

BRIEF COMMUNICATION

A Very Low-Carbohydrate Diet Improves Symptoms and Quality of Life in Diarrhea-Predominant Irritable Bowel Syndrome

GREGORY L. AUSTIN,* CHRISTINE B. DALTON,[†] YUMING HU,[‡] CAROLYN B. MORRIS,[‡] JANE HANKINS,[‡] STEPHAN R. WEINLAND,[‡] ERIC C. WESTMAN,[§] WILLIAM S. YANCY JR,^{§,||} and DOUGLAS A. DROSSMAN[‡]

*Division of Gastroenterology and Hepatology, University of Colorado Denver, Aurora, Colorado; [†]University of North Carolina Center for Functional GI and Motility Disorders, Division of Gastroenterology and Hepatology, University of North Carolina, Chapel Hill; [‡]Division of General Internal Medicine, Duke University, Durham; and [§]Center for Health Services Research in Primary Care, Department of Veterans Affairs Medical Center, Durham, North Carolina

Background & Aims: Patients with diarrhea-predominant irritable bowel syndrome (IBS-D) anecdotally report symptom improvement after initiating a very low-carbohydrate diet (VLCD). This study prospectively evaluated a VLCD in IBS-D. **Methods:** Participants with moderate to severe IBS-D were provided a 2-week standard diet, then 4 weeks of a VLCD (20 g carbohydrates/d). A responder was defined as having adequate relief of gastrointestinal symptoms for 2 or more weeks during the VLCD. Changes in abdominal pain, stool habits, and quality of life also were measured. **Results:** Of the 17 participants enrolled, 13 completed the study and all met the responder definition, with 10 (77%) reporting adequate relief for all 4 VLCD weeks. Stool frequency decreased ($2.6 \pm 0.8/d$ to $1.4 \pm 0.6/d$; $P < .001$). Stool consistency improved from diarrheal to normal form (Bristol Stool Score, 5.3 ± 0.7 to 3.8 ± 1.2 ; $P < .001$). Pain scores and quality-of-life measures significantly improved. Outcomes were independent of weight loss. **Conclusions:** A VLCD provides adequate relief, and improves abdominal pain, stool habits, and quality of life in IBS-D.

Irritable bowel syndrome (IBS) is a heterogeneous disorder, and subclassifications of diarrhea-predominant IBS (IBS-D) and constipation-predominant IBS have been identified.¹ However, the pathophysiology of IBS is not well understood. The role of diet in IBS has been investigated because patients frequently identify worsening of symptoms after meals and often cite particular foods as triggers of their IBS symptoms.² Nevertheless, data from clinical trials are insufficient to allow for specific dietary recommendations.³⁻⁵

Previous research has suggested a role for dietary carbohydrates in worsening IBS symptoms.^{6,7} Our combined clinical experience indicates that patients with IBS-D report improvement in their gastrointestinal symptoms after initiating a very low-carbohydrate diet (VLCD). The purpose of this study was to assess prospectively the effect of a VLCD on gastrointestinal symptoms and quality of life among patients with IBS-D.

Methods

Subjects

A total of 17 participants who met Rome II criteria for IBS-D were enrolled in this study.⁸ Only individuals with mod-

erate or severe symptoms were included, based on a score of greater than 36 using the Functional Bowel Disorder Severity Index.⁹ Participants were required to have a body mass index of greater than 25 kg/m². Individuals with a history of inflammatory bowel disease, any gastrointestinal surgery, diabetes or other serious medical conditions, previous use of a VLCD, or use of narcotics or weight-loss medications were ineligible. Antidepressants were allowed if the dose had been stable for at least 4 weeks before enrollment. Routine blood tests were performed to exclude other disorders that might produce symptoms similar to IBS-D. All subjects provided written informed consent, and the study was approved by the institutional review board of the University of North Carolina.

Study Design and Diet

All prospective participants met with a dietitian before study enrollment. All meals were provided for all 6 weeks of the study by the metabolic kitchen of the adult General Clinical Research Center at the University of North Carolina. The energy content provided in the meals was designed to achieve weight maintenance for the entire study period. Estimates of energy expenditure were calculated using the Harris-Benedict equation with an adjustment for activity level.¹⁰ A standard diet was provided for the first 2 weeks of the study, approximating the diet for the average adult American, according to the National Health and Nutrition Examination Survey.¹¹ Approximately 55% of calories were from carbohydrates, 30% from fat, and 15% from protein. During the final 4 weeks, participants consumed a VLCD in which carbohydrates were limited to 20 g/d. For the VLCD, approximately 51% of calories were from fat, 45% from protein, and 4% from carbohydrates. This distribution is consistent with diets used in previous studies evaluating VLCDs.^{12,13} Participants received meals 3 times a week. They returned any uneaten portions to the General Clinical Research Center so that actual energy intake could be calculated. Participants also strongly were discouraged from consuming any

Abbreviations used in this paper: IBS, irritable bowel syndrome; IBS-D, diarrhea-predominant irritable bowel syndrome; VLCD, very low-carbohydrate diet.

© 2009 by the AGA Institute
1542-3565/09/\$36.00
doi:10.1016/j.cgh.2009.02.023

food other than what was provided to them by the General Clinical Research Center kitchen.

Outcomes

The primary outcome was adequate relief of IBS-D symptoms during the VLCD phase.¹⁴ Participants completed a 1-item questionnaire at the end of each of the 4 weeks of the VLCD, assessing whether they had adequate relief of their IBS symptoms for the week. A responder was defined as reporting adequate relief in at least 2 of the 4 weeks on the VLCD. Participants also completed daily diary cards for all 6 weeks of the study. They recorded the number of bowel movements for each day, stool consistency (using the Bristol Stool Score, which ranges from 1 [hard/lumpy] to 7 [watery]), and abdominal pain.¹⁵ Daily abdominal pain scores were assessed using a 100-mm visual analog scale, with scores ranging from 0 (no pain) to 100 (severe pain). The Irritable Bowel Syndrome Quality of Life¹⁶ and Sickness Impact Profile¹⁷ questionnaires were completed at the end of the 2-week standard diet and again at the completion of the 4-week VLCD.

Statistical Methods

Paired *t* tests were used to analyze changes in Irritable Bowel Syndrome Quality of Life and Sickness Impact Profile scores. Trend regression analysis was used to assess changes in average abdominal pain rating, stool frequency, and stool consistency during the 4 weeks of the VLCD compared with the 2 weeks of the standard diet. We made an a priori decision to evaluate whether outcomes were different between individuals who lost more than 3 kg compared with those who lost less than 3 kg. Data were analyzed using SAS V.8.0 (SAS Institute Inc, Cary, NC).

Results

A total of 17 individuals were enrolled. The participants were predominantly women ($n = 15$) and white ($n = 14$). The mean (\pm standard deviation) age in years was 46 ± 10 , and the mean body mass index was 32.0 ± 4.8 kg/m². One participant dropped out during week 1 of the study (intolerance of standard diet), and 3 participants dropped out during week 3 of the study (2 because of intolerance of the VLCD and 1 because of emotional symptoms), and 13 participants completed all 6 weeks. All 13 participants who completed the study were responders who reported adequate relief of IBS-D symptoms for

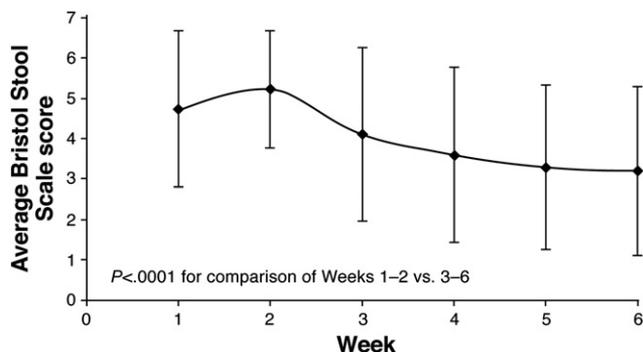


Figure 1. Average daily Bristol Stool Score during the standard diet (weeks 1–2) and the VLCD (weeks 3–6).

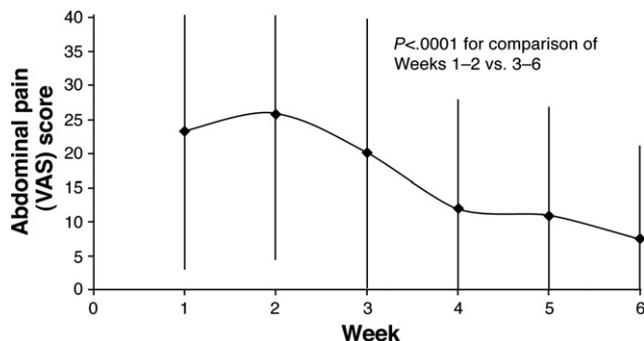


Figure 2. Average daily abdominal pain score during the standard diet (weeks 1–2) and the VLCD (weeks 3–6).

at least 2 of the 4 weeks during the VLCD, and 10 participants (77%) reported adequate relief for all 4 weeks (Supplementary Table 1). All 13 participants reported adequate relief in the last week of the VLCD.

With regard to secondary outcomes, participants reported a significant decrease in stool frequency with the VLCD, decreasing from 2.6 ± 0.8 bowel movements/day during the standard diet to 1.4 ± 0.6 bowel movements/day during the VLCD ($P < .001$). Participants reported an improvement in stool consistency (Figure 1), with the average Bristol Stool Score decreasing from 5.3 ± 0.7 on the standard diet to 3.8 ± 1.2 during the VLCD ($P < .001$). Abdominal pain scores improved (Figure 2), with average daily abdominal pain scores decreasing from 26 ± 18 during the standard diet to 10 ± 10 during the VLCD ($P = .007$).

Quality of life was improved significantly with the VLCD when compared with the participant's standard diet. Irritable Bowel Syndrome Quality of Life scores improved from 71 ± 22 on the standard diet to 81 ± 13 ($P = .02$) on the VLCD. Sickness Impact Profile scores improved from 5.5 ± 6.4 on the standard diet to 2.3 ± 3.6 on the VLCD ($P = .001$). Finally, participants did lose an average of 3.1 ± 1.7 kg during the study ($P < .0001$), but improvement for all outcomes was similar for those who lost less than 3 kg ($n = 6$) compared with those who lost more than 3 kg ($n = 7$).

Discussion

The purpose of this prospective trial was to assess the effect of a VLCD in patients with IBS-D. The results provide preliminary evidence that a VLCD provides adequate relief of IBS-D symptoms, decreases abdominal pain, improves stool frequency and consistency, and improves quality of life. All 13 participants who completed the 6-week study reported adequate relief of their IBS-D symptoms for at least 2 of the 4 weeks. More impressively, 10 of these 13 participants reported adequate relief for all 4 weeks.

This study assessed the effect of a low-carbohydrate diet in individuals with IBS-D, although previous research has investigated the role of carbohydrates in IBS.^{6,7} One study of 239 individuals with either IBS or nonspecific functional bowel complaints showed an improvement in symptoms after elimination of some combination of sorbitol, lactose, or fructose for 1 month.⁶ In addition, King et al⁷ found that individuals with IBS have abnormal colonic fermentation of carbohydrates. They found that an exclusion diet that reduced the load of potential

offending carbohydrates improved IBS symptoms. However, several studies have shown similarly high rates of abnormal colonic fermentation of carbohydrates in healthy volunteers.^{18,19} Also, not all studies have shown benefit when the potential offending carbohydrate is removed from the diet.²⁰

This study had a few limitations. Our study represents the experience of 17 individuals, with 13 participants completing all 6 weeks. The results must be confirmed in larger numbers. Three participants who dropped out did so primarily because of difficulty following a restrictive diet. There is no a priori reason why the drop-out group would be different from those who completed the study with regard to treatment benefit. The other main limitation was the lack of a standard control group. Although participants served as their own control for several outcomes, a placebo effect may explain the positive findings, particularly for subjective outcomes such as abdominal pain. However, the use of daily diary cards helped to obviate subjective interpretation or recall bias by providing a systematic and objective measure of daily bowel habits. Finally, most of the participants were women who were overweight or obese, so it is uncertain if these responses would be seen in men or normal-weight individuals.

Despite these limitations, this study found objective evidence that overweight and obese individuals initiating a VLCD had a profound clinical response in their IBS-D symptoms. This finding requires further investigation to identify mechanisms by which a VLCD affects the symptoms of IBS-D. This will elucidate additional dietary and pharmacologic methods for managing patients with IBS-D.

Supplementary Data

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org.

References

- Longstreth GF, Thompson WG, Chey WD, et al. Functional bowel disorders. In: Drossman DA, Corazziari E, Delvaux M, et al, eds. Rome III: the functional gastrointestinal disorders. 3rd ed. McLean, VA: Degnon Associates, Inc, 2006:487–555.
- Simren M, Mansson A, Langkilde AM, et al. Food-related gastrointestinal symptoms in the irritable bowel syndrome. *Digestion* 2001;63:108–115.
- Burden S. Dietary treatment of irritable bowel syndrome: current evidence and guidelines for future practice. *J Hum Nutr Diet* 2001;14:231–241.
- Dapoigny M, Stockbrugger RW, Azpiroz F, et al. Role of alimentation in irritable bowel syndrome. *Digestion* 2003;67:225–233.
- Floch MH. Use of diet and probiotic therapy in the irritable bowel syndrome: analysis of the literature. *J Clin Gastroenterol* 2005;39:S243–S246.
- Goldstein R, Braverman D, Stankiewicz H. Carbohydrate malabsorption and the effect of dietary restriction on symptoms of irritable bowel syndrome and functional bowel complaints. *Isr Med Assoc J* 2000;2:583–587.
- King TS, Elia M, Hunter JO. Abnormal colonic fermentation in irritable bowel syndrome. *Lancet* 1998;352:1187–1189.
- Thompson WG, Longstreth GF, Drossman DA, et al. Functional bowel disorders and D. Functional abdominal pain. In: Drossman DA, Talley NJ, Thompson WG, et al, eds. Rome II: functional gastrointestinal disorders: diagnosis, pathophysiology, and treatment. 2nd ed. McLean, VA: Degnon Associates, Inc, 2000:351–432.
- Drossman DA, Li Z, Toner BB, et al. Functional bowel disorders. A multicenter comparison of health status and development of illness severity index. *Dig Dis Sci* 1995;40:986–995.
- Pellett PL. Food energy requirements in humans. *Am J Clin Nutr* 1990;51:711–722.
- Wright SD, Kennedy-Stephenson J, Wang CY, et al. Trends in intake of energy and macronutrients—United States, 1971–2000. *MMWR Morb Mortal Wkly Rep* 2004;53:80–82.
- Foster GD, Wyatt HR, Hill JO, et al. A randomized trial of a low-carbohydrate diet for obesity. *N Engl J Med* 2003;348:2082–2090.
- Yancy WS Jr, Olsen MK, Guyton JR, et al. A low-carbohydrate, ketogenic diet versus a low-fat diet to treat obesity and hyperlipidemia: a randomized, controlled trial. *Ann Intern Med* 2004;140:769–777.
- Irvine EJ, Whitehead WE, Chey WD, et al. Design of treatment trials for functional gastrointestinal disorders. In: Drossman DA, Corazziari E, Delvaux M, et al, eds. Rome III: the functional gastrointestinal disorders. 3rd ed. McLean, VA: Degnon Associates, Inc, 2006:779–834.
- Lewis SJ, Heaton KW. Stool form scale as a useful guide to intestinal transit time. *Scand J Gastroenterol* 1997;32:920–924.
- Drossman DA, Patrick DL, Whitehead WE, et al. Further validation of the IBS-QOL: a disease-specific quality-of-life questionnaire. *Am J Gastroenterol* 2000;95:999–1007.
- Bergner M, Bobbitt RA, Carter WB, et al. The Sickness Impact Profile: development and final revision of a health status measure. *Med Care* 1981;19:787–805.
- Lea R, Whorwell PJ. The role of food intolerance in irritable bowel syndrome. *Gastroenterol Clin North Am* 2005;34:247–255.
- Fernandez-Banares F, Esteve-Pardo M, de Leon R, et al. Sugar malabsorption in functional bowel disease: clinical implications. *Am J Gastroenterol* 1993;88:2044–2050.
- Tolliver BA, Jackson MS, Jackson KL, et al. Does lactose maldigestion really play a role in the irritable bowel? *J Clin Gastroenterol* 1996;23:15–17.

Reprint requests

Address requests for reprints to: Gregory L. Austin, MD, MPH, 12631 East 17th Avenue, Room 7609, University of Colorado Denver, Aurora, Colorado 80045. e-mail: gregory.austin@uchsc.edu; fax: (303) 724-1858.

Conflicts of interest

The authors disclose no conflicts. The sponsors were not involved in the data collection, data analysis, or data interpretation in preparing this manuscript.

Funding

This research was supported by a research grant from the Atkins Foundation, the University of North Carolina Gastrointestinal Biopsychosocial Research Center (National Institutes of Health R24 DK067674), and in part by a grant from the National Institutes of Health (T32 DK 07634). Facility support for this study has been provided by the University of North Carolina General Clinical Research Center.

Supplementary Table 1. Adequate Relief During the Very Low-Carbohydrate Diet

Participant	Week 3 Adequate Relief	Week 4 Adequate Relief	Week 5 Adequate Relief	Week 6 Adequate Relief	Total Weeks with Adequate Relief
1	+	+	+	+	4
2	+	+	+	+	4
3	+	+	-	+	3
4	+	+	+	+	4
5	-	-	+	+	2
6	+	+	+	+	4
7	+	+	+	+	4
8	+	+	+	+	4
9	+	+	+	+	4
10	+	-	-	+	2
11	+	+	+	+	4
12	+	+	+	+	4
13	+	+	+	+	4
Total	12	11	11	13	