Published in final edited form as:

J Pediatr Gastroenterol Nutr. 2008 April ; 46(4): 461–464. doi:10.1097/MPG.0b013e3181373b91.

Multiple Micronutrient Deficiencies in a Child With Short Bowel Syndrome and Normal Somatic Growth

Debora Duro*, Tom Jaksic†, and Christopher Duggan*

*Division of Gastroenterology and Nutrition, Children's Hospital Boston, MA

†Department of Surgery and Center for Advanced Intestinal Rehabilitation, Children's Hospital Boston, MA

Children with short bowel syndrome (SBS) are at risk for a variety of macro- and micronutrient deficiencies and other complications as a result of loss of small bowel surface area (1). The amount and location of small intestine loss in SBS will generally define the degree of nutrient malabsorption and the likelihood of micro-nutrient deficiencies. Duodenal resection, for example, can result in iron and folate deficiencies. Extensive jejunal resection can lead to malabsorption of carbohydrates, proteins, and calcium. The terminal ileum is the primary site of absorption of vitamin B₁₂ and bile salts. Bile salt malabsorption can in turn present with steatorrhea and deficiencies of vitamins A, D, E, and K. Ileocolonic resection can predispose to several problems as a result of the loss of the ileocecal valve, resulting in loss of the ileal break, increased risk of anastomotic ulcers, and bacterial overgrowth.

The extent of nutrient malabsorption in SBS is generally assessed by history and physical examination, including assessment of growth parameters. Normal somatic growth generally implies adequate energy and macronutrient absorption. We describe a patient with SBS who developed severe iron-deficiency anemia and multiple micronutrient deficiencies despite normal growth, full oral intake, and limited ileal resection.

CASE REPORT

The patient was a 3-year-old girl with a history of gastroschisis and bowel dilation diagnosed by prenatal ultrasonography. She was born at 37 weeks' gestation with a birth weight of 3.45 kg. At surgery in the neonatal period, she was found to have a concomitant ileal atresia. She underwent primary gastroschisis repair, resection of 14 cm of distal atretic ileum including the ileocecal valve, and placement of a diverting ileostomy. At surgery she was found to have normal rotation and fixation at the duodenal level. She also was found to have matted distal bowel. The surgeon thus decided to perform an ileostomy with the plan to let the fibrinous peel reabsorb and create an anastomosis at a later date. Residual small bowel length measured intraoperatively from the ligament of Trietz to the ileostomy was 125 cm.

She initially received full parenteral nutrition and then increasing amounts of enteral nutrition. She was weaned from parenteral nutrition at age 3 months. At 4 months of age she underwent a takedown of the ileostomy. At age 4.2 months she was discharged home on full

oral nutrition. At her first outpatient visit at age 5 months, she was tolerating enteral nutrition (amino acid–based formula), was growing well (weight for length was between the 25th and 50th percentiles), and had no evidence of micronutrient deficiencies (Table 1). We requested continued outpatient follow-up in our multidisciplinary SBS program, but this did not occur. From 5 to 36 months of age, she grew well, at approximately the 50th percentile for weight and 10th percentile for length. She had no chronic abdominal pain, diarrhea, or vomiting. She did not receive any dietary supplements during this period.

At 3 years of age she presented with fatigue, pallor, and decreased activity. Her bowel movements were reported as occurring 3 to 4 times per day and were soft, light brown in color, and sometimes foul-smelling. She reported no symptoms of pica, easy bruising, hematuria, or hematemesis. She had no history of recent travel outside the United States. She had a good appetite and her diet consisted of 3 meals per day plus snacks, and included rice, chicken, sausage, fruits, meat, vegetables, and beans. She drank less than 16 oz of milk per day. She had no known allergies and was receiving no medications. Her family history was notable for iron-deficiency anemia in some relatives. She lived with both parents and was not exposed to lead at home.

On physical examination, her weight was 13.2 kg (50th percentile) and her height was 89.4 cm (10th percentile). She was noted to be pale and in no acute distress but tachycardic (heart rate of 126 bpm). She was afebrile and had a normal respiratory rate. Findings of chest examination were clear. She had a grade II/VI systolic ejection murmur. Her abdomen was soft, nontender, and nondistended without hepatosplenomegaly. Her extremities showed normal capillary refill and her skin had no rashes, jaundice, petechiae, or ecchymoses. The findings of neurological examination were grossly intact; deep tendon reflexes were not documented. Rectal examination revealed no skin tags or fissures and stool tested guaiac-positive.

Laboratory results showed a hematocrit of 11% with evidence of severe microcytosis and iron deficiency (Table 1). She was admitted for red blood cell transfusion and stabilization. She was discharged home with a hematocrit of 28%. Further laboratory evaluation showed deficiencies of vitamins A, D, E, and B₁₂ and zinc (Table 1).

An upper gastrointestinal series with a small bowel follow-through showed a markedly dilated distal portion of the ileum just proximal to the transverse colon anastomosis without evidence of bowel obstruction (Fig. 1). Upper endoscopy and colonoscopy were performed to identify the source of her blood loss. Upper endoscopy had grossly normal findings and showed no evidence of enteropathy. Colonoscopy revealed several ulcerations around the ileocolonic anastomosis with normal biopsy findings below and above the ulcers.

The patient was prescribed intramuscular injections of vitamin B₁₂ (100 µg monthly), oral elemental iron (2 mg/kg daily), and a chewable Adek multivitamin (1 tablet twice daily; Axcan Pharma, Birmingham, AL). We also treated her for presumptive bacterial overgrowth of the small intestine with rotating courses of antibiotics including metronidazole and amoxicillin with clavulanate. Sulfasalazine 300 mg twice daily was also prescribed for anastomotic ulcer disease.

At follow-up 6 months later, the patient had persistent gastrointestinal blood loss. Her multiple micronutrient deficiencies (vitamins A, E, and B₁₂ and zinc) were corrected (Table 1) but she continued to have iron-deficiency anemia. She underwent exploratory laparotomy in conjunction with intraoperative colonoscopy and enteroscopy. Ulcer lesions were identified approximately 10 cm proximal to the ileocolonic anastomosis (Fig. 2). The ileocolonic anastomosis was dilated and showed evidence of chronic stasis. The old anastomosis and the ulcer lesions were resected. The specimen consisted of 15 cm of small

bowel ranging from 4 to 7 cm in diameter. There was a large ulcerated area measuring 1.5 cm in maximum diameter with an irregular border. The anastomosis appeared unremarkable with fibrotic tissue. Histological examination showed ulcerated small intestinal mucosa with some mild submucosal fibrosis and gastric metaplasia of the crypts adjacent to the ulcer, consistent with chronic mucosal injury. The small intestinal mucosa away from the ulcers showed nonspecific mild villous blunting but was otherwise unremarkable histologically. No granulomas, intravascular thrombi, emboli, or vasculitis were present. She underwent re-creation of an ileocolonic anastomosis. The patient is doing well with a regimen of daily oral micronutrient supplementation and intramuscular vitamin B₁₂ supplementation once a month.

DISCUSSION

We present a patient with a history of gastroschisis and ileal atresia who underwent operative repair of these lesions in infancy. She subsequently had normal oral intake and exhibited normal somatic growth. She then presented with severe iron-deficiency anemia as a result of anastomotic ulcers, but also had evidence of multiple micronutrient deficiencies, including deficiencies of vitamins A, E, and B₁₂ and zinc. This case demonstrates the importance of biochemical monitoring and the need to maintain a high index of suspicion in assessing the micronutrient status of patients with SBS.

Several factors may have caused this patient's micronutrient deficiencies. Gastroschisis itself can predispose to poor motility, leading to stasis and presumptive bacterial overgrowth, although this patient seemed to have minimal motility problems because weaning from parenteral to oral nutrition was accomplished in only a few months. Ileocolonic resection with removal of the ileocecal valve can result in the loss of the ileal break, allowing rapid transit through the small intestine. Loss of the ileocecal valve can also predispose the small bowel to contamination with colonic bacteria, leading to bacterial overgrowth and anastomotic ulcers (2). Bacterial overgrowth syndrome can dispose to mucosal inflammation and even ulceration, consequently impairing absorption. Bacterial overgrowth has been associated with a number of gastrointestinal signs and symptoms, including malabsorption, intestinal bleeding, bacterial endotoxin translocation (3), and prolonged weaning from parenteral nutrition (4). Treatment of bacterial overgrowth can consist of rotating courses of antibiotics, as was done in our patient.

The relationship between bacterial overgrowth and anastomotic ulcer disease has been suggested by a number of observations. These include the fact that treatment with antimicrobial agents can improve anastomotic ulcers, as can anti-inflammatory and immunosuppressive medication and surgical resection (5). Unfortunately, the recurrence rate is high and surgical resection is not always curative (6).

The published data on ileal resection and nutritional status are limited. Davies et al (7) described 9 children (mean age of 7.4 years at the time of the study; range, 5.5–13.7 years) who had undergone isolated ileal resection ranging from 3 to 44 cm for necrotizing enterocolitis (at a median age of 11 days) or intussusception (at a median age of 4 months). Weight and height parameters after ileal resection were between the 25th and 50th percentiles for all of the subjects, and no child exhibited stunting or wasting. One child was found to have asymptomatic vitamin B₁₂ deficiency, 3 children had low plasma concentrations of vitamin A, and several children had borderline concentrations of selenium, manganese, and zinc (7). Another consequence of ileal resection is the development of cholelithiasis and renal calculi. Our patient had no evidence of liver dysfunction at any time. Davies et al (7) reported cholelithiasis in 4 children with a median age of 7.0 years who had a history of ileal resection in infancy.

Our patient's limited ileal resection as an infant would not have necessarily suggested a high risk for vitamin B₁₂ malabsorption. However, the precise length of ileal resection in infancy needed to engender B₁₂ malabsorption is not clear. Among adult patients with Crohn disease, ileal resection of <20 cm was not associated with vitamin B₁₂ malabsorption as measured by the Schilling test (8). The risk of development of abnormal Schilling test results was noted to increase with more ileal resection because 16 of 33 adults (48%) had abnormal Schilling test results when they lost 20 to 40 cm of terminal ileum, compared with 6 of 9 (67%) of those who underwent resection of >40 cm of ileum. In addition to losing ileal mucosa from surgical resection, our patient may have had reduced terminal ileal function as a result of a foreshortened ileum characteristic of ileal atresia.

Another reason for vitamin B₁₂ deficiency could be bacterial overgrowth of the small intestine. Our patient had significant small bowel dilation, which is another factor (in addition to the loss of ileal cecal valve discussed earlier in the present report) that could have lead to stasis and bacterial overgrowth. Bacterial over-growth can be a risk factor for vitamin B₁₂ deficiency as a result of competition between bacteria and intrinsic factor for B₁₂ absorption (9). In older adult patients with hypochlorhydria, bacterial overgrowth can also play a major role in limiting the bioavailability of dietary vitamin B₁₂ for absorption (10).

In summary, our patient with a history of gastroschisis and ileal atresia presented with normal somatic growth and minimal gastrointestinal symptoms. In addition to severe anemia as a result of anastomotic ulcers, she exhibited evidence of multiple micronutrient deficiencies, all likely related to her ileal atresia and resection. Her gastrointestinal anatomy also may have predisposed her to bacterial overgrowth, which may also play a role in vitamin B₁₂ malabsorption. In addition to close clinical monitoring and anthropometric assessment, patients with SBS require biochemical screening for micronutrient deficiencies.

Acknowledgments

The authors thank Drs Jonathan Glickman and Valerie Ward for assistance with the interpretation of the pathological and radiographic data, respectively.

References

1. Goulet O, Ruemmele F. Causes and management of intestinal failure in children. *Gastroenterology*. 2006; 130:S16–28. [PubMed: 16473066]
2. Parashar K, Kyawhla S, Booth IW, et al. Ileocolic ulceration: a long-term complication following ileocolic anastomosis. *J Pediatr Surg*. 1988; 23:226–8. [PubMed: 3357138]
3. Dibaise JK, Young RJ, Vanderhoof JA. Enteric microbial flora, bacterial overgrowth, and short-bowel syndrome. *Clin Gastroenterol Hepatol*. 2006; 4:11–20. [PubMed: 16431299]
4. Kaufman SS, Loseke CA, Lupo JV, et al. Influence of bacterial overgrowth and intestinal inflammation on duration of parenteral nutrition in children with short bowel syndrome. *J Pediatr*. 1997; 131:356–61. [PubMed: 9329409]
5. Sondheimer JM, Sokol RJ, Narkewicz MR, et al. Anastomotic ulceration: a late complication of ileocolonic anastomosis. *J Pediatr*. 1995; 127:225–30. [PubMed: 7636646]
6. Chari ST, Keate RF. Ileocolonic anastomotic ulcers: a case series and review of the literature. *Am J Gastroenterol*. 2000; 95:1239–43. [PubMed: 10811334]
7. Davies BW, Abel G, Puntis JW, et al. Limited ileal resection in infancy: the long-term consequences. *J Pediatr Surg*. 1999; 34:583–7. [PubMed: 10235328]
8. Duerksen DR, Fallows G, Bernstein CN. Vitamin B₁₂ malabsorption in patients with limited ileal resection. *Nutrition*. 2006; 22:1210–3. [PubMed: 17095407]

9. Giannella RA, Broitman SA, Zamcheck N. Competition between bacteria and intrinsic factor for vitamin B₁₂: implications for vitamin B₁₂ malabsorption in intestinal bacterial overgrowth. *Gastroenterology*. 1972; 62:255–60. [PubMed: 4629318]
10. Suter PM, Golner BB, Goldin BR, et al. Reversal of protein-bound vitamin B₁₂ malabsorption with antibiotics in atrophic gastritis. *Gastroenterology*. 1991; 101:1039–45. [PubMed: 1889697]

FIG. 1.
Upper gastrointestinal series and small bowel follow-through demonstrate an area of marked dilation of the distal portion of the ileum just proximal to the transverse colon anastomosis.

FIG. 2.
Colonoscopy shows anastomotic ulcer with normal mucosa above and below the ulcer.

TABLE 1

Laboratory data in a 3-year-old patient with a history of gastroschisis and ileal atresia in infancy

Laboratory data	Normal value	Age 5 mo	Age 3 y	Follow up, age 3.5 y
Hematocrit, %	31.8–37	32.6	11.0	29.0
Hemoglobin, g/dL	11.1–12.9	10.7	2.9	8.7
Mean corpuscular volume, fL	75–86	86	61	85
Red blood cell distribution width, %	12.7–14.7	15	20	20
Reticulocyte count, %	0.8–2.1	—	2.7	3.3
Ferritin, ng/mL	10–75	—	1.8	25
Iron, µg/dL	50–120	—	10	23
Total iron binding capacity, µg/dL	250–420	—	466	277
Prothrombin time, sec	9.5–12.1	—	—	9.8
25(OH) vitamin D, ng/mL	20–57	—	7	—
Vitamin A, µg/dL	20–80	34	15	20
Vitamin B ₁₂ , pg/mL	190–778	337	113	691
Vitamin E, mg/L	5.0–23	7.1	4.5	8.5
Zinc, µg/dL	60–120	72	50	72
Folate, mg/L	4.2–20	—	17	12