

Onset of Ulcerative Colitis during a Low-Carbohydrate Weight-Loss Diet and Treatment with a Plant-Based Diet: A Case Report

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ABSTRACT

Overweight and obesity are global health concerns. Various effective weight-loss diets have been developed, including the Atkins diet. The Atkins diet is known as an extreme low-carbohydrate diet. This diet reduces body weight and has gained widespread popularity. However, the metabolite profiles of such a diet have been shown to be detrimental to colonic health. Therefore, a concern for the long-term health effects of this diet exists. We encountered a case in which ulcerative colitis developed while the patient was following the Atkins diet.

A man, 172 cm in height and weighing 72 kg, at age 36 years followed a low-carbohydrate weight-loss diet. His weight decreased to 66 kg as desired. Thereafter he noticed bloody stool. Colonoscopy revealed diffuse inflammation limited to the rectum, and he was diagnosed with ulcerative colitis. He underwent an educational hospitalization for ulcerative colitis. A plant-based/semivegetarian diet was provided during hospitalization. Bloody stool disappeared during hospitalization and he achieved remission without medication for inflammatory bowel disease.

This case indicates that an onset of ulcerative colitis can be an adverse event to a low-carbohydrate weight-loss diet.

INTRODUCTION

Overweight and obesity are global health concerns.¹ Various effective weight-loss diets have been developed, including the Atkins diet.²⁻⁵ The Institute of Medicine's Acceptable Macronutrient Distribution Ranges of carbohydrate, protein, and fat for energy are 45% to 65%, 20% to 35%, and 10% to 35%, respectively.³ The Atkins diet is known as an extreme low-carbohydrate weight-loss diet (LCHWLD) and results in extreme high-fat content: percentages of carbohydrate, protein, and fat are 9%, 29%, and 62%, respectively.³ This diet reduces body weight, blood pressure, and triglyceride levels and has gained widespread popularity.²⁻⁵ However, the metabolite profiles of such a diet have been shown to be detrimental to colonic health.⁶⁻⁸ For example, butyrate, a key short-chain fatty acid in colonic homeostasis, significantly decreased in fecal samples.⁶ Therefore, concerns for the long-term health effects of this diet have been expressed.^{2,3,6-8} We encountered a case that seemed to substantiate this concern, in which ulcerative colitis developed during adherence to an LCHWLD.

CASE PRESENTATION

A 38-year-old man, a physician, 172 cm in height and 67 kg in body weight, was referred to the Division of Gastroenterology in late November 2013, with a chief complaint of bloody stool. He had undergone an appendectomy for acute appendicitis at age 27 years. He had no family history of inflammatory bowel disease (IBD). He practiced martial arts in his mid-20s. His maximum body weight was 76 kg. He started to follow an LCHWLD in August 2011 (Figure 1). He decreased his white rice consumption to approximately one-third and consumed meat every day and minced or processed meat 3 to 5 servings per week (Table 1). His body weight decreased from 72 kg to 66 kg as desired, and he continued the diet. He often noticed bloody stool beginning in April 2013.

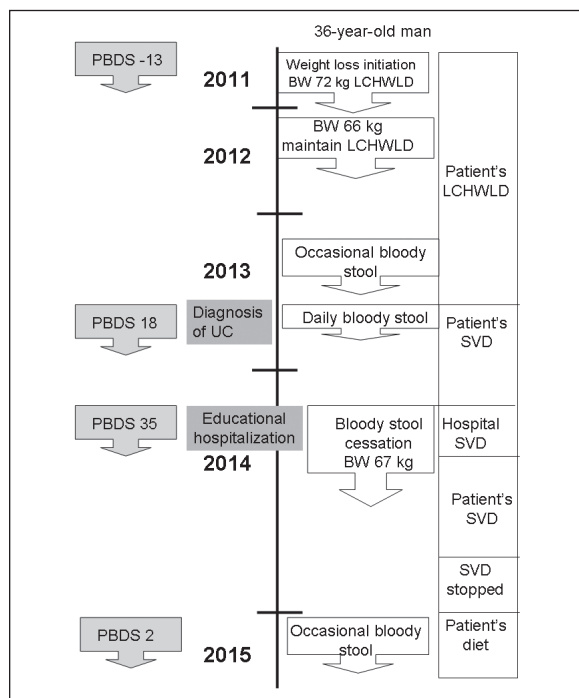


Figure 1. Timeline of case.

BW = body weight; LCHWLD = low-carbohydrate weight-loss diet; PBDS = plant-based diet score; SVD = semivegetarian diet; UC = ulcerative colitis.

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An abnormal fecal occult blood test was identified after a periodic health examination in October 2013. Colonoscopy revealed diffuse inflammation limited to the rectum (Figure 2). The histologic findings were consistent with ulcerative colitis: cryptitis, goblet cell depletion, and inflammatory cell infiltration. Results of routine laboratory studies, including a hematology study, liver and kidney function tests, C-reactive protein, and erythrocyte sedimentation rate, were normal. There was no increase in the number of eosinophils in the peripheral blood. *Clostridium difficile* antigen and toxin were not detected by a rapid membrane enzyme immunoassay (TECHLAB *C diff* Quik Chek Complete, TECHLAB Inc, Blacksburg, VA). Stool culture did not reveal any pathogen, including enterohemorrhagic *Escherichia coli*, *Campylobacter jejuni*, *Salmonella* spp, *Staphylococcus aureus*, and *Klebsiella oxytoca*. No abnormality was found in a double-contrast barium enema study. Ultimately, a proctitis type of ulcerative colitis was diagnosed.

The patient knew of a semivegetarian diet to treat IBD,⁹ and he therefore attempted to replace the LCHWLD with

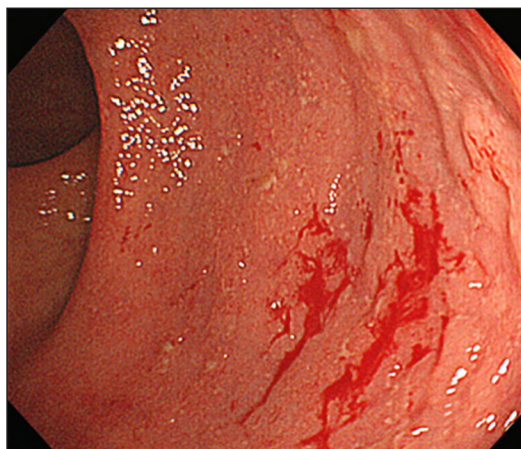


Figure 2. Photograph taken during colonoscopy. Diffuse inflammation was observed in the rectum. A small amount of blood was also observed.

Table 1. Plant-based diet score for Japanese patients with inflammatory bowel disease									
Food group	Comment	Scoring by frequency of consumption				Measured plant-based diet score			
		Daily	3-5 servings/ week	1-2 servings/ week	Rarely	Patient's LCHWLD	Patient's SVD after ulcerative colitis diagnosis	SVD during hospitalization	10 months after discharge
Vegetables	PBD, preventive factor for IBD	5	3	1	0	3	3	5	3
Fruits	PBD, preventive factor for IBD	5	3	1	0	1	1	5	1
Pulses (beans, soybeans, peas, etc)	PBD	5	3	1	0	1	3	5	1
Potatoes/starches	PBD	5	3	1	0	0	3	5	0
Rice	Washoku	5	3	1	0	5	5	5	3
Miso soup	Washoku	5	3	1	0	3	3	5	1
Green tea ^a	Washoku	5	3	1	0	0	5	0 ^a	5
Yogurt (plain)	Probiotic	5	3	1	0	0	5	5	3
Beef/pork/chicken	Western diet, risk factor for IBD	-5	-3	-1	0	-5	0	0	-1
Minced or processed meat	Western diet	-5	-3	-1	0	-3	0	0	-1
Cheese/butter/margarine	Western diet, risk factor for IBD	-5	-3	-1	0	-1	-1	0	-1
Sweets/ice cream/milk shake	Western diet, risk factor for IBD	-5	-3	-1	0	-3	-3	0	-3
Soft drinks/fruit juice	Western diet, risk factor for IBD	-5	-3	-1	0	-3	-1	0	-3
Alcohol	Risk factor for IBD	-5	-3	-1	0	-5	0	0	-1
Bread	Risk factor for Japanese IBD	-5	-3	-1	0	-5	-5	0	-5
Fish	Risk factor for Japanese IBD	-2	-1	0	0	-1	0	0	0
Plant-based diet score						-13	18	35	2

^a Green tea is recommended to drink at home but is not provided at the hospital.

IBD = inflammatory bowel disease; LCHWLD = low-carbohydrate weight-loss diet; PBD = component of plant-based diet; SVD = semivegetarian diet; Washoku = component of traditional Japanese diet.

the semivegetarian diet. Although he noticed a decrease in the amount of blood in his feces, bloody stool continued. He did not indicate any stress from his family or his work.

The patient was referred to our Division and underwent an 11-day “educational hospitalization” for ulcerative colitis¹⁰ in late March 2014. He had a good appetite and no abdominal pain. Physical examination, including of the abdomen, found no abnormalities. His retrospective food-frequency questionnaire identified plant-based diet score¹¹ was -13 (see Discussion) during an LCHWLD and +18 after the diagnosis of ulcerative colitis (Table 1). A semivegetarian diet (plant-based diet score = 35) was provided during the hospitalization (Table 1). He noticed that the bloody stool disappeared during hospitalization. At the end of the hospitalization, a fecal occult blood test showed a normal result (< 50 ng/mL). No medication was provided during hospitalization. He was advised to continue the semivegetarian diet after discharge.

The patient remained in remission until January 2015, when he again noticed faint blood in his stool every other day. His latest plant-based diet score, 10 months after discharge, was 2 (Table 1, Figure 1). He mentioned that he had been too busy to maintain a plant-based diet but would try to restore his diet to a sound plant-based diet. No medication was prescribed.

DISCUSSION

Progress in medicine has revealed that an imbalance (dysbiosis) or metabolism of gut microflora is a critical factor in various chronic diseases.¹²⁻¹⁵ It has also been shown that gut microflora is formed by diet.¹⁶⁻¹⁹ A recent large-scale prospective cohort study showed that intake of dietary fiber, nondigestible carbohydrates, reduces the risk of overall mortality and death caused by cardiovascular disease, infectious diseases, respiratory diseases, and cancer.²⁰ A low consumption of carbohydrates has been shown to result in a significantly higher risk of all-cause mortality.²¹⁻²³ These studies imply a critical role of diet and carbohydrates, particularly dietary fiber, in our health. The favorable effects of high amounts of dietary fiber in IBD have recently been stressed.²⁴

An LCHWLD is an extreme low-carbohydrate and extreme high-fat diet that results in decreased consumption of nondigestible carbohydrates.³ LCHWLD can be thought of as an extreme example of dietary westernization. Concerns for the long-term health effects of this diet have been expressed.^{2,3,6-8} Various minor adverse events associated with LCHWLD have been reported: headache, halitosis, constipation, muscle cramps, general weakness, diarrhea, and rash.²

To our knowledge, there have been no documented cases of newly diagnosed ulcerative colitis during LCHWLD. It is assumed that there are similar cases, but they have not been reported. We expect additional cases will be reported after this initial report. This case report provides additional information regarding the risk of LCHWLD.

Although the precise mechanisms have yet to be determined, epidemiology provides convincing evidence that a plant-based diet is a healthy diet providing therapeutic and/or preventive effects against current major chronic diseases.²⁵⁻²⁸ We recognize IBD as a lifestyle-related disease mediated mainly by a westernized diet. The greatest environmental factor in IBD is diet-associated gut microflora.²⁹ Diets rich in animal protein and animal fat cause a decrease in beneficial bacteria in the intestine.^{18,19,30,31} Prebiotics, foods that increase beneficial bacteria in the gut, are mostly extracts of plants.³² Therefore, a semivegetarian diet was designed to combat dietary westernization.^{9,24,29,33,34} Our semivegetarian diet is a lacto-ovo-vegetarian diet with an additional serving of fish once a week and meat once every 2 weeks.⁹ This semivegetarian diet is primarily a plant-based diet. Contemporary meals are far from a semivegetarian diet. Dietary intervention to restore dysbiosis in gut microflora is essential in the treatment of IBD. We treat patients with moderate or severe IBD with drugs and a semivegetarian diet. For mild ulcerative colitis, we recommend an educational hospitalization for about 2 weeks to familiarize patients with a semivegetarian diet.¹⁰ More than 50% of our patients experience an improvement in symptoms and/or a decrease in amount of fecal occult blood without medication by the end of hospitalization.¹⁰

To facilitate an efficient training tool regarding a plant-based diet, we developed a simple scoring method to evaluate the efficacy of a plant-based diet.¹¹ Components of the plant-based diet³⁵ with or without preventive factors for IBD are scored positively: pulses (beans, soybeans, peas), potatoes/starches, vegetables,³⁶ and fruits.³⁶ Components of a westernized diet³⁷ with or without risk factors for IBD are scored negatively: meat,^{36,38-42} minced or processed meat, cheese/butter/margarine,^{39,40,42,43} soft drinks,⁴⁴ and sweets.^{36,39,40,43,45} Components of the traditional Japanese diet, known as Washoku,⁴⁶ are scored positively: rice, miso soup, and green tea.^{39,40} Risk factors for IBD in Japanese individuals are scored negatively: fish^{41,45} and bread.⁴³ Plain yogurt, a probiotic, is scored positively. Alcohol is scored negatively.⁴⁷ Scores of 5, 3, and 1 are given for each food group according to the frequency of consumption, as shown in Table 1. A plant-based diet score is developed from the sum of plus and minus scores (Table 1). The maximum positive score is 35 for inpatients and 40 for outpatients because green tea is not provided as a drink at the hospital. The maximum negative score is -37. A higher plant-based diet score indicates a greater adherence to a plant-based diet.

In this case, a plant-based diet score of -13 was obtained during the patient's LCHWLD; a score of 18, during the patient's designed semivegetarian diet after the ulcerative colitis diagnosis; and a score of 35, while receiving the hospital's semivegetarian diet (Table 1). He achieved remission with the hospital's semivegetarian diet. In this case of mild inflammation, medication was unnecessary to induce remission. Although a plant-based diet was recommended as a dietary pattern as part of his lifestyle, it was not attained in

Although the precise mechanisms have yet to be determined, epidemiology provides convincing evidence that a plant-based diet is a healthy diet providing therapeutic and/or preventive effects against current major chronic diseases.

this case. His latest plant-based diet score was only 2, and he had very mild symptoms of ulcerative colitis.

Dietary fiber affects production of short-chain fatty acids, including butyrate, through fermentation of *Faecalibacterium prausnitzii* and *Roseburia* spp. Butyrate plays a major role in gut homeostasis owing to a variety of functions, including anti-inflammation, modulation of oxidative stress, energy for colonocytes, maintenance of epithelial permeability, and maintenance in gut barrier integrity.^{6-8,20,48} Short-chain fatty acid lowers stool pH, resulting in suppression of potentially pathogenic bacteria.⁴⁹ An LCHWLD is definitely deprived of dietary fiber.³ Short-chain fatty acids including butyrate, stool pH, and gut microflora were not studied in this patient. It is plausible that LCHWLD in a susceptible individual can cause dysbiosis of gut microflora, low production of butyrate, elevation of stool pH, disruption of homeostasis, and onset of ulcerative colitis. The patient's chronology, onset of ulcerative colitis during LCHWLD, and amelioration associated with shifting of the diet to a semivegetarian diet, indicate that dietary factors played a critical role in this case.

CONCLUSION

Weight loss diets that are low in carbohydrates are popular among obese people despite concern over the long-term adverse health effects. We encountered a case that seemed to substantiate this concern. Namely ulcerative colitis that apparently developed during adherence to an LCHWLD. Although we recognize that ulcerative colitis was not documented before the initiation of an LCHWLD, this case represents the possibility of one adverse reaction and how ulcerative colitis was treated in our patient. This case report provides additional information regarding the risk of an LCHWLD. We recommend a prospective investigation to look further into this possibility.

Diet-associated gut dysbiosis is becoming a leading environmental factor in a variety of current chronic diseases. A plant-based diet is advocated to counter these diseases. Ulcerative colitis is not an exception. A novel frontline approach consisting of dietary manipulation (ie, semivegetarian diet) induced remission without medication in this case. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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A Gold Coin

It soon became evident that appendicitis was on its last legs, and that a new complaint had to be discovered to meet the demand. The Faculty was up to the mark, a new disease was dumped on the market, a new word was coined, a gold coin indeed, COLITIS.

— *The Story of San Michele*, Axel Munthe, 1857-1949, Swedish physician