INTERNAL MEDICINE

□ CASE REPORT □

Persistent Metabolic Acidosis in a Hemodialyzed Patient with Short Bowel Syndrome

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Abstract

Short bowel syndrome (SBS) is characterized by a malabsorptive state. It is conceivable that the coexistence of SBS and end-stage renal disease can lead to severe metabolic acidosis; however, such a condition has rarely been documented. We herein describe the case of a 64-year-old man with SBS who required maintenance hemodialysis. Persistent metabolic acidosis and mineral and bone disorders should be of particular concern in hemodialyzed patients with SBS.

Key words: hemodialysis, metabolic acidosis, mineral and bone disease, short bowel syndrome

(Intern Med 52: 1379-1382, 2013)
(DOI: 10.2169/internalmedicine.52.0029)

Introduction

Short bowel syndrome (SBS) is a malabsorptive condition that develops following wide resection of the intestines. Fecal loss of bicarbonate leads to metabolic acidosis. A well-preserved renal function is indispensable for correcting the metabolic acidosis since the kidneys play a pivotal role in bicarbonate absorption. Although it is conceivable that severe metabolic acidosis can develop in patients with both SBS and renal dysfunction, such patients have rarely been described.

Case Report

A 64-year-old man with urolithiasis and kidney dysfunction (creatinine: 2.5 mg/dL, six months before admission) was admitted to our hospital with consciousness disturbance and a high fever (38.0℃). A physical examination was unremarkable, except for decreased skin turgor. Seven years previously, the patient had undergone surgery for thoracic aortic dissection. Postoperatively, occlusion of the superior mesenteric artery developed. Massive resection of the necrotized small intestine and right hemicolon was performed. The remaining small intestine measured 80 cm. Nutritional support delivered via a central venous port was discontinued due to infection two years before admission. The patient's body weight had stabilized around 44 kg (BMI 15.7) over the last two years. Watery diarrhea occurred five to seven times per day after the intestinal surgery.

Blood tests revealed an elevated creatinine level (8.8 mg/dL), severe metabolic acidosis with an increased anion gap (pH: 6.887, bicarbonate: 3.9 mEq/L, anion gap: 29.3) and hypoalbuminemia (2.72 g/dL). The arterial pCO2 was 21.6 Torr. If a 1.2-mmHg decline in arterial pCO2 is assumed for every 1 mEq/L reduction in serum bicarbonate (1), the respiratory compensation for metabolic acidosis appeared to be adequate, as the expected pCO2 was 23.2. Blood cultures revealed methicillin-resistant Staphylococcus capitis. The clinical data obtained at the time of admission are summarized in Table. Septic acute kidney injury was diagnosed. Meropenem and Teicoplanin were administered for 14 days. The patient also received continuous veno-venous hemodiafiltration (CVVH) for seven days. Twenty days later, his renal function again worsened (creatinine: 6.5 mg/dL). At that time, hemorrhagic tendencies, including continuous epistaxis and hematuria, manifested. Blood tests revealed marked elongation of prothrombin time-international normalized ratio (PT-INR) (9.44), progression of anemia (Hb: 8.4 g/dL), hypoalbuminemia (Alb: 2.76 g/dL) and severe

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Received for publication January 7, 2013; Accepted for publication February 19, 2013
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Table. Clinical Data on Admission

■Urinalysis			■Blood chemistry		
Specific gravity	1.012		T-bil	0.36	mg/dL
pH	5.5		AST	32	IU/L
Protein	(3+)		ALT	26	IU/L
Occult Blood	(3+)		LDH	576	IU/L
Sugar	(-)		ALP	306	IU/L
Ketone	(-)		γGT	11	IU/L
Red blood cells	20-29	/HPF	TP	5.6	g/dL
White blood cells	20-29	/HPF	Alb	2.72	g/dL
			BUN	65	mg/dL
■CBC			Cre	8.8	mg/dL
			UA	10.3	mg/dL
White blood cells	14700	/μL	Na	140	mEq/L
Red blood cells	229×10^4	/μL	K	4.6	mEq/L
Hemoglobin	7.3	g/dL	Cl	112	mEq/L
Hematocrit	21.4	%	Ca	7.2	mg/dL
Platelets	20.2×10^4	/μL	iP	11.4	mg/dL
			Glucose	134	mg/dL
■Arterial blood gas	(room)		CRP	6.23	mg/dL
			APTT	139	sec
pH	6.887		PT-INR	2.10	
pCO2	21.6	Torr			
pO2	108.3	Torr			
HCO3-	3.9	mEq/L			
BE	-27.3	mEq/L			
Anion gap	29.3				

metabolic acidosis with an increased anion gap (pH: 6.987, bicarbonate: 4.7 mEq/L, anion gap: 29.7). Warfarin-related nephropathy was suspected. The serum levels of L-lactate, pyruvate, ketones and organic amino acids were normal. The serum D-lactate level was 0.186 mmol/L. The D-lactate level was determined according to the light absorbance method using an F-kit (Boehringer Mannheim, Germany). D-lactate dehydrogenase is highly specific to D-lactate (2), and this method has been used in other reports (3). The reliability of the measurements was also confirmed by measuring accompanying standard D-lactate at the same time. Dual-energy X-ray absorptiometry (DEXA) revealed a marked decrease in bone mineral density (BMD) at the femoral neck (0.599 g/cm^2, Z score =-1.2 SD). Infusion of 7% sodium bicarbonate solution (MEYLON Injection 7%, Otsuka Pharmaceutical Factory, Inc., Japan) was initiated. The patient's bicarbonate deficit was calculated to be 212.3 mEq according to the formula in product information document: (bicarbonate deficit = (targeted [HCO3-] - current [HCO3-]) ×0.25× body weight (kg) = (24 - 4.7) ×0.25×44). However, increments in the serum bicarbonate level were less than expected (from 4.7 to 7.5 mEq/L) following the infusion of a total amount of 250 mL (208.25 mEq of bicarbonate ions). The bicarbonate distribution space is known to increase more than 80% under the conditions of metabolic acidosis (4). Based on Fernandez's formula (4), more than 679.36 mEq (0.8×44× (24-4.7)) of bicarbonate ions were necessary in this patient. However, general malaise and edema further worsened the next day. We decided that infusion of sodium bicarbonate alone was inappropriate to treat the acid-base and fluid balance in this patient. Hemodialysis was restarted using a conventional dialysate (Kindaly 2E, bicarbonate concentration of 30 mEq/L, Fuso Pharmaceutical Industries, Japan). Although hemodialysis clearly ameliorated the patient's symptoms, the predialysis serum pH and bicarbonate concentration stabilized at approximately 7.2 and 10 mEq/L, respectively. The patient's final dialysis conditions were as follows: 4-hour HD, Dialyzer: NV-10U (polysulfone membrane, TORAY Industries Inc., Japan); Qb: 150 mL/min; Qd: 500 mL/min; dry weight: 43.4 kg. The Kt/V (urea) value calculated using the Daugirdas method was 1.00. One month after the induction of hemodialysis, the patient received 2 g of oral sodium bicarbonate daily. The predialysis bicarbonate concentration increased to 13.6 mEq/L. We avoided prescribing more sodium bicarbonate since the patient exhibited a relatively high blood pressure

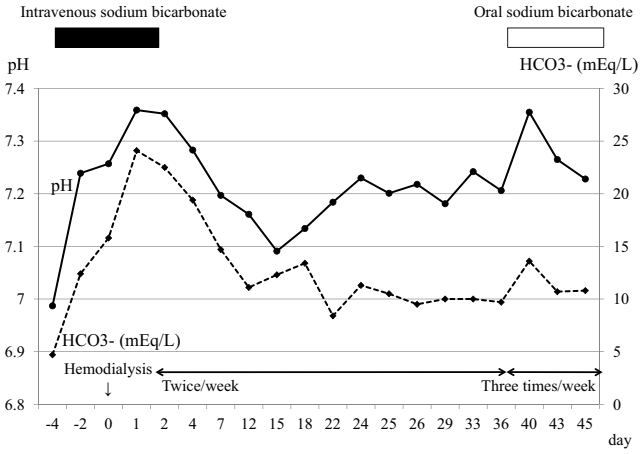

Figure. PH and the serum bicarbonate concentrations. After the initiation of dialysis, the serum bicarbonate concentration was measured using blood samples obtained at the beginning of each dialysis session. The bicarbonate concentration remained at approximately 10 mEq/L. The administration of 2 g of oral sodium bicarbonate slightly increased the serum bicarbonate concentration.

(systolic/diastolic blood pressure around 160/80 mmHg). Clinical course is denoted in Figure.

Discussion

Metabolic acidosis is associated with several adverse effects, including bone disorders, muscle degeneration, suppressed protein synthesis, progression of chronic kidney disease (CKD) and increased mortality (5, 6). SBS is characterized by impaired absorption of fluid, electrolytes and various nutrients due to massive resection of the small intestines. Continuous fecal loss of bicarbonate can lead to metabolic acidosis (7). A well-preserved renal function is indispensable for compensating for acidosis because the kidneys play a significant role in bicarbonate reabsorption. Our patient's predialysis serum bicarbonate level remained at approximately 10 mEq/L under standard hemodialysis. This finding is unusual since 84% of hemodialyzed patients exhibit values exceeding 18 mEq/L (6).

SBS is sometimes complicated with a rare form of metabolic acidosis called D-lactic acidosis, which occurs as a consequence of D-lactate overproduction by Gram-positive anaerobes (8). Uribarri et al. proposed that D-lactic acidosis be defined as a serum D-lactate level greater than 3.0 mmol/L (9). D-lactic acidosis is unlikely in the present case because the highest value of D-lactate was 0.186 mmol/L. The serum levels of L-lactate, pyruvate, ketones and organic amino acids were normal. Taking these findings into account, the patient's acidosis can be explained by three mechanisms: continuous fecal bicarbonate loss, impaired renal management of acid-base balance and nonvolatile acid accumulation.

Little information is available regarding the management of acidosis in hemodialyzed patients with SBS. Several different mineral and bone disorders are known to develop in patients with CKD, and persistent acidosis can exert a further negative impact on the bone status via bone buffering, i.e., release of calcium and phosphate from bone to neutralize excess hydrogen ions (10). Our current patient's bone mineral density had already significantly decreased at the time of hemodialysis initiation as a consequence of nutrition loss from the intestines. In this case, we administered 2 g of sodium bicarbonate daily even after the induction of maintenance hemodialysis. The patient's predialysis bicarbonate concentration increased to 13.6 mEq/L, without an increase in blood pressure or excessive intradialytic body weight gain. Although oral sodium bicarbonate is used to mitigate acidosis in patients with CKD, it is generally discontinued after the initiation of hemodialysis since sodium overload leads to cardiovascular complications and the bicarbonate concentration is usually corrected adequately with dialysis (6).

Oettinger et al. reported the efficacy of using a dialysate with a high bicarbonate concentration (42 mEq/L) to correct the predialysis serum bicarbonate level (11). In Japan, the use of a central dialysate delivery system is common, and making individual adjustments of the dialysate composition is thus technically difficult. We did not adopt this method in the present case. Therefore, the efficacy of such an approach remains to be examined in future studies.

We propose that the management of acidosis and mineral and bone disease in hemodialyzed patients with SBS should include the following: an adequate amount of bicarbonate supplementation with oral sodium bicarbonate or dialysate or infusion via a central venous port is indispensable for compensating for intestinal loss. Supplementation of vitamin D is recommended to compensate for the intestinal loss of minerals and fat-soluble vitamins. The efficacy of oral phosphate binders in controlling hyperphosphatemia remains unknown since the hyperphosphatemia observed in these patients is considered to be the consequence of bone buffering, not the consequence of intestinal absorption. These issues need to be clarified in further studies.

In conclusion, we herein described the course of a hemodialyzed patient with SBS. Standard hemodialysis alone was insufficient to treat the metabolic acidosis observed in this case. Mineral and bone disorders in such patients can be exacerbated by persistent acidosis. Providing appropriate management of acidosis is therefore mandatory.

The authors state that they have no Conflict of Interest (COI).

Acknowledgement

We are indebted to Ayano Endo and Kazunori Fukuda for measuring the serum D-lactate level.

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