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Short Bowel Syndrome: A Case Study of Multiple Micronutrient Deficiencies and High Ileostomy Output

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Abstract

Short bowel syndrome is a malabsorptive disorder of congenital or surgical etiology defined by less than 200 cm of small bowel *in situ*. Short bowel syndrome can result in the inability to maintain nutrition, hydration, electrolytes, and micronutrients. Significant micronutrient deficiencies can occur, which can exacerbate without regular monitoring and repletion. Malnutrition and nutritional deficiencies in short bowel syndrome are well documented yet published case studies are lacking. We describe a woman in her 50s with a history of Crohn's disease, complicated by multiple surgeries that resulted in short bowel syndrome. She presented with abdominal pain, poor oral intake and tolerance, weight loss, nausea, vomiting, dehydration, and excessive ileostomy output with clinical signs and symptoms suggestive of micronutrient deficiencies. She was found to have the following deficiencies: thiamine, pyridoxine, 25-hydroxyvitamin D, and borderline deficiencies in copper and zinc, which were all aggressively repleted. Her output continued to be high, necessitating the use of octreotide. At her six-month follow-up visit, her ileostomy output had stabilized, and all monitored micronutrient levels were within reference range; 25-hydroxyvitamin D level was within reference range at eighteen months. This case highlights the need for management of ileostomy output and active micronutrient surveillance and repletion in patients with short bowel syndrome and high output.

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Introduction

Short Bowel Syndrome (SBS) is characterized by less than 200 cm of small bowel remaining in the body and affects approximately 10,000 to 20,000 people in the United States [1]. SBS commonly occurs when the small intestine is surgically resected due to Crohn's Disease (CD), irradiation, malignancy, or superior mesenteric artery thrombosis [2]. SBS can result in the inability to maintain nutrition, hydration, electrolytes, and micronutrients. Malnutrition due to malabsorption of macronutrients and micronutrients can become a predominant clinical picture, in addition to loss of bowel motility, transit time, and gastroduodenal emptying. Patients at greatest nutritional risk are those with a duodenostomy or jejunoileal anastomosis with less than 35 cm of residual small intestine, jejunocolic or ileocolic anastomosis with less than 60 cm of residual small intestine, or an end jejunostomy with less than 115 cm of residual small intestine [3]. SBS can result in the malabsorption of protein, carbohydrate, electrolytes and micronutrients including fat-soluble vitamins, iron, folate, cyanocobalamin, selenium, zinc, and copper [1,2,4,5]. Decisive repletion reference values have not been defined in this condition.

Case Presentation

We present a case of a female in her 50s (Table 1) with a past medical history significant for severe CD. She has undergone 52 extensive surgeries over a 30-year time span after initial CD diagnosis, complicated by strictures and enterocutaneous fistula, resulting in SBS. Her extensive surgical history includes hysterectomy, cholecystectomy, thyroidectomy, appendectomy, multiple abdominal surgeries yielding total colectomy, end ileostomy and enterocutaneous fistula with 60 cm functional bowel remaining.

She was admitted with abdominal pain, poor oral intake, weight loss, nausea, vomiting, and increased ileostomy output with emptying approximately 40 times per day from a baseline of 7 times per day. Multiple regimens for her CD including adalimumab, infliximab, certolizumab pegol,

Table 1: Anthropometrics.

	Value at admission
Sex, Age	Female, 56 years old
Height, Actual body weight	1.626 m, 83.3 kg
Ideal body weight	54.4 kg
Adjusted body weight	58.4 kg
Estimated Energy needs	1700-1800 kcal/day
Estimated Protein needs	70-120 g/day
Estimated Fluid needs	2000-2400 mL/day

azathioprine, methotrexate, mesalamine, prednisone, and budesonide failed, and recently starting on natalizumab. At admission, her folate and cyanocobalamin levels were within normal limits; zinc and copper levels were borderline deficient (Table 2). We also obtained thiamine (plasma), pyridoxine, 25-hydroxyvitamin D, and ceruloplasmin levels at admission due to suspected micronutrient deficiency. On hospital day 2, her total ileostomy output increased from 900 mL to 1,625 mL (Table 3). The patient was initiated on Parenteral Nutrition (PN) that provided 29.1 kcal/kg/day, 1.5 g/kg/day protein, 4.71 g/kg/day glucose based on an adjusted body weight of 58.4 kg. Her PN formulation contained standard MVI and trace elements plus twice per week 500 mL 20% lipid emulsion. On hospital day 4, while awaiting thiamine and pyridoxine results, she was initiated empirically on thiamine 100 mg/day for five doses. Her ileostomy output continued to be greater than 1,000 mL per day through hospital day 7; her PN was modified to include higher doses of the following micronutrients for 3 days: Selenium 150 mg, zinc sulfate 20 mg, thiamine 100 mg, and pyridoxine 50 mg.

On hospital day 10, the volume of PN was increased from 2L to 3L, glucose was decreased from 275 g to 230 g, and protein was increased from 88 g to 120 g, and 20% lipids were increased from twice to thrice per week. She was maintained on a high protein, reduced caloric nutrition based on obesity and ongoing high output levels [6]. Octreotide was also initiated at 300 mcg due to continued increased ileostomy output; on hospital day 11, her ileostomy output transiently improved. On hospital days 14 and 15, octreotide was further increased from 300 mcg to 450 mcg and finally to 600 mcg due to no appreciable change in ileostomy output. With some stabilization in ileostomy output by hospital day 17, she was anticipating discharge, but suddenly had minimal output with fevers, nausea, multiple episodes of vomiting, abdominal tenderness and pain, lactic acid of 1.3, leukocytosis with an increase in white blood cells from 10.8 to 16.5, and distended bowel with localized peritonitis in the periumbilical area. An abdominal X-ray revealed dilated loops with end colostomy and small bowel obstruction. Trauma surgery was consulted and initially attempted to decompress her bowel, but our patient continued to have abdominal pain with high output from nasogastric tube. On hospital day 18, she was taken to the operating room for presumed small bowel obstruction, exploratory laparotomy, lysis of adhesions, and small bowel resection that resulted in 13 cm remaining bowel. Her pathology report revealed chronic, active inflammation, hemorrhage, and serositis, and was negative for dysplasia or granulomas. She was continued on PN and later given a trial of sips of fluid. Her bowel function slowly returned with gas and effluent present in her ostomy bag; she was discharged on hospital day 22 to an inpatient rehabilitation center with PN.

Table 3: Hospital Day with corresponding ileostomy and total output (mL).

Hospital Day	Ileostomy Output	Total Output
1	900	1320
2	1625	2425
3	2550	3450
4	1175	2525
5	1450	3850
6	1075	2975
7	1050	5100
8	925	2625
9	1720	5045
10	1325	4375
11	975	4200
12	1100	4050
13	2275	4375
14	1530	3930
15	1725	4075
16	1525	4800
17	25	3030
18	25	2145
19	250	3200
20	125	2775
21	150	3800
22	375	2725

Discussion

Micronutrient deficiencies are often multifactorial. Vomiting and diarrhea, with or without high ileostomy output, have been linked to micronutrient deficiencies due to excessive volume depletion with decreased absorption [2]. Small bowel resection can exacerbate

Table 2: Micronutrient laboratory parameters and patient values.

Lab	Reference range	Patient value at admission	Patient value at six-month follow-up
Thiamine, Plasma (B1)	8-30 nmol/L	<2 nmol/L	738 nmol/L
Pyridoxine (B6)	20-125 nmol/L	6 nmol/L	119.8 nmol/L
Cyanocobalamin (B12)	243-894 pg/mL	504 pg/mL	1101 pg/mL
25-Hydroxyvitamin D	>20 ng/mL	12.2 ng/mL	80 n/gmL*
Folate (B9)	4.4-19.9 ng/mL	16.1 ng/mL	18.7 ng/mL
Ceruloplasmin	20-60 mg/dL	22 mg/dL	30 mg/dL
Copper	80-155 ug/dL	99 ug/dL	134 ug/dL
Zinc	60-120 ug/dL	61 ug/dL	78 ug/dL

*Value at eighteen-month follow-up; six-month value not available

Table 4: Micronutrient deficiency repletion recommendations in SBS* [8-11].

Micronutrient	British Society of Gastroenterology[8]	Various sources
Pyridoxine (B6)	n/a	
Folate (B9)	n/a	
Cyanocobalamin (B12)	"Require long term treatment"	200 µg/month intramuscular[9]; 500-1000 mcg twice weekly oral
Vitamin A	"May need to be replaced"	10,000 IU daily[9]; 1-2 mL of Tri or Poly-Vi-Sol (Enfamil® Poly-Vi-Sol®) daily (divided into two doses)[11]
25-Hydroxyvitamin D	"May need to be replaced"	20,000-40,000 IU loading dose once per week (day 1) followed by daily doses 4000-6000 IU daily (days 2-6), repeated for 12 weeks[10]
Vitamin E	"May need to be replaced"	80-100 IUs daily (divided into 3 doses)[11]; 1200 IU daily[9]
Vitamin K	"May need to be replaced"	2-5 mg daily liquid phylloquinone[11]
Ceruloplasmin	n/a	
Copper	n/a	
Iron		6 mg/kg (elemental) daily divided into 2 or 3 doses[11]
Selenium	"May need larger amounts than normal subjects"	
Zinc	n/a	36-40 mg oral daily per liter of output (or 50-100 mg daily) [9]; 20-30 mg twice daily oral[10]

*These repletion recommendations are generally suggested until normalization

micronutrient deficiencies depending on the site of resection, even with intestinal structural adaptation [1,4]. Furthermore, ileocolonic resection can also result in the loss of the ileocecal valve and the ileal break leading to rapid transit through the small intestine [1].

We presented an SBS patient who had a history of severe CD, initially diagnosed 30 years ago, which was complicated by strictures, enterocutaneous fistulae and previous surgeries. The patient continuously had increased ileostomy output throughout her hospital stay until developing small bowel obstruction. Multiple pharmaceutical regimens given to her failed, including octreotide dosed up to 600 mcg/day. She was likely to be micronutrient deficient because of 60 cm remaining of functional bowel. Significant deficiencies in thiamine, pyridoxine, and 25-hydroxyvitamin D, as well as borderline deficiencies of copper and zinc, were found. The micronutrients found to be deficient were aggressively replaced. At six-month follow-up, thiamine, pyridoxine, copper, and zinc levels were within reference range; 25-hydroxyvitamin D was in reference range when checked at eighteen months.

Micronutrient dosages for parenteral nutrition maintenance have been well-researched with concise recommendations [7]; however published data on repletion recommendations for SBS-associated micronutrient deficiencies is very limited (Table 4). Our repletion doses were based on published data in SBS as well as general non-SBS repletion recommendations.

In addition, there are limited consensus guidelines of monitoring frequency for micronutrient deficiency or toxicity levels in SBS; however, the recommendations for home PN are more prolific. Based on a 2006 review of 42 centers in Europe providing home PN, it was found that stable patients were monitored every 1 to 6 months with 52% of centers reporting monitoring intervals of 2 to 3 months [12]. During monitoring visits, 19% of centers analyzed trace elements and 14% evaluated vitamins A, E, D, B-12, and folic acid. The remaining centers (67%) monitored micronutrient status but not at every visit -or only in case of concern. Overall, there was an agreement by the centers that "monitoring of trace elements and vitamin status should only be carried out more rarely or when clinical symptoms indicated that patients had a deficiency." The European Society for Clinical Nutrition and Metabolism (ESPEN) has also stated that all patients on home PN should have micronutrient status evaluated at six-month intervals (Grade C) [13]. The ESPEN released guidelines on chronic intestinal failure in adults with the following recommendations:

- Evaluate signs, symptoms, and biochemical indexes of vitamin and trace element deficiency or toxicity regularly at clinical review. (Evidence: Very low; Strength of recommendation: Weak)
- Monitor and adjust vitamin and trace element does in PN as needed (Evidence: Very low; Strength of recommendation: Weak);
- Measure baseline serum vitamin concentrations at onset of PN then at least once per year (Evidence: Very low; Strength of recommendation: Strong);
- Measure baseline serum trace element concentrations at onset of PN then at least once per year (Evidence: Very low; Strength of recommendation: Weak) [14].

Additionally, Australasian Society for Parenteral and Enteral Nutrition suggests monitoring for magnesium and iron of home PN patients at each visit, and other trace elements and vitamins every 6 to 12 months [15].

In summary, our patient with a history of severe uncontrolled CD was found to have significant SBS-associated micronutrient deficiencies including critically low values. Patients with SBS have a large degree of variability in levels, types of resections, and disease severity. Because of these distinct variables, individualized care is necessary to determine frequency and follow-up of screening for micronutrient deficiencies. This case demonstrates the importance of active micronutrient monitoring with aggressive replacement treatment in patients with SBS and excessively high ileostomy output.

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