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Review Article

Evolution of the Diet Plan for Patients with Diabetes Mellitus

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Abstract

A disciplined diet is essential to improve the glycemic control in patients with diabetes. Therefore, the purpose of this paper is to discuss the evolution of the nutrition recommendations for people with diabetes. We reviewed the most common restrictive and non-restrictive diets, pointing advantages and disadvantages of the starvation, low-carbs, high-carbohydrate, glycemic index, exchange lists, carbohydrate counting, high-fat, and high-protein diets. Although there current American Diabetes Association recommendations have been shown to improve glycemic control, the best macronutrient distribution depending on individual circumstances, and each patient should receive individualized dietary counseling.

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Introduction

Nutritional advices are essential for the diabetes management because a disciplined diet have been followed during all life[1]. Diabetes treatment is centered on controlling the blood glucose levels and some foods choices help to improve the glycemic control[1,2].

During the last century, the nutrition therapy guidelines were gradually revised and have undergone many changes over the past decades [3]. Therefore, the purpose of this paper is to explore the evolution of the diet plan for patients with diabetes, discussing about most common restrictive and non-restrictive diets used to improve metabolic control.

Review

Starvation diets

Prior to the development of insulin [4,5], Frederick Allen and Elliott Joslin proposed a calorie-restricted diet called "starvation diets" or "inanition" to increase the life expectancy of individuals with diabetes. This diet based on prolonged under nourishment which contained 1,200.00kcal and 10g of carbohydrates/day[6]. In carbohydrates restriction, the energy sources must be derived from fatty acids and ketones[7], contributing to ketoacidosis[8,9].

Low-carbs

Popular diets are based on calories and carbohydrates restriction. The early stages of low and very low carbs suggest an intake less than 20g and 10g of carbohydrates a day, respectively[10-12]. Studies have shown that these diets improve glycemic control, insulin resistance and weigh loss in patients with type 2 diabetes[13,14]. However, when carbohydrates are almost eliminated, the diet has inadequate levels of other nutrients provided by carbohydrate-rich foodstuffs[7].

In addition, a low-carbohydrate diet is accomplished by increases in saturated or monounsaturated fat, increasing the cardiovascular diseases risk[3]. Therefore, nutritional recommendations were being revised to moderate consumption of fats and reporting that carbohydrates are important sources of energy, fiber, vitamins, and minerals[1].

High-carbohydrate diets

The types of carbohydrates influence the postprandial glucose, insulin secretion, serum lipids, thermogenesis, substrate utilization and body composition[15,16]. This macronutrient may be classified according to the number of monosaccharide: sugars are sub-divided into monosaccharides (glucose, galactose, fructose) and disaccharides (sucrose, lactose, trehalose, maltose, isomaltulose); oligosaccharides (maltodextrins, raffinose, stachyose, fructooligosaccharides, galactooligosaccharides); polysaccharides comprise starches (amylose and amylopectin) and non-starch polysaccharides (cellulose, hemicelluloses, pectins, inulin, hydrocolloids); and hydrogenated carbohydrates (polyols)[7].

According to their physiological effects, Crapo et al. suggested that the different types of carbohydrates affect the body differently and this effect may be related to differences in digestion rather than to differences in absorption. The concept of simple and complex carbohydrates has often been used to explain the influence on blood glucose[17]. Studies showed that simple carbohydrates produce higher blood glucose, insulin responses[16,18,19] and exogenous carbohydrate oxidation (a higher respiratory quotient) than complex starches and fiber[20]. These peak glucose concentrations and higher respiratory quotient immediately after consumption of simple carbohydrates may relate to greater hunger later[21] and higher triglycerides levels[22,23]. Therefore, the nutrition recommendations began to focus on the quality of carbohydrate than the quantity alone[24]. However, the diets in most of these studies contained unusually high amounts of dietary fiber[25,26] and insoluble fibers have a greater influence on bowel function, whereas, soluble fiber may contribute to a reduction of postprandial blood glucose, serum and lipids concentrations. The content of dietary soluble fiber may affect the blood glucose response after a meal by delaying the emptying of the stomach and the passage of the food into the intestine because they are viscous and form gels in the intestine[25,26].

Very high-fiber diet (about 50g/day) are not recommended because possible negative effects on mineral absorption and reduced acceptability, being not well tolerated and impossible to eat over long time periods[25,26]. In summary, to obtain a better glycemic control, individuals with diabetes have to match doses of insulin and insulin secretagogues to the carbohydrate content of meals. A variety of methods can be used to estimate the nutrient content of meals, including carbohydrate counting, the exchange system, and experience based estimation[1].

Glycemic index and glycemic load

The ranking of specific foods based on the blood glucose response was first proposed by Jenkins et al.[27,28]. The glycemic index is a concept that ranks foods on the basis of their acute glycemic impact, using a scale of zero to hundred, with higher values given to foods that cause the fastest increase the blood glucose. To determine the glycemic index, blood samples were collected from health subjects before, during regular intervals, and 2-hours after a test food that provides 50g of carbohydrates and a control food (white bread or pure glucose) that provides the same amount of carbohydrate on different days. The changes in blood glucose over time are plotted as a curve and the glycemic index is calculated as the area under the glucose curve after the test food is eaten, divided by the corresponding area after the control food is eaten. The value is multiplied by 100 to represent a percentage of the control food[29]. The concept of glycemic load had also to be created to describe the quality and quantity of carbohydrates in a meal or diet. The glycemic load is calculated by multiplying the glycemic index value by the grams of available carbohydrates in the serving and dividing by 100[29]. However, several factors may affect the glycemic index of a food, among them we can mention: the fat and protein content of food (a lower glycemic index is associated with a slowing of gastric emptying); the presence of soluble fibers (that slow absorption of the carbohydrates); the type of carbohydrate (fructose have a lower glycemic index than sucrose and glucose); the ripeness of fruit; the food preparation (such as grinding or cooking because it makes those food quicker and easier to digest); individual differences (glycemic response is different from one person to another, and even in the same person from day to day)[30,31].

The difficulty to adoption this diet is another disadvantage because there are a limited number of foods with their respective glycemic index[30,31]. Similar foods could have different glycemic index values and it is not possible to estimate glycemic index from either food type or composition[30-32].

The American Diabetes Association based on methodological studies concluded that there is insufficient evidence of substantial long-term benefit to recommend use of glycemic index in the management of diabetes[1,33].

Exchange lists

Created in the 1950s, the exchange lists have foods with the same amount of carbohydrate, protein, fat and calories, allowing a more flexibility in choosing foods because each meal may be exchanged for any other food on the list[34].

The meals are grouped according the macronutrients compositions: carbohydrate group contains approximately 15g of carbohydrates, 3-8g of protein, less than 1g of fat and 25-80 calories in each portion; the items in fat group contain approximately 5g of fat and are composed for monounsaturated, polyunsaturated and saturated fatty acids lists; each serving in meat group contains about 7g of protein, and the amount of carbohydrates, fat and calories varies, depending on the choice; the free food contains less than 20 calories or less than 5g of carbohydrates per serving[35].

To use the exchange lists, the subjects with diabetes needs an individualized meal plan with the number of exchanges from each list for each meal.

A disadvantage of the food exchange system is the different types of foods that included in the same group, for example we may mention the monounsaturated should be substituted for saturated fats or fruits may be exchange by breads[36,37].

Carbohydrate-counting

As previous describe, carbohydrates is the primary nutrient that affects the postprandial glycemic response because 100% of carbohydrate must be converted to glucose, while, 35-60% of protein and 10% of fat can be converted to glucose. Thus, monitoring total grams of carbohydrates intake is a key strategy in achieving glycemic control, since the total amount of carbohydrates in meals or snacks is more important than the source or type[1,38]. Carbohydrate-counting had been created in Europe and adopted by The Diabetes Control and Complication Trial in the 1990s that used to helping people achieve glycemic control while allowing flexibility in their food choice[39]. There are three levels of carbohydrate counting[38], however the basic and advanced carbohydrate counting are the common methods used currently in clinical practice[40-42].

At the basic level, individuals must eat a consistent amount of carbohydrates at meals. It is useful to understand the effect of food and medication and to identify normal portion sizes, considering that one serving is equal to 15 g of carbohydrates. The advanced level includes pattern management and understanding how to use insulin to carbohydrate ratios[38].

Advanced carbohydrate counting should be adopted in type 1 diabetes considering that the subjects have to use insulin-to-carbohydrate ratios. To determining this ratio, the diabetes educator divides the grams of carbohydrates in a meal by the units of bolus insulin given[5].

Carbohydrates counting also have disadvantages. Requires the ability to determine the amount of carbohydrates in each food (particularly in homemade recipes), and it may promote weight gain when patients don't pay attention to their food choices[41].

High-fat diets

As described previously, a small amount of fat is converted into glucose[43]. Therefore, adolescents with type 1 diabetes sometimes consume fewer calories from carbohydrates and exceed the recommended levels of fat intake because their families may perceive foods high in fat and cholesterol as more acceptable than carbohydrates, avoiding foods high in sugar[44]. This occurs probably because of a delay in gastric emptying, which may be mediated through an effect of fat on the duodenum and/or ileum[45].

High fat diets are not recommended because may be related to overweight or obesity in patients with type 1[46,47] and 2 diabetes[48].

In addition, study assessing patients with type 2 diabetes have shown that a high intake of saturated fat is associated with increased risk of coronary heart disease, whereas high intakes of polyunsaturated and monounsaturated fatty acids are associated with reduced risk[49]. Others results were found in patients with type 1 diabetes, suggesting that these individuals have a low cholesterol synthesis high cholesterol absorption compared with healthy or patients with type 2 diabetes[50-52].

There is still much speculation about the reasons for these differences in cholesterol absorption and synthesis between patients with type 1 and type 2 diabetes.

However, glycated haemoglobin was associated with saturated fat and there was no evidence of an association with monounsaturated or polyunsaturated fat intake[53]. Several mechanisms have been proposed that may link dietary fat intake and glycemia, nevertheless, among some general aspects of potential theory to explain is that of the dietary fat may have an effect on glycemia through obesity, promoting a body weight gain, which is in turn associated with insulin resistance in type 2 diabetes[54]. Additionally, a meta-analysis including ten randomized, crossover trials with type 2 diabetes revealed that high-monounsaturated-fat diets improve lipoprotein profiles and the glycemic control for patients with type and type 2 diabetes[55]. Although, the diet conditions of most studies have contained higher amounts of monounsaturated fatty acids (average 30% of energy) and achieve these recommended levels of intake is very difficult[56].

High-protein diets

The bedtime snack always included a cup of milk always because protein is a good source of long-term energy, providing a sustained elevation in blood glucose concentrations and prevents recurrent (or nocturnal) hypoglycemia[1], since, the glucose produced from ingested protein does not increase blood glucose[57], however, excessive protein intake increased renal function in diabetics, leading to renal problems[58]. Diabetic nephropathy is a commonly complication occurred due to persistent high blood glucose levels, increasing the glomerular filtration rate and persistent microalbuminuria[59-61]. Thus, high-protein diets are not recommended[1].

Currently recommendations and future perspectives

The American Diabetes Association[1] recommends a dietary intake similar to that of the general public, in other words, equal reported in the Dietary Reference Intakes[62]: energy content of 45-55% carbohydrate (14g of fiber per 1,000 kcal and ≤ 10% of simple carbohydrate); 15-20% of protein; less than 30% of total fat (≤ 7% of saturated, 10-15% of monounsaturated and ≤10% of polyunsaturated fatty acids). The current American Diabetes Association recommendations are based on evidence regarding the effects of diet in reducing body weight and cardiovascular risk factors. However, not all patients require a caloric restriction and there are several differences between types of diabetes (type 1, type 2, gestational diabetes, maturity onset diabetes of the young, latent autoimmune diabetes mellitus in adults, and other forms of diabetes) that require others specific therapies (as example: prevent hypoglycemia, ketoacidosis, kidney and renal diseases).

Therefore, the ideal macronutrient distribution varies by circumstances (like as, body weight, ethnic differences, socio-cultural perceptions, beliefs, attitudes). Even as more effective treatments with oral hypoglycemic agents and insulin analogs with improved pharmacokinetic profiles are developed, the nutritionists should master counseling skills to assist their patients in acquiring knowledge to control nonroutine situations like parties, illness/disorders, fasting preparation before surgery, and other situations.

Conclusions

The macronutrient distribution depending on individual circumstances and each patient should receive individualized dietary counseling to optimize their blood glucose control.

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