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Research Article

Effect of meals with varying glycemic index on blood glucose response in type 2 diabetes mellitus

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ABSTRACT

Background: In diabetes mellitus (DM) glucose is underused, producing hyperglycaemia. Dietary interventions would be effective in management of glycemic control in DM. The glycemic index (GI) and glycemic load (GL) takes into account the glycemic response. Foods with contrasting GI when incorporated into a meal are able to differentially modify glycemia. Currently there is no universal approach to the optimal dietary strategy for DM. Also, little is known about whether this is dependent on the size and composition of the meal. The purpose of the study was to evaluate the blood glucose response to mixed meals (with varying GI and GL) served to Type 2 DM subjects and to determine the relationship between GI, GL and Postprandial Plasma glucose levels (PPG) in Type 2 DM.
Methods: This study included 30 Type 2 DM subjects and 30 Non Diabetic Subjects. The subjects were served Hospital based and Home based diet. The FPG (Fasting Plasma Glucose) and PPG values were analysed for comparing the effect of both the diets on plasma glucose levels.
Results: After analysis of study data we found that plasma glucose response (FPG-126±6.1 mg/dl, PPG-144.3±4.5 mg/dl) for hospital based low GI meals is significantly lower ($p < 0.0001$) than after one week follow up home based mixed GI meals, (FPG-135±4.5 mg/dl, PPG 158.3±4.5 mg/dl).
Conclusions: It was concluded in the study that Plasma Glucose shows a positive response to high GI foods and this may aggravate the hyperglycemia already present in Type 2 DM. Low GI diets may be helpful in reducing risks related to Type 2 DM.

Keywords: Type 2 diabetes mellitus, Glycemic index, Glycemic load, Hyperglycemia

INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disorders of carbohydrate metabolism in which glucose is underused, producing hyperglycaemia as a result of insufficient insulin secretion by pancreas, inadequate insulin function or both.

There are two main types of DM, Type 1 or Insulin Dependent Diabetes Mellitus (IDDM) and Type 2 or Non-Insulin Dependent Diabetes Mellitus (NIDDM). Amongst the endocrine disorders diabetes is identified as the most common disorder.[1] The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. Over the past 30 yrs, the status of diabetes has changed from being considered as a mild disorder of the elderly to one of the major causes of morbidity and mortality affecting the youth and middle aged people.[1]

Factors such as obesity, lack of physical activity, and smoking have been linked to the development of type 2 diabetes, but the role of dietary carbohydrate remains unclear. Little relation has been found between total carbohydrate intake and the risk of type 2 diabetes.[2] Almost all carbohydrates, regardless of the form in which they are consumed (e.g., starch, lactose, sucrose) are

metabolized to the monosaccharide glucose, which then enters general circulation causing a temporary rise in blood glucose levels. This "glycemic response" is the basis for the increasingly popular measure known as the glycemic index (GI). Several dietary factors that affect the glycemic response and therefore the GI of foods include the nature of the carbohydrate, the consumption of carbohydrate with other nutrients, and processing of the carbohydrate.

The GI was first introduced to the world of diabetes care about 30 years ago by Dr. David Jenkins and his team at the University of Toronto.[3] The GI is defined as a ranking of foods based on the response of postprandial blood glucose levels as compared with a reference food, usually either white bread or glucose.

The glycemic load (GL) is a ranking system for carbohydrate content in food portions based on their glycemic index (GI) and a standardized portion size of 100g. GL combines both the quality and quantity of carbohydrate in one number.

It is the best way to predict blood glucose values of different types and amounts of food.[4] Nutritional factors affect blood glucose levels; however there is currently no universal approach to the optimal dietary strategy for diabetes.

Improvement in glycemic control achieved through dietary interventions would lessen the risk of diabetic complications, improve quality of life for people with diabetes, increase their life expectancy, and minimise, or even avoid, the necessity for expensive medications.[5]

Few studies of dietary GI, GL and the risk of Type 2 DM have been conducted in older adults, despite the high incidence of diabetes and the evident influence of lifestyle on the risk of Type 2 DM in this age group.[3]

The aim of diabetes management is to normalise blood glucose levels, since improved blood glucose control is associated with a reduction in the development of and progression of complications.[6]

The objective of current study was to investigate the blood glucose response of diabetics and non-diabetics (control) fed with mixed meal and determine the blood glucose response to meals of varying GI in DM.

METHODS

The present prospective study was conducted in Department of Clinical Biochemistry Dhiraj General Hospital, S.B.K.S. MI and R.C. Piparia, Waghodiya, Gujarat.

The study included 30 non-diabetic individuals (as the control group) and 30 Type 2 diabetic subjects. The subjects were selected according to the following criteria:

Inclusion criteria

- Diagnosed with type 2 diabetes for a minimum of 1 year with insulin or
- Diagnosed with elevated fasting glucose and post prandial blood glucose.
- Age >18
- Indoor patients who admitted in Dhiraj General Hospital.

Exclusion criteria

- Dietary restrictions that would preclude eating the study diet
- Comorbid chronic illness requiring daily medical management
- Comorbid major psychiatric diagnosis

Approval was taken from research ethics committee of S.B.K.S Medical College, Waghodia, Vadodara, before starting the study. Informed consent was obtained from all individual participants included in the study. All Subjects were on low glycemic index (GI) meal from mess of Dhiraj General Hospital, Pipariya, Waghodiya, Vadodara.

We have calculated GI of hospital based meal and home based meal by using food formula mentioned below:

$$\mathrm{GI} = \frac{Blood\ Glucose\ Response\ to\ 50g\ test\ food\ (eg\ beans) \times 100}{Blood\ Glucose\ Response\ to\ 50g\ test\ food\ (eg\ glucose)}$$

Low GI food were served to the subject at a regular interval in the form of: Breakfast: 7.30 to 7.45 am, Lunch: 12 to 12.30 pm, Dinner: 7.00 to 7.30 pm, For continuous three days per week for total 3 weeks.

Preparation of samples

Venous blood was collected in fluoride bulb after overnight (10 hrs) fasting. Fasting plasma Glucose (FPG) measurement was done at 6:30 to 6:45 am and Postprandial plasma glucose (PPG) level was measured after 2hour of lunch for consecutive 3 days per week for 3 weeks. After 1 week of follow up history of subjects was taken regarding food intake. Samples were collected for plasma glucose measurement and for calculating GI for home based meal. FPG and PPG was measured from the samples for 3 consecutive days per week for total 3 weeks.

Measurement of analytes

Plasma glucose was assessed using the GOD (GLUCOSE OXIDASE)-POD (PEROXIDASE) Method. Instrument used for analyses was TRANSASIA (ERBA MANNHEIM) CHEM-5 PLUSV2 which has open system with photometric accuracy of ±1% of the reading + 0.005 Absorbance. The values for the reference food and test foods were plotted for each subject and the

incremental area was calculated geometrically per subject.

Statistical analysis

Data analysis was performed using statistical software. Data was analyzed by SPSS. Results were expressed as mean ± SD, χ^2; one-way analysis of variance (ANOVA) and *Student's t* test were used. A p value <0.05 was considered statistically significant.

RESULTS

The clinical demographic characteristics (Table 1) of diabetic subjects show that most of the patients 28 (93.3%) had history of diabetes mellitus since 5 years, and only 2 (6.66%) patients had history of diabetes mellitus since 10 years. The mean of duration of diabetes was 3.8±1.5years. (Table 1).

Table 1: Clinical demographic profile of study subjects.

Demographic profile according to the below mentioned criteria.	Number (n=30)	Percentage of subjects (%)
Duration of diabetes (in years mean= 3.8 ± 1.5)		
1 to 5 years	28	93.33%
6 to 10 years	2	6.66%
>10years	0	0%
Treatment strategies		
Diet+ insulin	24	80%
Diet+ oral hypoglycemic drug	6	20%

Table 2: Fasting and post prandial glucose levels in two different dietary conditions.

Study Group	Blood glucose response to meal	Hospital based meal (Mean of GI 43)	Home based meal (Mean of GI 63)	P Value
Diabetic Subjects	FPG (mg/dl)	126±6.1	135±4.4	<0.0001 (S)
	PPG (mg/dl)	144.3±4.5	158.3±4.5	<0.00001 (S)
Non Diabetic Subjects	FPG (mg/dl)	90±6.8	91.6±5.3	>0.0005 (NS)
	PPG (mg/dl)	123.2±4.2	125.4±3.4	>0.0005 (NS)

FPG: Fasting Plasma Glucose, PPG: Post Prandial Glucose, S: Significant, NS: Non-Significant

Table 3: Mean of composition of diet taken by subjects.

	GI	GL	Carb (g)	Protein (g)	Fat (g)	Fiber (g)	Calories (kilocalories)
Diet taken at hospital	43	119.1	277.9	106.25	44.2	46	2050
Diet taken at home	63	189	300	115	45	29	2190

GI: Glycemic Index; GL: Glycemic Load; CHO: Carbohydrate

The mean values of FPG and PPG (126 mg/dl; 144.3 mg/dl) were significantly lower (<0.0001) in diabetic subjects fed on low GI food (Hospital based diet) compared with the values of FPG and PPG (135.0mg/dl; 158.3 mg/dl) in diabetic subjects fed on high GI foods (Home based diet) (Table 2). Table 3 shows comparison between the hospital and home based food served to the subjects. The data shows that the hospital based food had a low GI (43) compared to the home based food (63).

DISCUSSION

The findings of the study showed the clinical demographic characteristic of diabetic patients (Table 1). Most of the patients 28 (93.3%) had history of diabetes mellitus since 5 years, and only 2 (6.66%) of patients had history of diabetes mellitus since 10 years. Lauren Gellar et al studied 12 participates diagnosed with DM. Johanna et al found that out of 21, 8 (38%) of patients had diabetes since 1 year and rest of the patients had history of diabetes since 10 years.[7,8] In the present study the low GI meal was contributing calories (2050 kcal/day), and other macronutrients like protein was 106.25 (23%), Carbohydrate 277.9 (60%), fiber 46g and Fat 44.2 (17%) in respect to total macronutrients served for whole day.

Mean GI of meal 43 was calculated as weighted mean based on the GI and amount of carbohydrate provided by each food. The GL of total daily intake was 102.3 grams/day for meal served in low glycemic dietary condition (Table 2). In the present study, diabetic Subjects were served hospital-based diet (low glycemic index meal) and after one-week follow-up, they had taken meal of varying glycemic index at home.

At hospital-based diet mean of FPG (mg/dl) was 126±6.1 and mean of PPG (mg/dl) was 144.3±4.5. Mean of FPG (mg/dl) was 135±4.5and Mean of PPG (mg/dl) was

158.3±4.5 after one week follow up of subject who had taken home based diet. There is significant difference in mean of blood glucose parameter under two different situations ($p<0.0001$). There is no significant difference in mean of blood glucose parameter under two different situations in non-diabetic subject ($p>0.05$). The findings in our study is supported by the findings of one study in which 12 participates were diagnosed with Type 2 DM.[7]

The average mean Blood Glucose was significantly lower for the low GI condition compared with the high GI condition. Subgroup analyses were conducted for descriptive purposes to determine the degree to which the pattern of findings was similar across diagnoses. Findings indicate a consistent pattern of outcomes across both groups, though not statistically significant for most outcomes due to the reduced sample size.

Kanchan Sandhu et al studied total of 90 Type 2 DM male patients aged 35-50. They measured mean FPG and PPG levels of the subjects. It was observed that there was a significant ($p<0.01$) improvement in the FPG and PPG levels in Nutrition counseling group and after three months of nutrition counseling as shown by mean values of fasting and post prandial glucose levels which decreased significantly (p 0.01) from the initial values.[9]

Panam parikh et al studied 25 type 2 diabetic subjects. They measured mean FPG and PPG levels levels of the Type 2 DM subjects. After giving low GI food, they found significant difference from the initial value. The results of this study suggest that consuming a low GI diet may have a favorable impact on the Plasma Glucose in Type 2 DM or Impaired glucose tolerance (IGT). The difference observed in plasma glucose was clinically relevant and if sustained could translate into meaningful health outcomes.[10]

Research has suggested that the incidence of Type 2 DM can be reduced through lifestyle interventions, preventing progression to Type 2 DM by as much as 58%. Findings from this study suggest that reducing dietary GI may be an important component of lifestyle interventions for management of IGT and Type 2 DM.[11]

In summary, both metabolic and epidemiologic evidence suggests that replacing high-glycemic-index forms of carbohydrate with low-glycemic-index carbohydrates will reduce the risk of type 2 diabetes.[12] Many metabolic and epidemiologic studies suggests that replacing high-glycemic-index forms of carbohydrate with low-glycemic-index carbohydrates will reduce the risk of type 2 DM.

Among patients with diabetes, the weight of evidence suggests that replacing high-glycemic-index with low glycemic-index forms of carbohydrate will improve glycemic control and reduce hypoglycemic episodes among those treated with insulin.

CONCLUSION

In the present study the average FBS and PP2BS mean was significantly lower for the low GI condition (Hospital based diet) compared with the high GI condition (Home based diet). There were statistically significant differences between mean of BG response of low GI meal and high GI meal.

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