Starvation Ketoacidosis Induced by Ketogenic Diet and Consumption of Ketone Supplement

Manjot S. Malhi 1, Frank Duerson 1, Joshua K. Salabei 1, Peters Okonoboh 2

1. Internal Medicine, University of Central Florida College of Medicine, Graduate Medical Education/North Florida Regional Medical Center, Internal Medicine Residency Program, Gainesville, USA 2. Internal Medicine - Critical Care, University of Central Florida College of Medicine, Graduate Medical Education/North Florida Regional Medical Center, Internal Medicine Residency Program, Gainesville, USA

Corresponding author: Manjot S. Malhi, manjot.malhi@hcahealthcare.com

Abstract

The ever-changing landscape of dieting and its correlation with health outcomes have continued to evolve with time. New diets appear and disappear just as quickly as they gain notoriety. This is a rare case of a 67-year-old female with a history of type II diabetes who presented with generalized weakness, nausea, and vomiting. She was found to have severe anion gap metabolic acidosis. In an effort to lose weight, she was combining a ketogenic diet with prolonged fasting and exogenous ketone supplement use that she purchased online. The patient reported drinking an exogenous ketone ester supplement that contained 30 g of D-beta hydroxybutyrate (BHB) per serving, three times per day. This case is unique in that the patient was initially thought to be in diabetic ketoacidosis upon arrival, but after further investigation into her initial labs, medication, and social history, the underlying factor for hospitalization became evident; that is, a combination of a ketogenic diet with prolonged fasting and exogenous BHB-induced ketoacidosis in the setting of type II diabetes. Thus, this case highlights the importance of thorough history taking, the dangers of over-the-counter supplement consumption, and the risks consumers inherit with trend dieting.

Categories: Endocrinology/Diabetes/Metabolism, Internal Medicine, Other
Keywords: keto diet, starvation ketoacidosis, starvation ketosis, chronic kidney disease (ckd), diabetes, metformin

Introduction

Although traditionally used to treat epilepsy and other neurological conditions over the past decades, the ketogenic diet has gained popularity for its weight-reducing effects [1,2]. The basic foundation of this diet is to eliminate nearly all carbohydrate intake, reduce protein-sourced calories, and consume 70% or more of one’s daily caloric intake from fats. Thus, the ketogenic diet ultimately causes a state of insulin deficiency which allows for the production of ketones in the liver by a process called ketogenesis [3]. One of the main benefits of ketones is their ability to act as an alternative energy source to glucose. Blood ketone levels above 0.5 mM indicate a state of ketosis [4].

Under certain circumstances, a ketogenic diet coupled with a prolonged fasting state and ingestion of exogenous ketones can quickly induce a state of ketoacidosis. When this occurs, the patient’s serum bicarbonate levels decrease along with the pH leading to metabolic acidosis [5-7]. Although ketoacidosis is commonly associated with diabetes, there are other causes of ketoacidosis including, but not limited to, the use of sodium-glucose co-transporter 2 (SGLT2) inhibitors, alcohol, and starvation.

Case Presentation

We present the case of a 67-year-old female with a history significant for type II diabetes mellitus and obesity (body mass index of 45) who had been trying to lose weight with a combination of intermittent fasting and consumption of exogenous ketone supplements purchased online. Three months prior to hospitalization, the patient began a ketogenic diet that entailed intermittent fasting, whereby she would fast for upwards of 40 hours at a time with only drinking water and ingesting keto supplements; she reported drinking the ketone ester supplement three times a day on an empty stomach. The patient stated she had lost over 25 pounds since the beginning of her diet. After one of her fasting cycles, she ate half an avocado, some shrimp, and drank a ketone ester drink. Shortly after, the patient began feeling dizzy and started to vomit and ultimately presented to the hospital with severe fatigue, lower abdominal pain, nausea, and vomiting. She last took metformin (she was on a 750 mg twice daily home dose) on the morning of her presentation to the hospital and admitted to taking exogenous ketone supplements containing 30 g of beta-hydroxybutyrate (BHB) three times a day.

On evaluation, she was hemodynamically stable with baseline normal mental function but appeared dehydrated. Assessment of vitals showed the patient was tachycardic with a pulse rate of 120 beats per minute and borderline tachypnea with a respiratory rate of 20 breaths per minute. Her electrocardiogram did not show any arrhythmias or concerning changes in ST segments. On examination, she had dry mucous membranes and diffuse lower abdominal pain to palpation without guarding or rebound tenderness.
Our patient almost entirely excluded carbohydrates from her diet while consuming exogenous ketone esters containing 30 g of D-BHB per serving three times per day. Exogenous D-BHB is directly absorbed into the circulation and quickly increases blood ketone concentrations to 2.8 ± 0.2 mM with just one ketone ester drink, as shown in a study where 15 participants consumed a ketone ester drink which contained up to 24 g of BHB resulting in a decrease of blood pH from 7.41 to 7.31 following one ketone ester drink. In addition, serum bicarbonate was reduced from 23.6 ± 0.7 to 17.0 ± 0.8 mM [4]. Of note, circulating ketone body levels, which in normal individuals are generally <0.5 mM, can reach up to 6-7.5 mM during prolonged fasting and up to 25 mM in cases of severe insulin deficiency [11].

The differential diagnoses including diabetic ketoacidosis, alcoholic ketoacidosis, lactic acidosis, and salicylate toxicity were considered. Given the patient’s normal salicylate and ethanol levels, these etiologies were ruled out. The patient did not have chronic kidney disease, making lactic acidosis secondary to metformin use less likely. Moreover, serum ketones were elevated further, suggesting an alternative cause of acidosis. Therefore, our differential was narrowed down to ketoacidosis caused either by diabetes or consumption of ketones/fasting. Although our patient did have type II diabetes mellitus, her random blood sugar was 176 mg/dL not suggestive of overt diabetic ketoacidosis. In addition, she was not taking any antidiabetic medication of the SGLT2 inhibitor class known to cause euglycemic ketoacidosis. Thus, her ketoacidosis was most likely due to prolonged fasting plus ingestion of exogenous ketone supplements. That notwithstanding, it is plausible that metformin use contributed to her acidosis given that she presented with lactic acidosis secondary to elevated levels of blood ketones because of low basal insulin levels/reduced responsiveness to insulin as insulin is needed to adequately reclear ketones [10,11]. Ketones are organic acids that are ionized at physiological pH; the hydrogen ions thus released bind to bicarbonate causing a drastic drop in serum bicarbonate. As the ketones in the blood increase, and as bicarbonate stores are depleted, metabolic acidosis with a corresponding drop in blood pH ensues, that is, ketoacidosis [5].

Conclusions

Here, we presented a case of ketoacidosis induced by keto dieting and consumption of ketone supplements. Although some studies have shown significant weight reduction with the implementation of a ketogenic diet, the adverse consequences of such dieting must be highlighted. As shown in this case, especially in at-risk patient populations such as those with diabetes and/or CKD, the use of exogenous ketone supplements, not often regulated to the same extent as Food and Drug Administration-approved medications, must be cautioned. Our patient was thus counseled on the dangers of taking these weight loss supplements that are unregulated. She was further counseled to follow up with her primary care provider for further education on other safer means to achieve weight loss.

Additional Information

Disclosures
Human subjects: Consent was obtained or waived by all participants in this study. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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