Short Communication

Efficacy of a Plant-based Diet (Semi-lacto-ovo-vegetarian Diet) for Treating Constipation

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Abstract

A modern lifestyle, including dietary westernization, has increased the prevalence of constipation. The authors developed a plant-based diet for inflammatory bowel disease. This study investigated whether a diet containing a high amount of dietary fiber is also effective for constipation. Consecutive patients with constipation were recruited in this study from April 2003 to March 2004. Their constipation was unresponsive to a conventional laxative. The patients were provided a plant-based diet during hospitalization for around two weeks. The plant-based diet was a semi-lacto-ovo-vegetarian diet: unrefined whole brown rice, fish once a week, and meat once every two weeks. The diet contained 29.9±1.9 g of dietary fiber/1,700 kcal. The plant-based diet score, where a higher score indicates greater adherence to the plant-based diet, was 35. A diet of 30 kcal/kg of standard body weight was provided.

Defecation within two days with the diet alone or in combination with laxatives was regarded as highly effective and effective, respectively. Eleven patients (three men and eight women, 16 to 92 years old; median age: 70 years) were included; seven patients had no complications of constipation, but the remaining four patients had complications that included fecal impaction, megabowel, colonic pseudo-obstruction, and abdominal distention. Among the seven patients with uncomplicated constipation, the diet was highly effective in six patients and ineffective in one patient. It was effective in all four patients with complicated constipation. There were no adverse effects of the diet. The mean plant-based diet score before hospitalization in nine cases was 18.0. A clinical path of 13 days of hospitalization for the management of uncomplicated constipation was designed. The plant-based diet was safe and highly effective for uncomplicated constipation and effective for complicated constipation. A plant-based diet can be introduced as a special meal in a hospital setting for patients suffering from serious constipation.

Keywords

Constipation; lifestyle medicine; lifestyle disease; semi-lacto-ovo-vegetarian diet; plant-based diet; plant-based diet score; whole grain; brown rice; educational hospitalization; case series

1. Introduction

Functional constipation is a common condition in the community. The prevalence of constipation differs depending on whether the data are based on self-reporting, questionnaires, or diagnostic criteria, such as the Rome criteria. Approximately 14% of adults were reported to suffer from constipation in a systemic review by Suares et al. (2011) [1]. The prevalence of constipation based on the Rome IV criteria in 2015 was 7.9%-8.6% in the United States, Canada, and United Kingdom [2], but it was reported to be only 2% in the United States in 1989 [3, 4]. Thus, the prevalence of constipation in the United States is increasing. The prevalence is higher in women and increases with age [1–4]. In Japan, the prevalence is lower than that reported above. It was 2.5% in 1992 [5], 3.6% in 2001 [6], and 3.5% in 2019 [7], according to a national survey conducted by a self-report questionnaire. Constipation negatively affects the quality of life of the patients [4]. Furthermore, constipation is associated with a higher risk of all-cause mortality, coronary heart disease, ischemic stroke, and chronic kidney disease [8–10]. Therefore, treatment of constipation might not only normalize bowel movements but also reduce the risk of these extraintestinal diseases. Gut microbial imbalance (dysbiosis) observed in constipation is a potential factor related to the underlying mechanisms of the observed association [11, 12]. As the gut microbiota can be influenced by diet [13], potential treatments of dysbiosis have been reported by the addition of probiotics, prebiotics, or synbiotics to the diet [14]. Moreover, changing the diet to a plant-based one has also been suggested [15].

Dietary transition through either economic growth or development of the food industry and urbanization has induced global dietary westernization [16–18]. Current global consumption consists of unhealthy foods such as red meat and sugar and a low frequency of consumption of healthy foods such as vegetables, fruits, whole grains, and nuts [19]. This causes diet-related obesity

and chronic diseases, including type 2 diabetes, metabolic syndrome, coronary heart disease, and stroke [19]. It may cause constipation due to low consumption of dietary fiber. Japan also experienced dietary westernization. Data from Japan showed an increase in the incidence of inflammatory bowel disease (IBD), a collective term for ulcerative colitis and Crohn's disease, associated with dietary transition (westernization) [20]. Although the etiology of IBD is unknown, the authors believe that a westernized diet is the most ubiquitous environmental factor in IBD [21]. Consequently, we developed a plant-based diet (PBD), i.e., a semi-lacto-ovo-vegetarian diet, for IBD. The incorporation of a PBD for treatment provides considerably better outcomes in IBD, and thus, we had previously recommended a PBD for treating IBD [22].

Fundamental medical research has revealed the interplay between diet, gut microbiota, microbial metabolites, and health/disease [13, 15]. The westernized diet tends to decrease microbial diversity (resulting in dysbiosis), while PBDs tend to increase microbial diversity. This difference in microbiota results in differences in microbial metabolites. Westernized diets are pro-inflammatory, while PBDs are anti-inflammatory [13, 15]. Epidemiology has shown that PBDs prevent chronic diseases and increase the lifespan, relative to the effects of omnivorous diets. Therefore, PBDs are recommended to people of all ages [19, 23, 24].

Although the addition of dietary fibers to the diet of patients with constipation increases stool frequency, it does not improve stool consistency, treatment success, and painful defecation [25]. Intervention studies of PBDs for constipation are extremely limited [26]. In this study, we examined whether a PBD was effective for constipation unresponsive to conventional laxatives. We hypothesized that a PBD rich in dietary fiber would ameliorate constipation.

2. Materials and Methods

2.1 Patient Selection

Consecutive patients with a chief complaint of constipation, defined as the passage of fewer than three bowel movements per week, who met all the following criteria were enrolled between April 2003 and March 2004: 1) able to walk and eat meals without help, 2) eager to improve their constipation, 3) willing to be admitted for 7-10 days, 4) willing to try to eat brown rice during the stay, and 5) willing to continue eating a PBD in the future if the PBD is effective for constipation. The following patients were excluded: 1) patients with constipation being managed with conventional laxatives and 2) patients complaining of constipation, where the condition is caused by an organic lesion.

Complications of constipation include fecal impaction and megabowel (collective term for megacolon and megarectum) [4]. Megabowel is expressed as abdominal distention. Megabowel with constipation often forms air-fluid level(s) in the colon and is diagnosed as colonic pseudo-obstruction. In this study, megabowel was diagnosed based on the criteria proposed by Preston et al. [27]. By examining double-contrast barium enema films or plain films of the abdomen, the diameter of the contour of the large bowel was measured, and megabowel was diagnosed when it was more than 6.5 cm for the rectosigmoid or descending colon, 8 cm for the transverse and ascending colon, and 12 cm for the cecum [27]. The plain films of the abdomen were examined to evaluate whether such complications were present before hospitalization.

2.2 Hospitalization for Constipation

To examine the possibility of secondary constipation associated with hypothyroidism, diabetes mellitus, progressive systemic sclerosis, or muscle dystrophy, blood tests were conducted before or immediately after hospitalization [4]. Blood tests included thyroid-stimulating hormone, free T3, free T4, fasting blood glucose, glycated hemoglobin A1c (HbA1c), anti-centromere antibody, anti-Scl-70 antibody, and creatine phosphokinase. Abdominal sonography and esophagogastroduodenoscopy were performed in the second week of admission. Barium enema or colonoscopy was performed at the end of admission to confirm that colorectal cancer was absent. A qualified dietitian provided dietary guidance to the patient and the person who generally prepared the patient's meals at the end of hospitalization regarding how to boil brown rice. The patients were discharged when the number of bowel movements increased to more than three bowel movements per week.

2.3 Plant-based Diet

2.3.1 Plant-based Diet (PBD)

The staple food in the PBD was unrefined whole brown rice [28]. Brown rice contains more vitamins, minerals, and dietary fiber than conventional refined white rice (Figure 1) [28, 29]. Eggs and milk were included in the PBD. Fish was served once a week, and meat was served once every two weeks, both at about 50 g and 30 g, respectively. About 30 kcal per kg of standard body weight was given. The mean ±SD % of protein, fat, and carbohydrate in the diet was 16.5 ±0.5, 18.0 ±1.5, and 66.5 ±1.6, respectively. In the case of a 1,700-kcal diet, it contained 29.9 ±1.9 g of dietary fiber, 17.1 ±1.0 mg of iron, 10.6 ±1.0 g of salt, and 225.3 ±90 mg of cholesterol. The details of the PBD are shown in Figure 2 [28]. Consumption of foods other than those on the meal service was discouraged. Coarse tea (bancha), a kind of green tea made from low-quality leaves, was served along with the meal. Consumption of green tea after discharge was encouraged.
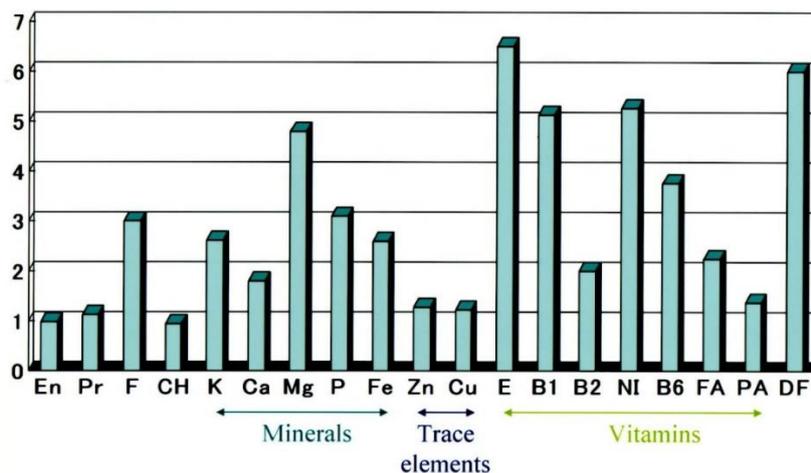
Figure 1 The nutritional elements of unrefined whole brown rice compared to those of refined white rice. This figure was created based on a book titled "Table of nutritional element analysis of Japanese food" [29]. The amount of elements in 100 g of edible food is expressed relative to that in refined rice, whose value is one. Brown rice is richer in almost all items. En: energy; Pr: protein; F: fat; CH: carbohydrate; K: potassium; Ca: calcium; Mg: magnesium; P: phosphorus; Fe: iron; Zn: zinc; Cu: copper; NI: niacin; FA: folic acid; PA: pantothenic acid; DF: dietary fiber.

Figure 2 A plant-based diet. The figure shows an example of a 1,700-kcal/day plant-based diet. From left to right: breakfast, lunch, and dinner, respectively. Boiled brown rice is at the bottom left of the tray, and miso (fermented bean paste) soup is at the bottom right. Breakfast: raw grated nagaimo (yam) and shreds of toasted nori seaweed at the top left, natto (fermented soybeans) and grated daikon (Japanese radish) at the top right, and braised hijiki seaweed, nama-age (thick, deep-fried bean curd), and edamame (young soybeans) in the center. Lunch: boiled potato, onion, and corn in tomato soup at the top left, isomaki-tamago (dried nori seaweed inside egg roll) and boiled chrysanthemum with sesame dressing at the top right, takuan (pickled radish) in the center, and a mixture of banana and plain yoghurt at the bottom right. Dinner: boiled chingensai (qing gin cai), soybeans, and wakame seaweed with vinegar soy sauce dressing at the top left, simmered ganmodoki (bean-curd-based mixture), tofu (bean curd), boiled egg, Japanese-variety eggplant, Japanese butterbur, Japanese-variety pumpkin, and snow peas at the top right, and the citrus fruit iyo in the center.

2.3.2 Plant-based Diet Score (PBDS)

A PBDS for Japanese patients with IBD was calculated based on a questionnaire. The method for calculating the PBDS has been described previously [30]. Briefly, eight items considered to be preventive factors for IBD (vegetables, fruits, pulses, potatoes/starches, rice, plain yogurt, miso soup, and green tea) were assigned a positive score, and eight items considered to be IBD risk factors (meat, minced or processed meat, cheese/butter/margarine, sweets, soft drinks, fish, bread, and alcohol) were assigned a negative score. The PBDS was calculated as the sum of the positive and negative scores. A higher PBDS indicated greater adherence to the PBD. The PBDS of the PBD during hospitalization was 35 [30].

2.4 Medication for Constipation

Laxatives were not administered for uncomplicated, simple constipation. Patients with complications of constipation were treated as follows. When the patient's appetite was poor due to a complication, fluids and electrolytes were replaced intravenously. Otherwise, consumption of a PBD and bananas was encouraged. Removal of hard stool in fecal impaction was attempted via enema with 4 g of carmellose sodium (Bulkose[R]) in 400 mL of water a day [31] and oral administration of magnesium oxide and casanthranol/dioctyl sodium sulfosuccinate (Vemas Combination Tab[R]). Since beneficial bacteria are known to be a laxative [32, 33], probiotics, including two capsules of Bificolon[R] (Nishin-Kyorin, Tokyo) a day and 400–500 g/day of plain yogurt, were also given. One capsule of Bificolon contains 2×10^9 *Bifidobacterium longum,* and the capsule can deliver viable bacteria to the colon.

2.5 Evaluation of Efficacy

When defecation occurred once a day or every two days only due to the consumption of the PBD, it was considered highly effective. When it occurred due to the combination of the PBD with other modalities such as laxatives and probiotics, it was considered to be effective. When bowel movement was unchanged, it was considered to be ineffective.

2.6 Designing a Clinical Path

A clinical path is useful for both patients and staff. A rough clinical path during hospitalization for the management of simple constipation with the PBD was designed.

2.7 Statistical Analysis

We set a hospitalization of 10 days to two weeks for treatment of constipation. A Chi-square test was performed to evaluate the hypothesis that there was no difference in the days of hospitalization between patients with simple constipation and those with complicated constipation. The differences were considered to be statistically significant at $P \leq 0.05$. All statistical analyses were performed using JMP 8 (SAS Institute Inc., Cary, NC, USA).

2.8 Ethics Statement

The study conformed to the ethical principles of the Declaration of Helsinki (1975). Mitsuro Chiba obtained written informed consent from all participants.

3. Results

3.1 Patients

Eleven patients, including three men and eight women, participated in the study (Table 1). The median age was 70.0 years (IQR 56.0–82.0). Seven patients had simple constipation, and the remaining four had complications with or without overlapping: fecal impaction (Figure 3), megabowel (Figure 3), abdominal distention (Figure 3), and colonic pseudo-obstruction. Three patients were brought to our hospital in an ambulance because of abdominal pain associated with constipation. Feces were removed manually in two cases. Case 6 felt fear of gut rupture, and case 3 felt fear of death due to laxative use. Of the eleven patients, one had diabetes mellitus, and two had impaired glucose tolerance. Two patients were taking anti-depressants that caused constipation as a side effect. None of the patients tested positive in a screening test for thyroid disease, progressive systemic sclerosis, or muscular dystrophy, which might cause constipation. None of the patients had colorectal cancer. The mean duration of admission was 13.0 ±3.9 days for patients with simple constipation and 31.5 ±16.1 days for patients with complicated constipation (P < 0.05). The details of the patients are presented in Table 1. The PBDS was not available in two cases due to an error. The PBDS of nine patients is presented in Table 2. The mean PBDS was 18.0 ±10.7.

Table 1 A plant-based diet (PBD) for treating constipation.

Case	Sex	Age	Condition of constipation*	Associated condition# DM	Anti depressants	Others	Laboratory tests	Use of laxative† during admission (other treatment)	Duration of stay (days)	**Efficacy of PBD§**
Simple (uncomplicated) constipation										
1	f	16	Laxative tends to be ineffective	−	−	−	FBS	−	8	◎
2	f	56	Use of laxatives for 30 years	IGT	−	−	FBS	−	19	×
3	f	70	A fear of death by a new laxative	−	−	−	FBS	−	15	◎
4	f	72	Am, ER, DE	+	+	Hypertension	Set	−	15	◎
5	f	82	Abdominal pain due to a laxative	−	−	Arthrosis (knee)	FBS	−	14	◎
6	m	56	A fear of rupture of the gut	−	−	Hypertension	Set	−	11	◎
7	m	92	Constipation for 12 years	IGT	−	−	FBS	−	9	◎
Complicated constipation										
8	f	59	DE Megacolon (transverse colon)	−	+	DEP, SD	FBS	Se	15	○
9	f	55	Am 2 times Fecal impaction	−	−	Coloptosis	FBS TSH T3 T4	Ve, Mo, Cs enema (Bi, Py, banana)	25	○
10	m	80	Am 3 times, constipation for 12 days Fecal impaction, megacolon, & pseudo-obstruction	−	−	Influenza A during stay	Set	Ve, Mo, Cs enema (Bi, Py, banana)	33	○
11	f	85	Megarectum & megacolon with abdominal distension	−	−	CVA Hypertension	FBS TSH T3 T4	Ve, Mo, Cs enema (Bi, Py, banana)	53	○

*Am: visited by an ambulance; ER: visited an emergency room; DE: digital evacuation

[#]DM: diabetes mellitus; IGT: impaired glucose tolerance test; DEP: depression; CVA: cerebral vascular accident; SD: spondylosis deformans

[¶]FBS: fasting blood sugar; TSH: thyroid-stimulating hormone; T3: free T3; T4: free T4

Set: FBS, HbA1c, TSH, T3, T4, anti-centromere antibody, anti-Scl-70 antibody, and creatine phosphokinase

[†]Se: senna; Ve: vemas combination tabR; Mo: magnesium oxide; Cs: carmellose sodium; Bi: Bificolon; Py: plain yoghurt

[§]◎: constipation solved solely by a PBD; ○: constipation solved by a PBD & others; ×: constipation unchanged by a PBD

Table 2 The plant-based diet score (PBDS) for Japanese patients.

Food group	Scoring by frequency of consumption				Measured PBDS before hospitalization Case number in Table 1									PBDS during hospitalization
	Daily	3–5 servings /wk	1–2 servings /wk	Rarely	1	3	4	5	6	7	8	9	10	
Vegetables	5	3	1	0	5	5	5	5	3	5	5	5	5	5
Fruits	5	3	1	0	1	1	5	5	0	5	0	5	5	5
Pulses (beans, soybeans, peas, etc.)	5	3	1	0	3	5	5	5	3	5	5	5	5	5
Potatoes/starches	5	3	1	0	0	3	5	5	0	1	0	5	0	5
Rice	5	3	1	0	5	5	5	5	5	5	5	5	5	5
Miso soup	5	3	1	0	5	5	5	5	3	5	5	5	5	5
Green tea	5	3	1	0	0	0	5	5	5	5	0	5	5	5*
Yoghurt (plain)	5	3	1	0	0	3	5	0	3	0	0	5	3	5
Meat (beef, pork, chicken)	-5	-3	-1	0	-1	-3	-1	-3	-1	0	0	0	0	0
Minced or processed meat	-5	-3	-1	0	-1	-1	0	-5	0	0	0	-3	0	0
Cheese/butter/margarine	-5	-3	-1	0	0	-1	0	-5	0	0	0	-3	0	0
Sweets/ice cream/milk shake	-5	-3	-1	0	0	-3	-1	-5	0	0	-5	0	-5	0
Soft drinks (cola/carbonated beverages/juice)	-5	-3	-1	0	-3	0	0	-3	-3	0	0	0	-3	0
Alcohol	-5	-3	-1	0	0	-3	0	0	-5	0	0	-5	-5	0
Bread	-5	-3	-1	0	-3	-1	0	-5	-1	-1	-5	0	-1	0
Fish	-2	-1	0	0	0	-2	0	-2	-2	-2	0	-1	-2	0
Plant-based diet score (PBDS)					**11**	**13**	**38**	**7**	**10**	**28**	**10**	**28**	**17**	**35**

*Drinking green tea at home was recommended, but it was not provided at the hospital.
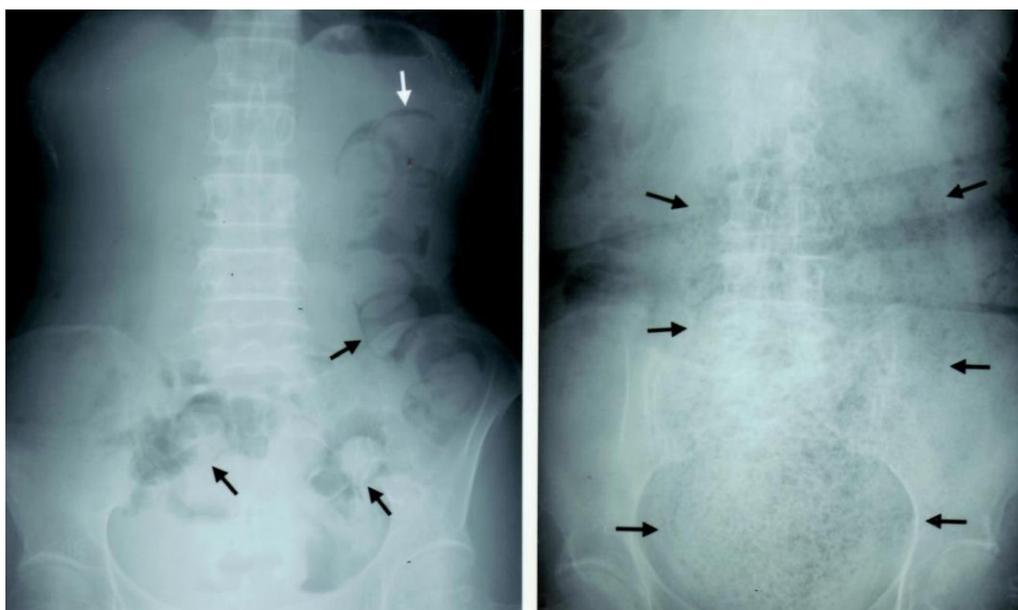
Figure 3 Fecal impaction in case 9 (left) and megabowel in case 11 (right). The simple radiograph of the abdomen showed multiple large, round masses of stool in the sigmoid and descending colon indicated by arrows, namely fecal impaction (left). The simple radiograph of the abdomen showed a huge stool mass manifested as numerous fine gas pictures. The border of the stool mass is indicated by arrows measuring 15.0 cm of the bowel width, namely megarectum and megacolon, which were confirmed by computed tomography. This megabowel caused huge abdominal distension (right).

3.2 Effects of the PBD on Constipation

Six of the seven patients with simple constipation defecated every day with PBD without the administration of laxatives (highly effective rate: 86%). Defecation usually occurred one to three days following commencement of the PBD. Although defecation was not induced by the PBD in case 2, defecation became easier than before. In a complicated patient with megacolon (case 8) who was administered senna, the PBD induced defecation. In the remaining three cases with serious complications (cases 9–11), the PBD was effective in combination with laxatives, probiotics, prebiotics, and bananas (Table 1). Fecal impaction or abdominal distention due to megabowel started to resolve in five to seven days. The PBD was also effective after fecal impaction was resolved or abdominal distention was relieved. There were no adverse effects associated with the diet, such as loose stool, bloating, diarrhea, or frequent defecation.

3.3 Design of Clinical Path

The duration of admission exceeded three weeks in three patients with complicated constipation. However, in the patients with simple constipation, it was about two weeks (mean 13 days) (Table 1). Therefore, a rough clinical path for simple constipation could be designed. Since systemic studies, including those of the digestive organs, require fasting, which may disturb bowel movements, such studies were conducted in the second week (Figure 4).
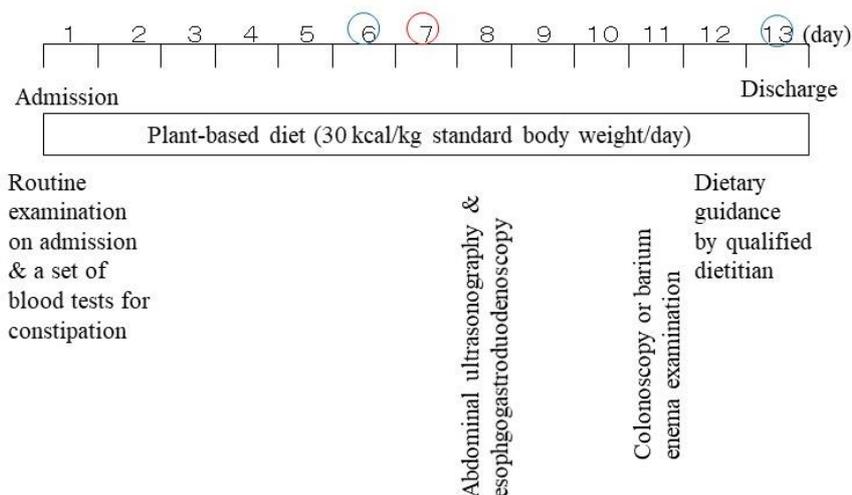
Figure 4 A rough clinical path for the management of simple constipation using a plant-based diet. A set of blood tests includes thyroid-stimulating hormone, free T3, free T4, fasting blood glucose, HbA1c, anti-centromere antibody, anti-Scl-70 antibody, and creatine phosphokinase.

4. Discussion

In this study, we showed that a PBD was effective for treating constipation unresponsive to conventional laxatives. Japanese eat refined white rice rather than unrefined brown rice. Although none of the patients had eaten brown rice before, none of them discontinued the PBD. Our patients, who were provided a PBD, did not experience (crampy) abdominal pain that is often associated with laxatives.

As there is an interplay between diet, gut microbiota, microbial metabolites, and health/disease [13–15], clinical trials targeting gut dysbiosis via dietary manipulation or pro- and/or prebiotics are increasing for the treatment of various diseases. In IBD and constipation, the exclusion of potentially untoward foods or the addition of beneficial foods is not possible beyond a certain extent [25, 34–37]. A PBD is effective in such cases of constipation and IBD. Since brown rice contains six times more dietary fiber (Figure 1), which is known to increase fecal bulk and decrease transit time [4], brown rice facilitated smooth defecation in this study.

Currently, special diets are universally served in hospitals for diabetes mellitus, kidney diseases, and gastric ulcers, but not for constipation. Since the current diet is far from a PBD, it would be difficult for people to follow a PBD [38]. If it is served during hospitalization, where it induces smooth defecation and solves constipation-associated unpleasant symptoms, patients may appreciate the importance of the diet. This may allow the patients to continue a healthy diet and improve self-management skills. Therefore, a PBD should be provided in hospitals as a treatment strategy for constipation.

The mean baseline PBDS of nine patients with constipation was 18.0 ±10.7 (Table 2). This was higher than that in patients with IBD: 8.2 ±8.2 (n = 70) in Crohn's disease (P = 0.0081, chi-square analysis) and 10.8 ±9.4 (n = 159) in ulcerative colitis (P = 0.15) [30]. The difference in the median age

influenced the PBDS; patients with constipation were 70 years old, and those with Crohn's disease and ulcerative colitis were 23 and 36 years old, respectively.

As discussed above, a PBD is healthy and does not have adverse effects associated with medication. We have reported the efficacy of PBD in IBD [22, 28, 38], non-alcoholic fatty liver disease [39], metabolic syndrome [40], and type 2 diabetes (unpublished observation). A PBD induces normal stool in patients with diarrhea/loose stool in the acute phase of Crohn's disease or ulcerative colitis. It can also normalize bowel movements in constipated patients. Apart from medicine, a transition from the current animal-based diet to a PBD has been advocated as it promotes a sustainable environment and food system [19, 24, 41].

Our study had some limitations. It was a small case series, and there was no control group. Further studies with control groups and more participants need to be conducted to validate our results.

5. Conclusion

A plant-based diet was highly effective for treating simple constipation and effective for treating complicated constipation. The diet can induce defecation in patients seriously suffering from constipation.

Acknowledgments

Author Contributions

Study design and writing: Mitsuro Chiba. Acquisition, analysis, or interpretation of data: All authors. All authors approved the final version of the manuscript for submission.

Competing Interests

The authors have declared that no competing interests exist.

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