysaccharides), but relatively low in fat and oxalate. Parenteral nutrition is needed only rarely, but should be considered if less than 50 cm jejenum remains.

**Short Bowel Patients With a Jejunostomy**

Malabsorption of nutrients in patients with a jejunostomy is important, although it does not cause immediate problems. If patients absorb less than 35% of their oral energy intake, they are likely to need long-term parenteral nutrition with additional fluids; this tends to occur at a jejunal length of less than 75 cm.⁷ Patients with a jejunostomy absorb a constant proportion of the nitrogen, energy, and fat from their diet.²⁷,⁴⁷,⁴⁸ Increasing fat in the diet raises fat excretion, but does not increase stomal output, nor make the output offensive.²⁷,⁴⁷,⁴⁸ One study showed that increasing fat in the diet increased the loss of Mg and Ca,⁴⁷ but this was not the case in another.³⁹ There is no advantage in giving a diet of small molecules, which causes a feed to be hyperosmolar.⁴⁸ Thus jejunostomy patients need a large total oral energy intake with a polymeric, iso-osmolar diet relatively high in fat with added salt.

**GALLSTONES**

Gallstones are common (45%) in both types of patient (especially men)⁵ and are often calcium bilirubinate stones formed in biliary sludge, which results from gallbladder stasis.⁴⁹ The male predominance may be explained, as calcium bilirubinate crystals occur more commonly in men with biliary sludge than women.⁵⁰ Cholecystokinin injections have been used to prevent gallbladder stasis⁵¹ and there may be a role for a prophylactic cholecystectomy.⁵²

**ADAPTATION**

In animals there is marked ileal adaptation after a jejunal (+/− colon) resection. Many factors help this to occur, including luminal nutrients, pancreaticobiliary secretions, and gastrointestinal hormones. Jejunal adaptation in rats occurs if the colon is perfused with nutrients.⁵³ Evidence for jejunal adaptation in man is scarce. There may be a small reduction in fecal weight in both patient groups in the 3 mo following the small bowel resection.⁵⁴ The evidence for structural⁵⁵–⁵⁷ and functional⁶⁸ jejunal adaptation in patients with a retained colon is scarce, and it may not occur in patients with a jejunostomy.⁵⁹

Therapy with growth factors (growth hormone, glutamine, fiber, and epidermal growth factor) have shown some success in maximizing intestinal adaptations.⁶⁰ Epidermal growth factor has been used to treat microvillous atrophy in children.⁶¹ Aminoguanidine, which inhibits diamine oxidase and thus reduces polyamine breakdown, has been used successfully in animals.⁶²

**SOCIAL PROBLEMS**

Most patients with a short bowel have a body mass index within the normal range and most are at full-time work or looking after the home and family unaided.⁵ Patients with a short bowel and a colon may have unpleasant malodorous diarrhea due to steatorrhea. Patients with a jejunostomy may have a high output from a stoma and they are very dependent on treatment. If they miss their treatment for 1 d they are likely to be unwell due to sodium and water depletion.
SURGERY FOR SHORT BOWEL AND INTESTINAL TRANSPLANTATION

Surgical methods of increasing absorption in patients with a short bowel attempt either to slow small bowel transit or increase the surface area for absorption. Reversing a 10-cm segment of small bowel has been successful in adults, as has intestinal lengthening and tapering in children.64,65

The survival rate for patients on home parenteral nutrition for non-neoplastic reasons is 70% at 3 yr.64 Currently 40–60% of patients having a small bowel transplant will be alive 3 y later if tacrolimus is used for immunosuppression, and 37–51% will have a functioning graft. Only 78% of those who survive with the transplant are able to stop parenteral nutrition. Thus small intestinal transplantation cannot currently be recommended for most patients, as it is a life-endangering procedure and most patients with a short bowel have a good quality of life.6 It has not been determined if Crohn’s disease recurs after a transplant. It is likely that future advances will be made, making small bowel transplantation a good option for some patients.

REFERENCES

32. Anonymous. The colon, the rumen, and d-lactic acidosis. Lancet 1990;336:599
48. McIntyre PB, Fitchew M, Lennard-Jones JE. Patients with a high jejunalostomy do not need a special diet. Gastroenterology 1986;91:25
55. Porus RL. Epithelial hyperplasia following massive small bowel resection in man. Gastroenterology 1965;48:753
62. Rokkas T, Vaja S, Murphy GM, Dowling RH. Aminoguanidine blocks intestinal diamine oxidase (DAO) activity and enhances the intestinal adaptive response to resection in the rat. Digestion 1990;46(suppl 2):447
63. Thompson JS. Surgical considerations in the short bowel syndrome. Surg Gynecol Obstet 1993;176:89
66. Grant D. Current results of intestinal transplantation. Lancet 1996;347:1801