Original Article

A simple meal plan of 'eating vegetables before carbohydrate' was more effective for achieving glycemic control than an exchange–based meal plan in Japanese patients with type 2 diabetes

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This study aimed to determine whether educating diabetic patients to 'eat vegetables before carbohydrate' was as effective on long-term glycemic control as a traditional exchange-based meal plan. To test this hypothesis, we carried out a randomized, controlled trial in patients with type 2 diabetes that compared changes in HbA1c as the primary outcome. A total of 101 patients were stratified according to sex, age, BMI, duration of diabetes, and HbA1c, and then randomized to receive instructions to eat either vegetables before carbohydrate (VBC, n=69) or an exchange-based meal plan (EXB, n=32). The impact of the two plans on glycemic control was compared over 24 months of follow-up. Significant improvements in HbA1c over 24 months were observed in both groups (VBC, 8.3 to 6.8% vs EXB, 8.2 to 7.3%). HbA1c levels were significantly lower in the VBC group than in the EXB group after 6, 9, 12 and 24 months of the study. Both groups exhibited similar improvements in dietary practices with respect to intake of carbohydrate, fats and sweets, while the VBC group had a significant increase in consumption of green vegetables and a significant decrease in fruit consumption. A simple meal plan of 'eating vegetables before carbohydrate' achieved better glycemic control than an exchange-based meal plan in Japanese patients with type 2 diabetes over a 24-month period.

Key Words: type 2 diabetes, dietary interventions, glycemic control, vegetables, carbohydrate

INTRODUCTION

It is essential to manage good metabolic control in patients with diabetes in order to prevent chronic complications.[1,2] However, a significant number of patients with diabetes remain poorly controlled, mainly as a result of low compliance with eating a good diet.[3-5] The important choices that affect blood glucose control in people with diabetes are made by themselves, not by their physicians or other medical professionals. Patients need to make a series of choices regarding eating and physical activity that are necessary to regulate blood glucose levels and prevent complications.

People with diabetes are advised to adopt an appropriate diet including dietary habits and meal patterns on a lifelong basis. Frequently, the efforts of patients are not in the appropriate direction, or alternatively they may receive confusing and contradictory advice from the media or social contacts. Diabetes education, especially dietary education, requires training by medical professionals and provision of unequivocal information based on sound evidence. Traditionally, recognition of the relationship between dietary constituents and glucose tolerance has contributed to the development of nutritional prescriptions, such as the food exchange system. Such strategies aim to restrict energy intake and provide macronutrient balance. However, diabetic patients may have trouble understanding diets based on a food exchange system, and even if they do understand the system, they may have difficulty changing their daily food habits.[3] In particular, elderly diabetic patients may experience difficulties implementing the recommendations of the exchange-based meal plan.

It has been demonstrated that postprandial hyperglycemia is associated with increased risk for macrovascular

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Manuscript received 27 April 2010. Initial review completed 8 November 2010. Revision accepted 9 March 2011.

disease.[6] The recommendations of the International Diabetes Federation in 2007 were intended to assist in developing strategies to effectively manage postprandial glucose levels in people with diabetes. Strategies for nutritional education should be re-organized to provide a simple and easy meal plan that lowers postprandial hyperglycemia in patients with diabetes and has high compliance on a lifelong basis. In a previous paper we reported an acute study of a simple meal plan that involved 'eating vegetables before carbohydrate'. We demonstrated a 20% reduction in postprandial plasma glucose and a 30% reduction in postprandial serum insulin levels in patients with type 2 diabetes mellitus (T2DM).[7]

In addition to lowering acute postprandial glucose and insulin responses, the current study aimed to determine whether educating diabetic patients to 'eat vegetables before carbohydrate' was as effective on long-term glycemic control as a traditional exchange-based meal plan. To test this hypothesis, we carried out a randomized, controlled trial in patients with T2DM that compared changes in HbA1c as the primary outcome and changes in weight, serum lipids, and blood pressure as secondary outcomes.

MATERIALS AND METHODS

Participants

The study was carried out between 2005 and 2009 at Kajiyama Clinic in Kyoto, specialized for diabetes treatment, using a protocol approved by the Ethics Committee of the School of Comprehensive Rehabilitation at Osaka Prefecture University. We enrolled patients diagnosed with T2DM who fulfilled the World Health Organization (WHO) criteria for diabetes. Informed consent was obtained from all the subjects before enrollment in the study. A total of 221 outpatients with T2DM from Kajiyama Clinic were selected for possible participation in the study if they had no major complications or medical illnesses. The exclusion criteria were as follows: (1) chronic liver disease or a clinical history and/or signs of cardiovascular disease, cerebrovascular disease, or peripheral arterial disease and (2) heavy smoking (more than 40 cigarettes a day), and drinking (more than 50 g alcohol a day). A total of 148 patients were judged capable of performing basic self-management skills and able to participate in the study. Agreement to participate in the study was obtained from 101 patients, who were stratified according to sex, age, body mass index (BMI; kg/m^2), duration of diabetes, and HbA1c. The patients were then randomized into two groups to receive instructions on either a simple meal plan that involved eating vegetables before carbohydrate (VBC group, n=69) without taking into account energy intake, or a traditional exchange-based meal plan (EXB group, n=32) that used the food exchange system to focus on energy intake. We set the number of participants in the VBC group was be twice as much as the EXB group out of ethical consideration for the participants. This is because the VBC method is simple and easy to understand for the participants, and the VBC method was effective for reducing postprandial plasma glucose and insulin levels as described previously.[7]

Research design

This study was a 2-year randomized controlled trial in subjects with T2DM that compared the effectiveness and acceptability of a simple meal plan that involved an intervention of eating vegetables before carbohydrate (VBC) with a traditional exchange-based meal plan (EXB). The primary outcome was changes in HbA1c, while secondary outcomes were changes in body weight, serum lipids, and blood pressure. Individual dietary counseling was provided by dietitians with the initial visit, including extensive evaluation and education focused on self-care management. After the initial visit, patients were scheduled for return clinic visits every month. The patients were also scheduled to see dietitians at every visit for 24 months. The dietitians were trained in all aspects of instruction and coping skills, which include menu planning and making appropriate food choices. Instructions for the VBC or EXB groups regarding diet and physical activity involved the same dietitian each time for each group.

Current dietary habits, physical activity and eating behavior were determined in all the participants prior to intervention. Detailed written instructions for completion of the food diaries were provided and the participants were encouraged to contact the dietitian if they had any questions regarding this procedure. The dietary values were entered into a computer database and analyzed by a dietitian, using a dietary computer soft program (Eiyokun, Kenpakusya, Tokyo, Japan) based on Standard Tables of Food Composition in Japan.[8] Physical activity involving moderate exercise such as walking 30 to 40 min each day was recommended, and assessed in both groups using Kens Activity Monitor Life Corders® (Suzuken, Aichi, Japan) for 7 days prior to intervention and 21 days after intervention. Dietary restraint and overeating tendencies, such as emotional and external eating were measured using the Dutch Eating Behaviour Questionnaire (DEBQ).[9] The patients were required to complete the DEBQ at the initial visit and after 2 months of intervention. Emotional eating was defined as eating in response to states of emotional arousal such as fear, anger or anxiety, while external eating was classified as eating in response to external food cues such as the sight and smell of food or eating in response to food-related stimuli. Restrained eating was defined as overeating after a period of slimming when the cognitive resolve to diet was abandoned.

Exchange-based meal plan (EXB) group

Patients in the EXB study group were instructed on both the food exchange system and portion size using educational material that consisted of "Food Exchange Lists: Dietary Guidance for Persons with Diabetes" which provided a rough gauge on the amount of energy and nutrients contained in each food, as the basis for dietary instructions.[10] The exchange lists are used routinely as a method for meal planning in patients with diabetes. The justification for specific food inclusions and general food groups in the "Food Exchange Lists: Dietary Guidance for Persons with Diabetes" is provided by a food database that includes associated energy and macronutrient values.[8] The mean energy and macronutrient values for each of the lists closely match the mean exchange values. The patients were recommended to consume more than 350g of vegetables and 80 kcal of fruits a day. The intervention focused on setting individual and realistic goals in order to achieve gradual dietary change. Approximately 60 min were spent on dietary counseling at the initial visit and 40 min at each subsequent session. Dietary intake was assessed by food records collected over three days at the initial visit (baseline) and over seven days after 2 months of intervention.

Vegetables before carbohydrate (VBC) group

The VBC method includes nutritional advice given in the form of a simple and easy meal plan of eating vegetables first and carbohydrate last in each meal. In order to reduce postprandial hyperglycemia, patients in the VBC group were encouraged to consume every meal eating vegetables prior to carbohydrate; green vegetables at least once a day, not fruits, and chewing each bite more than 20 times. Depending on the patient's current dietary intake, the intervention aimed to encourage increased consumption of vegetables, mushrooms, and seaweeds and low glycemic index (GI) foods using an original educational brochure. The intervention focused on setting individual and realistic goals in order to achieve gradual dietary change. Approximately 30 min were spent on dietary counseling at the initial visit and 20 min at each subsequent session. Dietary intake was assessed by food records collected over three days at the initial visit (baseline) and over seven days after 2 months of intervention.

Laboratory analyses

Laboratory data, body weight and BMI measurements were collected from all participants at baseline and every 4 weeks thereafter for 24 months. Weight was measured to the nearest 100 g without shoes while wearing minimal clothes. Height was measured without shoes with the shoulders in the normal position. BMI was calculated as weight in kilograms divided by height in meters squared. Blood pressure was measured twice in the seated position during the physical examination after the subject had rested for 10 min. Fasting blood samples were collected from all the participants every 4 weeks in the morning after an overnight fast. HbA1c levels (JDS: Japan Diabetes Society) were determined by a latex cohesion method (JCA-BM2250, KYOWA MEDEX, Co, Ltd, Tokyo, Japan), total cholesterol and triglyceride levels by an enzyme assay, high density lipoprotein (HDL) cholesterol levels by a direct method (Labospect 008K, Bio Majesty JCA-BM 8060, JEOL, Ltd, Tokyo, Japan), and low density lipoprotein (LDL) cholesterol levels by an enzymatic method (Bio Majesty JCA-BM 8060, JEOL, Ltd, Tokyo, Japan).

Statistical analysis

All values are expressed as mean ± SD unless otherwise indicated. The measurements were analyzed using SPSS 15.0 for Windows (SPSS Inc, Chicago, IL, USA). Student's *t*-test was used to test differences between the two study groups and paired *t*-tests were performed to analyse within-group changes over time. Chi-square tests were used to compare categorical data. Repeated-measures ANOVA was performed for comparisons among time (baseline and 12-month or 24-month of follow-up) and the two study groups. Spearman's correlation coefficients were calculated to investigate the association among dietary intakes and HbA1c, BMI, and serum lipids levels. Differences were considered significant at $p<0.05$.

RESULTS

A flow diagram of the study with the number of patients is shown in Figure 1. Of the 69 participants who enrolled in the VBC group, four patients (6%) dropped out from the 2-year-study as a result of moving or changing medical institutions, 65% of patients completed the dietary education over two years, and 4% took only one dietary session. In contrast, in the EXB group five participants dropped out from the 2-year study (16%) out of 32 participants as a result of changing medical institutions, 31% completed the dietary education over two years, and 28% took only one dietary session ($p<0.001$). The retention rates of the study were 94% in the VBC and 84% in the EXB group at 24-month. The mean dietary sessions were 13.2±7.9 times in the VBC and 8.2±8.4 times in the EXB ($p<0.01$) and dropouts rates were 33% in the VBC and 69% in the EXB group in two years. Comparison of participants who withdrew from the sessions and the difference of the mean dietary session between two groups over the same period, showed participants in the VBC group

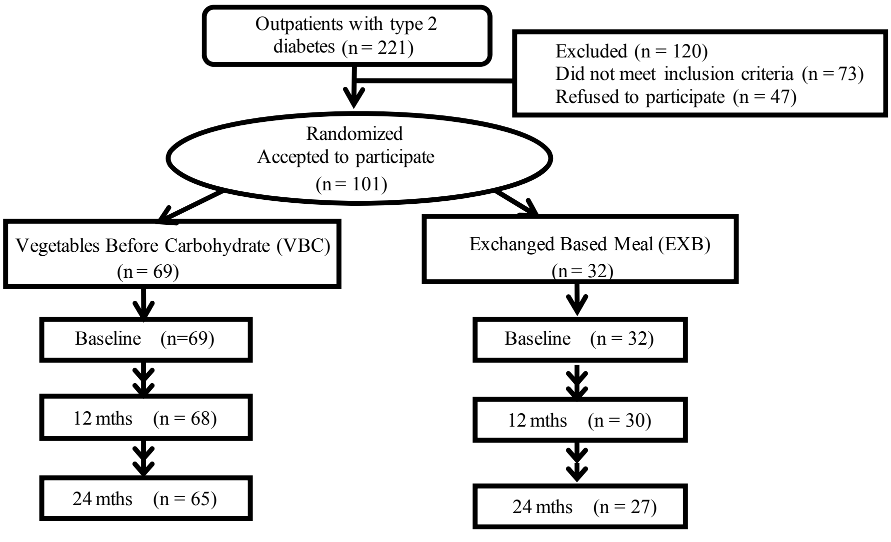

Figure 1. Flow of participants through the study

Table 1. Characteristics of the patients at baseline in two study groups

	VBC (n=69)	EXB (n=32)	*p*
Gender (males / females)	31/38	17/15	0.443
Age (yrs)	63.4±11.7	65.1±12.4	0.503
BMI (kg/m^2)	23.7±4.0	22.7±4.4	0.726
Duration of diabetes (yrs)	7.5±8.4	7.0±8.3	0.777
SBP (mmHg)	132±15	136±25	0.391
DBP (mmHg)	75±11	77±13	0.651
HbA1c (%)	8.3±1.7	8.2±1.8	0.642
T-C (mg/dL)	213±34	220±32	0.377
HDL-C (mg/dL)	56±17	56±13	0.932
LDL-C (mg/dL)	129±30	138±28	0.166
TG (mg/dL)	141±87	144±83	0.866
Diabetes treatment			
Diet only	21	9	0.504
OHA	39	19	0.480
OHA + insulin	9	4	0.607

Data are means ± SD or n.
SBP: systolic blood pressure, DBP: diastolic blood pressure, T-C: total cholesterol, HDL-C: high density lipoprotein cholesterol, LDL-C: low density lipoprotein cholesterol, TG: triglyceride, OHA: oral hypoglycemic agents

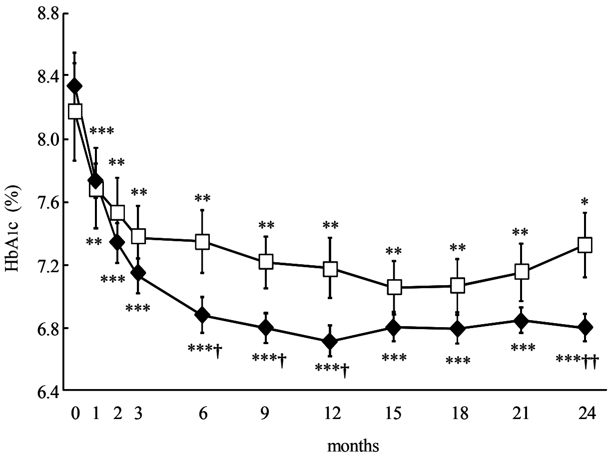

Figure 2. Changes in mean HbA1c levels in patients in the VBC group (closed diamond-shape) and EXB group (opened square) over the 24-month follow-up period. Data are expressed as mean (SE). Significant difference from baseline, *p<0.05, **p<0.01, ***p<0.001. VBC group vs EXB group; †p<0.05, ††p<0.01

were more likely to accept the dietary sessions and adapt their eating habits. Using an 'intention-to-treat' model, analysis of fasting blood samples was performed for 68 patients in the VBC group at 12 months and 65 patients at 24 months. The corresponding values for the EXB group were 30 patients at 12 months and 27 patients at 24 months.

There were no significant differences between the VBC and EXB groups for gender, mean age, duration of diabetes, HbA1c levels, BMI, blood pressure, serum lipids, and percentage of each therapy at baseline (Table 1). As illustrated in Figure 2, HbA1c decreased significantly soon after intervention and also over the 24-month follow-up period in both groups. However, HbA1c levels were significantly lower in the VBC group compared to the EXB group at 6, 9, 12 and 24 months after intervention. Comparison of the two groups showed that patients in the VBC group maintained better glycemic control after 6 months of intervention, with mean HbA1c being less than 7.0% (Figure 2 and Table 2). Neither BMI, diastolic blood pressure nor serum lipids levels was significantly different between the two groups at 12-month or 24-month of follow-up (Table 2).

Table 2. Laboratory data after 12 and 24 months of follow-up in patients in the two study groups

	Baseline	12-month	24-month	*p* time[1]	*p* time × group[1]
BMI (kg/m^2)				0.963	0.320
VBC	23.7±4.0	23.3±4.8	23.6±3.8		
EXB	22.7±4.4	23.7±4.4	22.7±4.3		
SBP (mmHg)				<0.001	0.381
VBC	132±15	123±11*** †	123±10***†		
EXB	136±25	129±16*	129±12		
DBP (mmHg)				<0.001	0.301
VBC	76±11	70±8***	69±8***		
EXB	77±13	72±10*	71±8		
HbA1c (%)				<0.001	0.016
VBC	8.3±1.7	6.7±0.8*** †	6.8±0.7*** ††		
EXB	8.2±1.8	7.2±1.1**	7.3±1.1*		
TC (mg/dL)				0.004	0.180
VBC	213±34	197±31***	205±35		
EXB	220±32	202±33*	200±33**		
HDL-C (mg/dL)				0.315	0.459
VBC	56±17	58±16	58±16		
EXB	56±13	54±14	57±14		
LDL-C (mg/dL)				<0.001	0.065
VBC	129±30	117±28***	121±28*		
EXB	138±28	120±28**	116±29***		
TG (mg/dL)				0.595	0.099
VBC	141±87	123±63	129±63		
EXB	144±83	149±83	164±104		

Data are mean ± SD. *p<0.05, **p<0.01 , ***p<0.01 vs baseline. †p<0.05 VBC vs EXB group, [1]Repeated-measures ANOVA.

After the intervention, the decreased consumption of grain (rice), meat, egg, sweets and beverages (Figure 3) caused a reduction in intake of energy, carbohydrate, protein, fat, saturated fatty acids and cholesterol intake in both study groups (Table 3). On the other hand, consumption of vegetables and fish increased after intervention in both groups. In particular, the VBC group had a significant increase in consumption of green vegetables (97 to 209 g/d, $p<0.001$), associated with a decrease in consumption of fruits (131 to 58 g, $p<0.05$). This resulted in a significant increase in vitamin A, vitamin K, and folic acid intake in the VBC group after intervention (Table 3). However, the energy ratio of carbohydrate remained unchanged in this group after intervention (54.6 to 53.4%), whereas it increased significantly in the EXB group (53.6 to 59.1%).

In order to evaluate the effect of the HbA1c and other variables on dietary intakes, clinical parameters changes were calculated as Δ value (clinical values at 24-month minus baseline) and analyzed by Spearman's correlation. Δ HbA1c was correlated with Δ green vegetables (ρ=0.360, p=0.011) and Δ fruits (ρ=0.457, p=0.001) in the VBC group. Δ BMI was also correlated with Δ green vegetables (ρ=0.335, p=0.028 in VBC group) and Δ fruits (ρ=0.811, p=0.027 in VBC, ρ=0.811, p=0.027 in EXB group). Meanwhile, Δ LDL-C was correlated with Δ oil (ρ=0.321, p=0.044) in the VBC group. We found no relationship between clinical variables and other dietary intakes.

There were no significant differences between two groups for energy expenditure at baseline and after intervention that resulted from moderate exercise increased

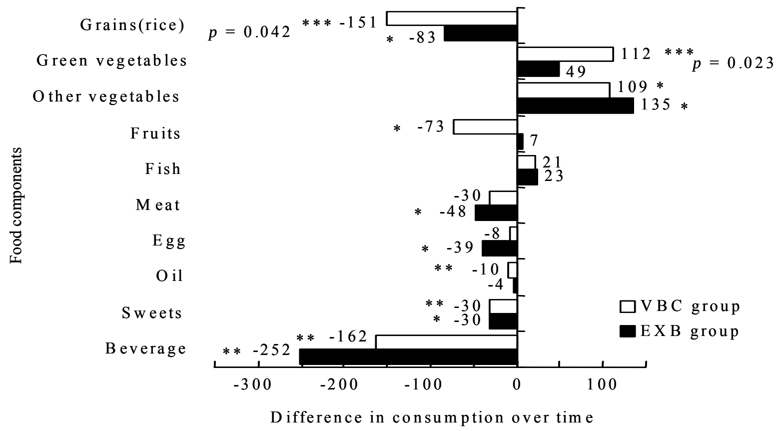

Figure 3. Changes from baseline to after intervention in terms of mean daily consumption of 10 components in the two study groups. Data expressed as mean (g). Significant difference from baseline, *$p<0.05$, **$p<0.01$, ***$p<0.001$. Between-group comparison of changes after intervention in the two study groups (p values).

Table 3. Dietary intakes at baseline and after intervention in patients in the two study groups

	VBC		EXB	
	Baseline	After intervention	Baseline	After intervention
Energy (kcal)	2464±153	1711±47***	2281±179	1661±95 **
Protein (g)	82±4	73±2* †	77±6	61±4*
Total fat (g)	71±6	48±2**	67±6	44±4**
Carbohydrate (g)	336±26	229±9***	301±20	243±13*
Total fiber (g)	14.8±0.8	18.4±1.4*	12.4±1	14.5±1
Salt equivalents (g)	11.2±0.6	9.6±0.3**	11.0±0.8	8.7±0.5*
Potassium (mg)	2958±135	3139±159	2598±168	2652±161
Calcium (mg)	494±28	536±35	540±65	585±91
Iron (mg)	9.0±0.5	8.6±0.4 †	7.6±0.6	6.9±0.8
β-Carotene equivalents (μg)	3919±353	5621±725*	2636±613	3716±558
Vit A (μg)	504±46	707±84* †	435±48	425±52
Vit D (μg)	11.4±1.9	10.6±1.5	6.5±1.6	8.5±2.2
Tocopherols (mg)	10.7±0.9	10.4±0.6	8.6±1	8.0±1.2
Vit K (μg)	232±25††	372±42** †	150±17	214±38
Thiamin (mg)	1.11±0.07	1.03±0.05	0.98±0.13	0.9±0.09
Riboflavin (mg)	1.17±0.06	1.11±0.05	1.28±0.08	1.01±0.11
Niacin (mg)	22.1±1.3	19.8±1	19.5±1.7	16.9±1.3
Vit B-6 (mg)	1.62±0.1	1.42±0.08	1.39±0.1	1.25±0.11
Vit B-12 (μg)	7.4±0.9	7.9±1.1	7.3±1.4	8.9±2.7
Folate (μg)	325±18†	425±27** †	260±19	315±34
Vit C (mg)	104±10	130±12	81±18	93±12
SFA (g)	19.3±2	12.3±0.8**	19.3±1.6	11.9±1.4**
MUFA (g)	25.7±2.8	15.9±0.9**	22.9±1.9	14.4±2.0**
PUFA (g)	15.5±1.3	11.7±0.6*	13.8±1.4	10.2±1.4
Cholesterol (mg)	354±35	281±29*	433±53	192±42**

Data expressed as means±SE.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$ compared with baseline; † $p<0.05$, †† $p<0.01$ compared with EXB group

after intervention in both groups. Eating behavior assessed by the DEBQ demonstrated that external and restrained eating behaviors improved in both groups after intervention.

DISCUSSION

The aim of this study was to re-organize nutritional strategies for helping diabetic outpatients adhere to dietary regimens. We observed a reduction in HbA1c, blood pressure, total cholesterol, and LDL-cholesterol levels in both study groups, with these changes being possibly attributable to decreased total energy intake and lower consumption of salt, protein, fat, carbohydrate, saturated fatty acids, and cholesterol after intervention. In addition, an increase in physical energy expenditure and changes in eating behavior in both groups might have contributed to the metabolic improvements observed after intervention.

Comparison of the two groups showed the VBC group was significantly different from the EXB group in several aspects. This included better glycemic control for the patients in the VBC group during two years of follow-up. Our study showed three major differences between the two study groups. First, the patients in the VBC group had a significant increase in consumption of green vegetables and a decreased consumption of fruits compared to the EXB group. We found the correlation between the reduction of HbA1c levels and the increase of green vegetables and the decrease of fruits. As a result, the intake of fiber, vitamin A, vitamin K, and folic acid was higher in the VBC group than in the EXB group. In addition, half of the patients adapted to eating low GI foods in the VBC group, whereas only 8% of the patients in the EXB group made this adaptation. These findings are important, as they suggest the strategy of eating vegetables before carbohydrate was successful in promoting patient education, particularly with regard to consumption of food that are not monitored regularly in nutrition intervention studies.[11] Although the strategy of VBC did not focus on restricting energy intake, the results showed that patients in this group reduced their intake of energy after intervention. Second, the energy ratio of carbohydrate increased significantly in the EXB group after intervention, whereas it remained unchanged in the VBC group, despite neither total energy nor carbohydrate intake being different between the two groups after intervention. Third, a marked difference was observed between the two study groups in the number of sessions or dropout rates. Patients reported anecdotally that the VBC approach was easy to understand, which contrasts with the difficulty patients may have with the EXB group. The patients in the EXB group exhibited difficulties for restrictive behaviors with regards to food intake and portion sizes for the rigid dietary control. This comparison of the two groups confirmed our initial hypothesis that the intervention to eat vegetables before carbohydrate would result in a more favorable dietary regimen for participants.

Patients with diabetes encounter several psychological and lifestyle difficulties in modifying their lives to achieve diabetic management.[12] They exhibit restrictive behaviors with regards to food intake and are convinced that rigid dietary control is the only way to obtain good glycemic control. The approach of eating vegetables before carbohydrate is easier to understand and teach than other approaches. The most important aspect is that it is also easier to attain by making the appropriate behavioral changes. These changes lead to reduced energy intake in diabetic patients; although in order to maintain these benefits, it is necessary for the dietary changes to be applied consistently over a lifetime.

Our data showed that mean dietary fiber intake in the VBC group was higher than in the EXB group, although this intake was still only 18.4 g/day after intervention, a value less than the 14 g fiber/1,000 kcal recommended by the American Diabetes Association.[13] The reason for the reduction in glycated hemoglobin levels in the VBC group can be explained, partly, by the dietary fiber content in the vegetables consumed before the carbohydrates.[14,15] The diet of the VBC group that was rich in dietary fiber and low GI foods improved glucose tolerance by decreasing peak postprandial glucose levels.[16] These results indicated that dietary carbohydrates consumed after vegetables were digested slowly and required less insulin for subsequent metabolic disposal. These changes would be expected to benefit subjects with diabetes, as their secretion of insulin is often delayed.[12] Numerous other factors may influence the glycemic response and digestion of carbohydrates in the small intestine. These include the rate of digestion, type of food, cooking method, type of starch, presence of α-amylase inhibitors, transit time, amount of protein and fat, rate of gastric emptying, rate of intestinal absorption, hormonal gastro-intestinal response,[17-26] hepatic glucose balance, and cellular metabolism of glucose. The patients in the VBC group showed increased post-meal satiety and decreased subsequent hunger when they consumed more vegetables than the EXB group. This led them to decrease their intake of carbohydrate eaten at the end of each meal. Further studies are, however, required to determine the details of the mechanisms responsible for these metabolic changes.

There are some limitations which should be considered in this study. First, some medical changes were made to therapy during the study period. In the VBC group 14% of patients had decreased and 7% increased the dose of medicine. Meanwhile, 50% of patients in the EXB group had increased the dose of medicine, included one from oral hypoglycemic agents to the insulin therapy. Second, all participants were not newly diagnosed T2DM. About 33% of the patients in the VBC group had been treated for diabetes in other medical institutions and had a chance to learn the EXB meal plan in the past. Additionally, we think the continuous dietary sessions are important to educate diabetic patients, but the number of dietary sessions should have been decided as needed. Patients who completed the 2-year dietary sessions consisted of 65% and 31% of the VBC or EXB groups respectively, despite the fact that all participants were supposed to be routinely schedule to see a dietitian at every visit. The return rates of participants and complete rates of the dietary sessions were higher the VBC than the EXB group. These results suggest that the VBC approach is easier to understand and easier to teach than the EXB approach, and the VBC approach may be preferable as the first-line method in patients with T2DM.

Our results support the hypothesis that educating patients with T2DM to eat vegetables before carbohydrate is more effective for achieving glycemic control and lowering blood pressure than an exchanged-based meal plan when high compliance with the dietary regimen is maintained for 2 years. This approach of 'vegetables before carbohydrate' supports the concept of emphasizing food choices, what to eat first, how to eat and not just to concentrate on energy intake. All of these factors are important elements in the patient's education. With regard to nutritional approaches, our research study showed nutritional advice could be given to patients with T2DM in the form of a simple and easy meal plan. Further and longer term studies are therefore warranted to investigate the effects of this dietary approach in preventing vascular complications associated with T2DM.

CONCLUSION

A simple meal plan consisting of eating 'vegetables before carbohydrate' was more effective in achieving glycemic control over a 24-month period than an 'exchange–based meal plan' in Japanese patients with diabetes.

ACKNOWLEDGEMENTS

This study was supported partly by a Grant-in Aid for Scientific Research from the Ministry of Health, Labor and Welfare (project number 19500605).

AUTHOR DISCLOSURES

None of the authors has financial interest or conflict of interest in this study.

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Original Article

A simple meal plan of 'eating vegetables before carbohydrate' was more effective for achieving glycemic control than an exchange–based meal plan in Japanese patients with type 2 diabetes

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'吃醣類食物前先吃蔬菜'的飲食方式對日本糖尿病患者比飲食份量代換更有效控制血糖

本研究目的是探討"吃醣類食物之前先吃蔬菜"的飲食方式，是否比傳統的飲食份量代換更有利於糖尿病患者的長期血糖控制。為了測試這個假說，採用隨機對照試驗，比較第二型糖尿病患者的 HbA1c 變化情形。將 101 名患者根據性別、年齡、BMI、罹患糖尿病時間長短和 HbA1c 作分層，再隨機分配到"吃醣類食物之前先吃蔬菜"組(簡稱 VBC，共 69 人)和傳統的飲食份量代換(簡稱 EXB，共 32 人)。追蹤這兩組接下來 24 個月的血糖控制情形。在這 24 個月中，兩組的 HbA1c 都獲得明顯的改善(VBC: 8.3 降至 6.8%，對照 EXB: 8.2 降至 7.3%)。而在第 6、9、12 和 24 個月時，VBC 組的 HbA1c 都顯著比 EXB 組低。兩組患者在飲食習慣上有相似的改善，包括減少醣類、脂肪和甜食的攝取；但 VBC 組的綠色蔬菜攝取量顯著增加，而水果攝取量則顯著減少。研究結果顯示，對於日本的第二型糖尿病患者而言，在 24 個月內，簡單的飲食計畫"吃醣類食物之前先吃蔬菜"比傳統的飲食份量代換更能有效控制血糖。

關鍵字：第二型糖尿病、飲食介入、血糖控制、蔬菜、醣類