Letters

DOI: 10.1111/dme.12073

Eating vegetables before carbohydrates improves postprandial glucose excursions

Diabet. Med. 30, 370–372 (2013)

Large fluctuations in blood glucose are reported to promote the micro- and macrovascular complications associated with Type 2 diabetes. Postprandial plasma glucose and glycaemic spikes are more strongly associated with atherosclerosis than fasting plasma glucose or HbA_{1c} level [1]. Therefore, safe and effective interventions, including diet, are needed to reduce glycaemic variability and minimize hypoglycaemic events. The continuous glucose monitoring system is capable of detecting hypoglycaemia and hyperglycaemia that may be undetectable by self monitoring blood glucose and HbA_{1c} [2]. In particular, the mean amplitude of glycaemic excursions is a significant determinant of overall metabolic control, as well as increased risk of diabetes complications.

We reported acute effects of eating vegetables before carbohydrates on postprandial glucose and insulin levels [3] and the long-term glycaemic improvements in patients with Type 2 diabetes [4]. The method of the education included nutritional advice given in the form of a simple and easy meal plan of eating vegetables before carbohydrates. In order to reduce postprandial hyperglycaemia, patients were encouraged to consume every meal by eating vegetables prior to carbohydrates. In this study we evaluated whether eating vegetables before carbohydrates could reduce the daily postprandial glucose excursions assessed by continuous glucose monitoring system in Japanese patients with Type 2 diabetes and subjects with normal glucose tolerance.

Consecutive patients with Type 2 diabetes were recruited among outpatients regularly attending a diabetes clinic, the Kajiyama Clinic located in Kyoto, Japan, from 2011 to 2012. Diagnosis of diabetes was made according to the World Health Organization criteria. Confirmation of normal glucose tolerance was based on fasting blood glucose

Table 1 Characteristics of glycaemic excursion in subjects with Type 2 diabetes and normal glucose tolerance.

	Patients with Type 2 diabetes			Subjects with normal glucose tolerance		
	Vegetables before Carbohydrates	carbohydrates before vegetables	*P*	Vegetables before Carbohydrates	carbohydrates before vegetables	*P*
Mean plasma glucose (mmol/l)	8.01 ± 1.97	8.16 ± 1.90	NS	5.04 ± 0.37	5.22 ± 0.49	NS
Standard deviation (mmol/l)	1.69 ± 0.67	2.38 ± 1.13	< 0.01	0.69 ± 0.19	0.91 ± 0.38	< 0.01
Mean amplitude of glycaemic excursions (mmol/l)	4.36 ± 1.86	6.52 ± 3.17	< 0.01	1.56 ± 0.74	2.44 ± 1.09	< 0.01
Largest amplitude of glycaemic excursions (mmol/l)	6.82 ± 2.24	9.43 ± 3.98	< 0.01	3.10 ± 0.74	4.53 ± 1.66	< 0.01
1-h postprandial plasma glucose of breakfast (mmol/l)	9.53 ± 2.21	11.00 ± 3.54	< 0.05	5.92 ± 0.81	6.28 ± 1.06	< 0.05
2-h postprandial plasma glucose of breakfast (mmol/l)	9.66 ± 2.77	10.54 ± 3.27	NS	5.33 ± 0.54	5.21 ± 0.80	NS
1-h postprandial plasma glucose of lunch (mmol/l)	8.55 ± 2.78	9.78 ± 3.94	NS	5.62 ± 0.78	7.23 ± 1.58	< 0.001
2-h postprandial plasma glucose of lunch (mmol/l)	8.90 ± 2.96	10.84 ± 4.55	< 0.05	5.67 ± 0.95	5.95 ± 1.33	NS
1-h postprandial plasma glucose of dinner (mmol/l)	9.28 ± 2.44	10.17 ± 3.13	NS	5.68 ± 0.94	7.08 ± 1.59	< 0.01
2-h postprandial plasma glucose of dinner (mmol/l)	9.06 ± 2.50	10.48 ± 3.67	< 0.01	5.67 ± 0.78	6.19 ± 1.42	NS
$IAUC_{0–3h}$ of breakfast (mmol/l)	321 ± 225	472 ± 331	< 0.05	114 ± 66	108 ± 54	NS
$IAUC_{0–3h}$ of lunch (mmol/l)	397 ± 278	640 ± 421	< 0.05	155 ± 93	235 ± 135	< 0.05
$IAUC_{0–3h}$ of dinner (mmol/l)	287 ± 260	532 ± 308	< 0.01	125 ± 93	229 ± 165	< 0.05
Mean $IAUC_{0–3h}$ (mmol/l)	334 ± 254	546 ± 356	< 0.001	132 ± 85	191 ± 138	< 0.05
Incremental glucose peak of breakfast (mmol/l)	3.34 ± 1.63	5.08 ± 2.69	< 0.01	1.50 ± 0.63	1.97 ± 0.88	< 0.05
Incremental glucose peak of lunch (mmol/l)	3.10 ± 2.01	6.97 ± 3.53	< 0.05	1.67 ± 0.79	2.83 ± 1.40	< 0.01
Incremental glucose peak of dinner (mmol/l)	2.53 ± 1.84	4.71 ± 3.57	< 0.05	1.43 ± 0.76	2.66 ± 1.51	< 0.01
Mean incremental glucose peak (mmol/l)	2.99 ± 1.82	5.50 ± 3.34	< 0.001	1.56 ± 0.73	2.50 ± 1.33	< 0.001

< 5.6 mmol/l and 2-h glucose concentration in an oral glucose tolerance test < 7.8 mmol/l. All participants were assigned to perform the continuous glucose monitoring system (CGMS, Medtronic Minimed Gold; Medtronic Minimed, Northridge, CA, USA) for 72 h by eating test meals of vegetables before carbohydrates and carbohydrates before vegetables on the 2nd and the 3rd day in a randomized crossover design. The test meals consisted of rice/bread, meat/fish and 500 g of vegetables, and contained 21 g of dietary fibre and 125.6 kJ kg^{-1} per day. The energy ratio of protein, fat and carbohydrates was 17, 25 and 58%, respectively. The subjects ate the first dish of vegetables for 5 min, then the main dishes, and consumed rice or bread with a 10-min interval between vegetables and carbohydrates in each meal, and then vice versa.

The glucose fluctuations were assessed by the following parameters obtained from the continuous glucose monitoring system and compared between the day of eating vegetables before carbohydrates and the day of eating the carbohydrates before the vegetables: the mean plasma glucose, standard deviation (SD), mean amplitude of glycaemic excursions and the largest amplitude of glycaemic excursions, postprandial plasma glucose, incremental area under the curve 0–3h ($IAUC_{0–3h}$), and incremental glucose peak.

Nineteen outpatients with Type 2 diabetes [men/women 6/13; age 65.5 ± 9.4 years, duration of diabetes 16.4 ± 10.2 years; BMI 22.5 ± 3.1 kg/m^2; HbA_{1c} 55.0 ± 10.9 mmol/mol (7.2 ± 1.0%); fasting plasma glucose 8.06 ± 2.67 mmol/l, diet/oral hypoglycaemic agents/insulin + oral hypoglycaemic agents 3/3/13; mean ± SD or *n*] and 21 subjects with normal glucose tolerance [men/women 2/19; age 29.8 ± 11.3 years; BMI 20.8 ± 3.0 kg/m^2; HbA_{1c} 36.0 ± 6.6 mmol/mol (5.4 ± 0.6%); fasting plasma glucose 4.89 ± 0.50 mmol/l] were enrolled in the study. The levels of standard deviation, mean amplitude of glycaemic excursions, largest amplitude of glycaemic excursions, 1-h postprandial plasma glucose of breakfast, $IAUC_{0–3h}$ of lunch and dinner, mean $IAUC_{0–3h}$ and incremental glucose peak were significantly reduced when the participants ate vegetables before carbohydrates compared with the reverse regimen in both subjects with Type 2 diabetes and those with normal glucose tolerance; however, the values of mean plasma glucose were not different in either of the subject groups (Table 1). Two-hour postprandial plasma glucose levels of lunch and dinner, and $IAUC_{0–3h}$ of breakfast were also significantly reduced in patients with Type 2 diabetes, while 1-h postprandial plasma glucose levels of lunch and dinner were significantly decreased in subjects with normal glucose tolerance. The reason for the reduction of postprandial plasma glucose levels by eating vegetables before carbohydrates can be explained, partly, by the dietary fibre content in the vegetables taken before the carbohydrates. Dietary carbohydrates consumed after vegetables were digested slowly and required less insulin for subsequent metabolic disposal [5]. Other factors may influence the glycaemic response and digestion of carbohydrates in the small intestine, including the rate of digestion, cooking method, transit time and rate of intestinal absorption. Vegetables given before carbohydrates might stimulate incretin hormone secretion, which leads to the reduction in glycaemic excursions [6].

In this study, we demonstrated that eating vegetables before carbohydrates reduced the postprandial glucose excursions compared with the reverse regimen in both subjects with Type 2 diabetes and those with normal glucose tolerance using continuous glucose monitoring system for the first time. The result of this study is important because eating vegetables before carbohydrates could be a novel method to reduce the incidence of cardiovascular disease [7–10]. As one of the educational points in nutrition, the advice to patients with Type 2 diabetes should be to eat vegetables before carbohydrates, and this advice could even be applicable to healthy subjects in order to prevent future cardiovascular events.

Funding sources

This study was supported in part by a Grant-in Aid for Scientific Research from the Ministry of Education, Science and Culture (project number 23500809) and Osaka Prefecture University.

Competing interests

None declared.

S. Imai[1], M. Fukui[2], N. Ozasa[3]*, T. Ozeki[1], M. Kurokawa[1], T. Komatsu[4] and S. Kajiyama[2,5]

[1]School of Comprehensive Rehabilitation, Osaka Prefecture University, Osaka, [2]Department of Endocrinology and Metabolism, Kyoto Prefectural University of Medicine, [3]Department of Cardiovascular Medicine, Kyoto University, Graduate School of Medicine, [4]Doshisya Women's College of Liberal Arts, and [5]Kajiyama Clinic, Kyoto, Japan

References

1 Cederberg H, Saukkonen T, Laakso M, Jokelainen J, Härkönen P, Timonen M *et al*. Postchallenge glucose, A1C, and fasting glucose as predictors of type 2 diabetes and cardiovascular disease: a 10-year prospective cohort study. *Diabetes Care* 2010; **33**: 2077–2283.

2 Klonoff DC. Continuous glucose monitoring: roadmap for 21st century diabetes therapy. *Diabetes Care* 2005; **28**: 1231–1239.

3 Imai S, Matsuda M, Fujimoto S, Hasegawa G, Miyatani S, Kajiyama S *et al*. Crossover study of the effect of 'vegetables before carbohydrates' on reducing postprandial glucose and insulin in Japanese subjects with type 2 diabetes mellitus. *J Japan Diab Soc* 2010; **53**: 112–115.

4 Imai S, Matsuda M, Hasegawa G, Fukui M, Obayashi H, Ozasa N *et al*. 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. *Asia Pac J Clin Nutr* 2011; **20**: 161–168.
5 Wong JM, Jenkins DJ. Carbohydrates digestibility and metabolic effects. *J Nutr* 2007; **137**: S2539–2546.
6 Ma J, Stevens JE, Cukier K, Maddox AF, Wishart JM, Jones KL *et al*. Effects of a protein preload on gastric emptying, glycemia, and gut hormones after a carbohydrate meal in diet-controlled type 2 diabetes. *Diabetes Care* 2009; **32**: 1600–1602.
7 Ceriello A. Acute hyperglycaemia and oxidative stress generation. *Diabet Med* 1997; **14**: S45–49.
8 Ceriello A. The emerging role of postprandial hyperglycemic spikes in the pathogenesis of diabetic complications. *Diabet Med* 1998; **15**: 188–193.
9 Succurro E, Marini MA, Arturi F, Grembiale A, Lugarà M, Andreozzi F *et al*. Elevated 1-h post-load plasma glucose levels identifies subjects with normal glucose tolerance but early carotid atherosclerosis. *Atherosclerosis* 2009; **207**: 245–249.
10 Mori Y, Shiozaki M, Matsuura K, Tanaka T, Yokoyama J, Utsunomiya K. Evaluation of efficacy of acarbose on glucose fluctuation and postprandial glucose using continuous glucose monitoring in type 2 diabetes mellitus. *Diabetes Technol Ther* 2011; **13**: 467–470.

DOI: 10.1111/dme.12015

'Training' friends and family to provide positive social support in diabetes self-management: experience of ethnically diverse patients

Diabet. Med. 30, 372–373 (2013)

A recent article by Schiotz and colleagues [1] highlighted the important role of social support in facilitating appropriate diabetes self-management practices. The impact of both positive and negative social support on patient health behaviours has been identified previously [2]; however, it is not clear how these processes manifest. An exploratory qualitative study of diabetes self-management among Arabic, English and Vietnamese-speaking Australians attending diabetes education may shed some light on the challenges posed by families and friends in the patient adjusting to and subsequently self-managing their diabetes.

We undertook three group interviews with 28 patients with diabetes, two of whom were co-facilitated and interpreted by a bilingual health worker: an Arabic-speaking group (n = 11), an English-speaking group (n = 9) and a Vietnamese-speaking group (n = 8). Most patients were female (n = 17), aged between 65 and 74 years (n = 13), had been born overseas (n = 25), spoke a language other than English at home (n = 25) and were reliant on a pension as their main source of income (n = 23). Group interviews were recorded, transcribed and then coded thematically using an approach based on phenomenology. We received ethical approval for the study from the University of New South Wales.

Friends and family were often seen to be barriers to diabetes self-management, particularly when the person had just been diagnosed and was struggling to come to terms with a lifelong disease. This negative social support was commonly expressed in a minimization of diabetes and its impact on the individual. Family and friends did not stick to meal plans or times, encouraged participants to eat high-fat foods and even, in the experience of one participant, questioned the validity of his diagnosis because 'you don't look like there's anything wrong with you'. Participants attributed this negative social support to family and friends' poor knowledge of diabetes and its consequences. They perceived that it was their role to educate those close to them about the importance of receiving support in self-management activities.

Turning negative social support into positive social support required a high level of psychological control. Participants had to be authoritative, persistent and beyond embarrassment, particularly in situations where receiving food was a cultural expectation. They had to have a high level of confidence or self-efficacy in regulating their behaviour and communicate this consistently to others. One participant likened this slow but consistent process of educating friends and family to training a horse. Friends and family expressed hurt when he first refused their food, but, after consistently communicating what he would and would not eat over time, they accepted his new lifestyle and were now supportive of his dietary needs.

Consistent messages to family and friends were seen to be most effective when they focused on the potential negative life-altering or life-threatening consequences of not performing diabetes self-management activities. These messages were intended to scare. One participant, for example, found that telling her daughter that she could pass out if she did not eat at a specific time was a useful turning point in gaining her support:

> 'I found a very good thing was my daughter says "oh we don't need to eat now" and I said, "well, it's like this; if we don't eat you'll be picking me up off the floor". "What do you mean, mum?" 'I said, "I've got the shakes and I have to go eat". A few times like that and… I found, Debbie says, "oh yes it's about time mum ate", you know and that's it, sort of thing, and they'll go and get something for me.'

Ethnically diverse patients with diabetes can face added burdens in self-management, performing behaviours within the context of social, family and cultural duties [3,4]. While challenging, patient efforts in educating friends and family in diabetes and the importance of self-management activities were well worthwhile. Educated friends and family often proved to be a great support; making sure participants eat at certain times and limiting household food to match the diet requirements of diabetes self-management. Ethnically diverse patients' experience in shaping social support to assist self-management may be a promising area for future research.