Metabolic acidosis in a lactating woman induced by a deliberate ketogenic diet.

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CASE REPORT

Metabolic acidosis in a lactating woman induced by a deliberate ketogenic diet

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ABSTRACT

This article describes a rare case of lactation ketoacidosis in a patient who started a ketogenic diet while nursing an infant and toddler. The patient presented to the ED with a history of nausea, vomiting, and postural dizziness, and was found to have a significant metabolic acidosis and elevated lipase level. The metabolic changes induced in this patient could occur in anyone with high metabolic demands who also is on a strict ketogenic diet. The case highlights the importance of a dietary history in patients with unexplained metabolic derangements.

Keywords: ketogenic diet, lactation, ketosis, metabolic acidosis, starvation, postpartum

CASE

A 27-year-old woman presented to the ED complaining of 4 days of nausea and dizziness worsened by postural changes.

History The patient also reported nonradiating frontal head pressure, one episode of diarrhea, vomiting, and a lack of appetite. She said that the vomiting was brought on by eating any quantity larger than sips and was nonbilious and nonbloody. For the past 4 days, she had been unable to tolerate food and was only able to consume sips of water. She denied fevers, chills, abdominal pain, back pain, shortness of breath, chest pain, seizures, and loss of consciousness.

Four months ago, the patient had a cesarean section secondary to the fetus being in breech position. She was breastfeeding her 4-month-old and providing on-demand nursing for her 2-year-old for comfort. She stated that although she had been drinking more fluids, she believed that her milk production had decreased. She had tried Fioricet capsules (containing butalbital 50 mg, acetaminophen 300 mg, and caffeine 40 mg) once every 6 hours as prescribed by her primary care provider for the headache without resolution of symptoms.

Two months ago, the patient adopted a ketogenic diet to lose weight and had lost 35 lb (15.9 kg). Her typical breakfast consisted of 3 to 4 eggs cooked with cheese and spinach. Lunch was usually a chicken salad in lettuce cups. Dinner consisted of beef and vegetables. The patient reported that she and her husband consumed at least 5 lb (2.3 kg) of cheese per week. She monitored her ketogenic diet by testing her urine for ketones, which were invariably positive at home.

Outpatient daily medications before hospitalization included (in addition to the Fioricet) 10 mg of cetirizine for environmental allergies, and 25 mg of sertraline for postpartum depression and anxiety. She endorsed an allergy to oxycodone. The patient was a former cigarette smoker who quit 5 years ago. She drank alcohol socially but quit before her most recent pregnancy and denied any recreational drug use. She had no history of diabetes, and her family history was noncontributory.

Physical examination The patient's vital signs were: BP, 111/71 mm Hg; pulse, 96 beats/minute; respirations, 20; temperature, 98.8° F (temporal); and Spo_2, 98% on room air. The patient was noted to be alert, fully oriented, and in no acute distress on initial evaluation. The physical examination was remarkable for dry mucous membranes and mild tenderness in the epigastric area and left upper quadrant. Her abdomen was otherwise soft and nondistended. The remainder of the physical examination, including cardiac and pulmonary examinations, was unremarkable.

Diagnostic testing A complete blood cell (CBC) count, complete metabolic panel (CMP), urinalysis, and urine hCG were ordered. The patient's hemoglobin was 16.5 g/dL (normal range, 11.5 to 14.5 g/dL); hematocrit, 49.1% (normal range, 35% to 43%); and white blood cell count, 12,300 cells/mm^3 (normal range, 4,000 to 10,000 cells/mm^3). Her serum sodium level was 131 mmol/L (normal range, 135 to 145 mmol/L); potassium was 5.3 mmol/L

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Key points

- Ketogenic diets are popular for weight loss, but can cause severe physiologic disturbances and symptoms referred to many different organ systems.
- Be aware of the potential for refeeding syndrome during treatment of patients with either voluntary or involuntary reduced carbohydrate intake resulting in ketosis or poor nutrition.
- Treatment for the refeeding syndrome requires slow nutrition and fluid repletion to avoid potentially serious metabolic and electrolyte derangements.

(normal range, 3.5 to 5.2 mmol/L); carbon dioxide, 8 mmol/L (normal range, 23 to 31 mmol/L); alkaline phosphatase, 162 U/L (normal range, 35 to 120 U/L); total protein, 9.7 g/dL (normal range, 6.3 to 8.3 g/dL); anion gap, 18 (normal range, 3 to 11); and lipase, 1,040 U/L (normal range, 80 to 360 U/L). All other values were within normal limits. The urinalysis was positive for bilirubin, ketones, protein, and red blood cells. The urine hCG test was negative.

An ECG was ordered and revealed sinus tachycardia at 114 beats/minute. CT of the abdomen and pelvis with IV contrast showed mild hepatic steatosis with no significant peripancreatic inflammatory changes. Initial intervention in the ED included a 1L bolus of IV 0.9% sodium chloride solution, 10 mg IV prochlorperazine, and 25 mg IV diphenhydramine to treat dehydration and nausea. She received an additional 1L bolus of IV lactated Ringer solution in the ED.

The patient was admitted to the ICU with a diagnosis of metabolic acidosis secondary to starvation ketosis. Additional laboratory tests in the ICU showed a magnesium level of 2.3 mg/dL (normal range, 1.4 to 2.2 mg/dL) and a phosphorus of less than 0.5 mg/dL (normal range, 2.3 to 4.6 mg/dL). A repeat metabolic panel was significant for a potassium level of 2.5 mmol/L. She was started on an IV isotonic bicarbonate infusion (D_5W with 150 mL of sodium bicarbonate per liter) and a clear liquid diet with plans to slowly advance her diet as tolerated to prevent refeeding syndrome, a condition characterized by multiple electrolyte abnormalities. The patient also was started on oral and IV potassium and phosphorus replacement with a goal of potassium above 3 mmol/L and phosphorus above 1.2 mg/dL before being considered for transfer out of the ICU. Nutrition management was consulted.

The patient was transferred out of the ICU on day 2 and was discharged home on hospital day 4 after her electrolyte abnormalities were corrected. She remained hemodynamically stable during her ICU admission. Her albumin remained at 3 g/dL on discharge day. Repeat outpatient laboratory tests were ordered, including a complete metabolic panel with liver enzymes, magnesium, and phosphorus to monitor for refeeding syndrome. The patient was advised to discontinue her ketogenic diet and made aware of the importance of including a minimum of 15 g of carbohydrates in her diet, especially while breastfeeding. She was advised that following a ketogenic diet may be problematic, particularly while nursing, and may lead to renal and hepatic abnormalities. She was educated about carbohydrate counting, and was understanding of and receptive to her new dietary recommendations.

At her 1-week follow-up visit, she was no longer following a ketogenic diet but maintained a mainly plant-based diet with incorporation of carbohydrates as recommended. Repeat CMP, magnesium, and phosphorus levels showed no evidence of refeeding syndrome. She had restarted breastfeeding her two children and continued meeting with a nutritionist for dietary management.

DISCUSSION

Deliberate induction of systemic ketosis is an important element in several common dietary strategies for weight loss, including such popular diets as paleo and Atkins.[1] Ketogenic diets have been shown to aid in the treatment of epilepsy in adults and children and compare favorably to low-fat diets for weight loss.[2,3] To assist with postpartum weight loss, some women resort to various diet trends such as low-carbohydrate diets that allow consumption of high-fat and high-protein foods. Early satiety from high protein-containing foods suppresses the appetite, further reducing food consumption.[4] These diets let the body undergo gluconeogenesis to supply the glucose that normally would come from ingesting carbohydrates. Glucose, the body's primary energy source, comes for dietary sugars and glycogenolysis, the breakdown of glycogen stored in the liver. After the body's glycogen and glucose stores are depleted with continued carbohydrate restriction, the body turns to ketogenesis, breaking down fat into ketone bodies for energy.[5] Weight loss is ultimately achieved as the body depletes its fat stores for energy, but the initial weight loss effects of ketogenic diets are due to the depletion of glycogen stores, leading to excretion of bound water.[4,6] This leads to the phenomenon known as the natriuresis of fasting. This may also explain her elevated hemoglobin and hematocrit. Although the exact mechanism is unknown, this natriuresis involves sodium depletion. This process of water loss may present clinically as a fall in BP that can lead to multiple clinical presentations including postural hypotension and associated complaints of lightheadedness and/or dizziness.[6] Other common adverse reactions to ketogenic diets include nausea, vomiting, headache, and fatigue, and are sometimes referred to as the *keto flu*.[2] The physiologic disturbances and common adverse reactions associated with ketogenic diets are exaggerated in a lactating patient because of the high energy cost of breast milk production; this can lead to potentially dangerous metabolic derangements.[7]

The World Health Organization recommends exclusive breastfeeding until infants reach age 6 months. Breast

milk has been found to be preventive against some diseases and is considered the optimal nutrition for infants given its uniquely balanced profile.[8] Breastfeeding also may be encouraged to help facilitate postpartum weight loss. Studies have shown that on average, exclusively breastfeeding women can expect to lose about 500 g (1.1 lb) per month. The energy cost of breast milk production has been estimated to be about 595 kcal/day for the first 2 months postpartum and 670 kcal/day for the next 3 to 8 months postpartum in exclusively breastfeeding women.[7]

Even in patients who do not restrict carbohydrates through a ketogenic diet, breastfeeding twins can contribute to metabolic imbalances and ketoacidosis.[9] When lactating mothers were compared with nonlactating mothers after a long period of fasting, lactating mothers were found to be more acidotic than nonlactating controls.[10] The metabolic demands of breastfeeding along with a caloric deficit can exacerbate worsening physiologic disturbances and lead to lactation ketoacidosis, which has been demonstrated in previous case reports.[11-14] This report differs from previously reported cases because our patient was breastfeeding two children, as opposed to only one child, while dieting. The demands of breastfeeding two children likely worsened and contributed to the patient's diagnosis of metabolic acidosis.

An important consequence of the ketogenic diet, which permits the consumption of high-fat foods, is hyperlipidemia and an elevation in the body's triglycerides.[15] Hypertriglyceridemia is a risk factor for acute pancreatitis.[16] This may be a possible explanation for our patient's elevated lipase level on admission, suggesting pancreatic irritation. Although the mechanism is unclear, one theory is that hydrolysis of triglycerides in the pancreas by pancreatic lipase may lead to accumulation of free fatty acids in high concentrations, which is toxic and can lead to acinar cell or capillary injury.[17]

When treating patients who develop metabolic derangements secondary to malnutrition, fasting, or starvation, consider refeeding syndrome as a possible complication of treatment. Rapid refeeding after prolonged fasting can cause metabolic and hormonal changes. Increased glucose after nutritional repletion leads to increased insulin levels that stimulate the influx of potassium, magnesium, and phosphate into cells, ultimately causing a decrease in the serum levels of these electrolytes. Phosphate is used at the cellular level by enzymes, secondary messengers, and is essential for energy storage as adenosine triphosphate (ATP). Potassium imbalances can lead to dysrhythmias and cardiac arrest. Magnesium also is an important cofactor for many enzymes, including ATP production.[18] Insulin has antinatriuresis and antidiuretic effects. Therefore, nutrition and fluids should be reintroduced to patients slowly. Aggressive fluid administration also may result in pulmonary edema and cardiac failure.[19]

CONCLUSION

Although lactation ketoacidosis is rare, many women face pressure about weight and body image and many have a strong desire to exclusively breastfeed. Clinicians must be aware of various dietary practices used by postpartum women, including the intentional establishment of a ketogenic state. This case report illustrates how the negative consequence of one such practice may be entirely reversed through appropriate education and counseling. **JAAPA**

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