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"Green Smoothie Cleanse" Causing Acute Oxalate Nephropathy

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Oxalate nephropathy is an uncommon condition that causes acute kidney injury with the potential for progression to end-stage renal disease. Diagnosis is based on the kidney biopsy findings of abundant polarizable calcium oxalate crystals in the epithelium and lumen of renal tubules. We report a case of acute oxalate nephropathy in a 65-year-old woman, temporally associated with the consumption of an oxalate-rich green smoothie juice "cleanse" prepared from juicing oxalate-rich green leafy vegetables and fruits. Predisposing factors included a remote history of gastric bypass and recent prolonged antibiotic therapy. She had normal kidney function before using the cleanse and developed acute kidney injury that progressed to end-stage renal disease. Consumption of such juice cleanses increases oxalate absorption, causing hyperoxaluria and acute oxalate nephropathy in patients with predisposing risk factors. Given the increasing popularity of juice cleanses, it is important that both patients and physicians have greater awareness of the potential for acute oxalate nephropathy in susceptible individuals with risk factors such as chronic kidney disease, gastric bypass, and antibiotic use.

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Teaching Cases focus on interpretation of pathology findings, laboratory tests, or imaging studies to educate readers on the diagnosis or treatment of a clinical problem.

The "green smoothie cleanse" is the exclusive consumption for 10 days of a beverage composed of green leafy vegetables, fruits, and water.[1] This general activity has been termed "juicing," which is the act of making liquid from vegetables and fruits by adding water and blending them together. There has been a growing trend of juicing for the purposes of weight loss and increasing energy.[2] Green leafy vegetables such as spinach, kale, chard, dandelion greens, beets, collard greens, and parsley are usually recommended in these regimens.[1] With the exception of kale, all these greens are rich sources of oxalates.[3,4] Table 1 lists a number of foods rich in oxalate content.[3,5]

Oxalate is a simple dicarboxylic acid, commonly found in a variety of plant products.[6] It is produced endogenously from the metabolism of amino acids and ascorbic acid or exogenously from the ingestion of an oxalate-rich diet. It is excreted exclusively by the kidney.[7] Excessive oxalate in the kidney binds to calcium, forming insoluble calcium oxalate crystals. This in turn results in several renal manifestations, including nephrolithiasis, nephrocalcinosis, and oxalate nephropathy leading to acute and chronic kidney failure.[8]

Consumption of oxalate-rich juice increases oxalate absorption, causing hyperoxaluria and acute oxalate nephropathy in patients with reduced kidney function.[2,9] We report a case of biopsy-proven acute oxalate nephropathy due to a patient with remote gastric bypass surgery and recent prolonged antibiotic use performing the green smoothie cleanse. Our case is novel because the patient had baseline normal kidney function and consumed only a 10-day course of oxalate-rich juice that resulted in acute oxalate nephropathy, ultimately leading to end-stage renal disease (ESRD).

Case Report

Clinical History and Initial Laboratory Data

A 65-year-old woman presented with 2 weeks of refractory nausea, decreased appetite, and weakness. The patient reported that she was on a weight-loss diet, but denied using herbal medications. There was no history of kidney stones or use of nephrotoxic agents. She had a history of a right upper-quadrant abdominal wall abscess 3 months prior, which was treated with percutaneous drainage and oral moxifloxacin for 6 weeks. She had a history of dyslipidemia and type 2 diabetes mellitus for 20 years with no diabetic retinopathy or hypertension. She had undergone Roux-en-Y gastric bypass (RYGB) surgery in 2003 for obesity. She maintained normal body mass index of 24.8 kg/m^2 and reported that she took supplements of calcium citrate, 1,200 mg, and vitamin D, 1,000 IU, daily.

Physical examination findings were unremarkable. Laboratory data were obtained and on presentation, the patient's serum creatinine concentration was 10.7 mg/dL (corresponding to estimated glomerular filtration rate of 4 mL/min/1.73 m^2 calculated using the 4-variable Modification of Diet in Renal Disease

Table 1. High-Oxalate–Containing Foods

Food Item	Serving Size	Oxalate Value
Vegetables and legumes		
Spinach, raw	1 cup	656 mg
Beets	½ cup	76 mg
Rhubarb	½ cup	541 mg
Navy beans	½ cup	76 mg
Okra	½ cup	57 mg
Baked potato	1 medium	97 mg
Nuts		
Almonds	1 oz	122 mg
Peanuts	1 oz	29 mg
Rice and grains		
Brown rice flour	1 cup	65 mg
Rice bran	1 cup	281 mg
Wheat berries	1 cup	98 mg
Soy flour	1 cup	94 mg
Cooked millet	1 cup	62 mg
Corn grits	1 cup	97 mg
Snacks/beverages		
Chocolate	1 cup	65 mg
Potato french fries	½ cup	51 mg
Miso soup	1 cup	111 mg

Note: Listed items contain >50 mg per average serving size.
Source: Based on references 3-5.

[MDRD] Study equation),[10] and she was nonoliguric, with a baseline creatinine concentration of 0.8 mg/dL (estimated glomerular filtration rate > 60 mL/min/1.73 m^2) 1 month prior. Laboratory test results were remarkable for hemoglobin concentration of 8.5 g/dL, decreased from a baseline value of 11.1 g/dL, and serum albumin concentration of 2.8 g/dL. Urinalysis showed bland urine with no crystals, no eosinophils, and minimal proteinuria (570 mg/g on spot urine protein-creatinine ratio). The patient was admitted to the hospital and treated with aggressive intravenous hydration and ondansetron. C3 and C4 concentrations were in the normal range, hepatitis B virus surface antigen and hepatitis C virus antibody were not detected, and serum protein electrophoresis results were unremarkable. On kidney ultrasonography, the right and left kidneys measured 11.5 and 13.2 cm, respectively, with no evidence of calculus or hydronephrosis. A kidney biopsy was performed to determine the cause of acute kidney injury.

Additional Investigations

The kidney biopsy specimen contained 27 glomeruli for light microscopy, 8 of which were globally sclerotic. Glomeruli exhibited mild diffuse and global mesangial sclerosis with rare nodularity. Glomerular basement membranes appeared mildly thickened by matrix material. Tubular lumina were distended by numerous diffuse calcium oxalate casts that appeared refractile under polarized light and stained negative with von Kossa stain, indicating the absence of phosphate (Fig 1A and B). Calcium oxalate crystals were also identified in the cytoplasm of some tubular epithelial cells, associated with widespread acute tubular epithelial injury. Approximately 40% of the cortex had patchy tubular atrophy and interstitial fibrosis with a mild chronic inflammatory infiltrate of mononuclear leukocytes (Fig 1C). No interstitial eosinophils or tubulitis were identified. There was moderate arteriosclerosis and arteriolar hyalinosis. Immunofluorescence revealed weak linear staining of glomerular and tubular basement membranes for albumin and immunoglobulin G, as commonly observed in patients with diabetes. Electron microscopy revealed oxalate crystals within the tubular lumina. The mesangial matrix and glomerular basement membranes were mildly thickened by extracellular matrix, with no evidence of electron-dense deposits.

Diagnosis

Acute oxalate nephropathy with multifocal calcium oxalate casts, acute tubular injury, moderate tubular atrophy and interstitial fibrosis, and mild diabetic glomerulosclerosis.

Clinical Follow-up

After the biopsy, a more extensive dietary history of the patient's weight-loss plan was taken. One month prior, the

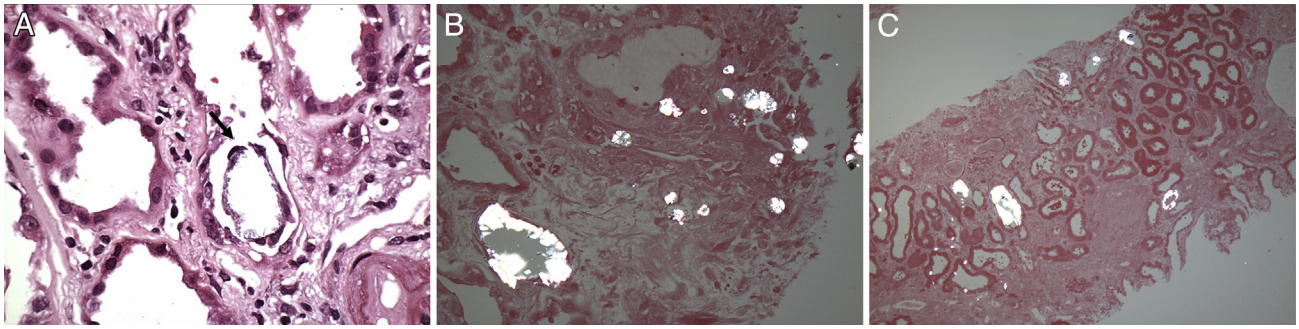

Figure 1. Kidney biopsy specimen. (A) A tubule containing an intraluminal crystalline cast (solid arrow) with simplification and focal shedding of the adjacent tubular epithelial cells (hematoxylin and eosin [H&E]; original magnification, ×600). (B) On high-power view, the multiple polarizing oxalate crystals exhibit a spoke or sheaf-like arrangement within tubular lumina, tubular cells, and the adjacent interstitium (H&E; original magnification, ×400). (C) Polarization of the histologic slide at low power shows abundant refractile oxalate casts within tubular lumina. There is focal interstitial fibrosis and tubular atrophy (H&E; original magnification, ×100).