Review

LOW CARBOHYDRATE OR HIGH CARBOHYDRATE: WHAT IS RIGHT?

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ABSTRACT

This review examines the role of high and low carbohydrate diets from the angle of their effect on glycemic control, blood lipids and body weight. The issue of high carbohydrates or low carbohydrates is intertwined with low or high fat intake because the protein intake is usually fixed around 12-20 % of energy intake. High carbohydrate diets such as the Dean Ornish diet was found to increase the lipids, especially triglycerides. A 10% substitution of fat by carbohydrate increased the VLDL profoundly. High carbohydrate diets also resulted in deterioration of insulin resistance and glycemic control. High carbohydrate, low fat diets have played a great role in weight loss and weight maintenance programs. Low carbohydrate diets usually tend to be high fat and/or high protein. Low carbohydrate, low fat, high protein diets which were also hypocaloric e.g. the South beach diet and Zone diet were found to influence the triglycerides favorably, ameliorate insulin resistance and retain lean body mass. Yet, some side-effects like ketosis, gout and increased LDL were seen .In this regard, recent interest in high-fat, high-protein diet of Atkins requires critical analysis. The positive feature of such a diet is carbohydrate restriction, which may be a very important maneuver in Asian Indians. However, an indiscriminate increase in fat intake may be undesirable. Also, the fat intake should occur mainly in the form of kindly fats, like MUFA with a parallel decrease in SFA and trans-fatty acids. In our study, based on 3-day dietary recall, we found high carbohydrate intake; high overall fat consumption, high SFA and PUFA, and unusually low MUFA and protein consumption. This study shows that we need both a quantitative and a qualitative correction in the dietary constituents.

In obesity the weight loss regime recommended is a low carbohydrate, high protein, and moderate MUFA fat diet. Future guidelines for the nutrition management of diabetes should strike a fine balance without a major increase or decrease in macronutrients. Also, the right amount and type of carbohydrate needs to be steered in the correct direction. Hence, a recommendation of 40% carbohydrate, 20% protein and 40% fat (MUFA, omega-3) appears correct. In the nineties, the role of MUFA versus carbohydrate in the management of diabetes emerged as an important concept. In Type 2 diabetes, a high MUFA diet was associated with improved glycemic control and decreased insulin dosage. In addition, a high MUFA diet reduced triglyceride levels and increased HDL-cholesterol. The LDL-cholesterol was not much altered by the high MUFA diet. The debate between high MUFA and/or low carbohydrate diet as a nutrition management strategy in diabetes and obesity continues. High triglyceride levels are common in obesity, diabetes and as a part of syndrome X. In this setting, especially in the presence of impaired glucose tolerance, diabetes and obesity, lowering of triglycerides has become an important objective. Here again the low carbohydrate, high MUFA diet is beneficial.

KEY WORDS: Low carbohydrate diet; High carbohydrate diet; High protein diet; Obesity; Monounsaturated fat.

INTRODUCTION

Medical nutrition therapy is crucial in the management of diabetes mellitus and its associated complications. The optimum proportion of the different macronutrients is debatable. The controversy of low or high carbohydrate (CHO) content of the diet is still under constant discussion and this issue is yet to be resolved.

HISTORICAL PERSPECTIVE

In a diet for diabetes the macronutrients exert a see-saw effect. When the CHO content is low, it implies an increase in the fat content, whereas when the CHO content is high, it implies a low fat content in the diet. Generally, the protein content remains fixed at 12 to 15% of energy intake. Thus it can only vary by 3 – 5%.

The last four decades have witnessed major turn of events in the recommendations of CHO and other

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macronutrient content of diet. The relationship of dietary cholesterol and fat to atherosclerosis was established as early as the 1950's (1). At this point the distribution of calories was 40% carbohydrate, 40% fat and 20% protein. In the sixties, the relationship of total fat and especially saturated fat (SFA) to serum cholesterol was established. The benefits of polyunsaturated fatty acids (PUFA) and its ratio to SFA were set at 3:1. The total fat intake was advised to be at about 35% of calories (2). Simultaneously, simple CHO's were found to raise triglycerides (TG's) very significantly in the disease states. In fact, substitution of the simple CHO by complex CHO concomitantly with an increase in dietary fibre, especially of the soluble variety, was found to be a very important health promoting maneuver. The concept of Glycemic index (GI) of foods was also initiated and studied extensively (3).

The next decade brought a substantial increase to 55% as CHO from total calories and a downward revision of fat to 25–35 % and protein to 15% of total calories. An equal division into SFA: MUFA: PUFA was considered desirable. Certain adverse effects of PUFA were demonstrated; for example, ability to cause increased peroxidation and generation of free oxygen radicals (4).

The 1990's continued with a similar trend of macronutrient distribution but with a positive qualitative difference in the ratio of SFA : MUFA : PUFA to 0.8 : 1.5: 1. The role of MUFA versus CHO in the management of diabetes emerged as an important concept. In type 2 diabetes, a high MUFA diet was associated with improved glycemic control and decreased insulin dosage (5) .

At our centre, DENMARC we conducted a study comparing the blood lipid trends with different oil blends (6). In this study, a three day dietary recall was taken. The composition of macronutrient intake was calculated for a patient population from South Mumbai who were educated and affluent. Baseline data revealed that the nutrient intake in both, diabetic and non-diabetic was similar. However, the CHO intake was 52%. Thus there is a downward trend of CHO consumption in this population. The protein intake was 13% and fat intake was 35%. This trend is likely to be a desirable one except that the type of fat consumed is the unkindly type which is detrimental to the cardiovascular system and hence requires both quantitative and qualitative correction.

CARBOHYDRATE CONTENT AND METABOLIC PARAMETERS

The CHO content of the diet impacts various metabolic parameters such as glycemia, insulin resistance and lipid profile; as well as body weight. These parameters need to be dealt with individually.

The type of carbohydrate has a profound effect on the metabolic parameters. Most simple carbohydrates like mono- and disaccharides are known to have a high GI, raise blood TG levels and increase insulin resistance (IR). The exceptions to this are fructose, lactose and sucrose (7). Ingestion of fructose upto 50–60 g/day does not raise TG levels. Complex CHO's are desirable components of dietary fibre in the diet for diabetes which are non-absorbable and non-calorigenic. They are known to exert a positive effect on blood glucose and lipids and hence play a beneficial role in a diet for diabetes. An exception is starch rich in amylopectin which has a higher GI than most complex CHO's (8). Hence, the overall effect of the CHO content of the diet on metabolic parameters is both quantitative and qualitative. This effect is determined more by the glycemic load (GL), a combination of the GI and carbohydrate content of the food (9).

HIGH-CARBOHYDRATE DIETS

The impact of a high CHO diet is mainly seen as severe post-prandial glycemia and an increase in IR. A study was conducted in type 2 diabetic individuals with a comparison of low GI and high GI foods (10). One group was administered a diet recommended by the American Diabetic Association (ADA diet) which comprised of 55% CHO, 15% protein, 30% fat, 24g/d dietary fibre in the ratio 1:2 for soluble fibre (SF): insoluble fibre (IF). The other group was given an equicaloric, high-fibre diet containing 55% CHO, 15% protein, 30% fat, and 50 g/d dietary fibre in the ratio 1:1 for SF:IF. After six weeks, the high fibre diet was seen to reduce the blood glucose and glycosylated hemoglobin (GHb); TG, total cholesterol (TC), very low-density lipoprotein (VLDL), low-density lipoprotein (LDL) and insulin resistance. The high-density lipoprotein (HDL) was unchanged. This beneficial effect was attributed to the high dietary fibre content (especially soluble fibre) in the diet.

Dietary fibre especially increases satiety but has a poor palatability. Such low GI CHO's which are observed to positively affect IR, lower HbA_{1c}, provide

better satiety than high GI CHO's (11). This is required to be considered in weight maintenance and weight loss programs.

An eminent example of high carbohydrate diets such as the Dean Ornish diet is found to unfavorably increase the lipids, especially TG and decrease the HDL (12). As this diet is low in fat it is likely to cause essential fatty acid deficiency. Although the metabolic parameters are found to be adverse clinically, by virtue of being a low fat diet, considerable benefit in the reversal of ischemic heart disease is seen.

Overall metabolic parameters are impacted unfavorably by high CHO diets, but this effect seems to disappear a year down the line. These changes are not considered entirely detrimental as they stabilize gradually as the body makes its own adjustments on a long-term basis. This indicates that such changes occur more acutely and sub-acutely and not chronically. A 10 % substitution of fat by CHO is seen to alter the VLDL profoundly and discussion on the beneficial effect of replacing CHO with fat in management of diabetes continues (13).

LOW CARBOHYDRATE DIETS

Low CHO diets correspondingly tend to be high fat and/or high protein. Low CHO, low fat, high protein diets which were also low calorie eg. the South beach diet and Zone diet are found to influence TG's favorably, ameliorate insulin resistance and retain lean body mass. Yet, some side-effects like ketosis, gout and increased LDL are seen (14). Similarly very low carbohydrate diets with high–fat, high-protein such as the popular Atkins diet requires critical analysis. This is a much discussed diet for which scientific validation has been done recently. The positive feature of such a diet is carbohydrate restriction, which may be a very important maneuver in Asian Indians. However, an indiscriminate increase in the fat intake may be undesirable. Also, the fat intake should occur mainly in the form of kindly fats, like MUFA with a parallel decrease in SFA and trans-fatty acids.

EFFECT OF CARBOHYDRATE CONTENT

Carbohydrate intake affects the multi-metabolic syndrome, also known as insulin-resistance syndrome or syndrome 'X'. About one-third of the individuals suffering from the multi-metabolic syndrome have diabetes as an integral part of their disease.

It is important to note the characteristic lipid pattern in Indians, with or without the metabolic syndrome as compared to the western Caucasian population. Both, persons with diabetes and those without diabetes are likely to suffer. A typical lipid profile of an Indian shows elevated TG, marginally high TC, low HDL and elevated Lp(a); a deadly lipid quartet. Hence, high or low CHO content has to take these abnormalities into consideration. This typical atherogenic phenotype shows a 75% incidence in Asians as compared to 25% incidence in Westerners.

The see-saw battle between CHO and fat content has emerged through further studies. Grundy laid down some guidelines for the general population. He suggested that neither low fat nor conversely high CHO is required for the population (15). A recommendation of moderate fat content in terms of quantity is advisable with emphasis on the quality of fat being mainly MUFA and PUFA and a reduction in SFA and trans-fatty acids. Going along this same line of thought, an important study emerged from the same group led by Garg (16). They studied type 2 individuals with diabetes where one group was subjected to a high CHO, low fat diet and the other group was given a low CHO, high fat diet (with high MUFA). The latter group showed a reduction in blood glucose, requirement of insulin dose and TG. A favorable increase in HDL was seen and the LDL remained unchanged. This data threw light on the possible benefits of a moderate CHO and fat content of diet on various metabolic parameters.

CARBOHYDRATE CONTENT AND BODY WEIGHT

Carbohydrate content of the diet also tremendously impacts body weight of an individual. Obesity, is a common accompaniment of diabetes. Which would be a more effective diet in obesity and weight management strategy? A key question is whether an individual gains or loses more weight at a faster rate on a low CHO or high CHO diet.

Another very important aspect of the macronutrient intake is the palatability of food. The organoleptic properties of food such as palatability, satiety are crucial in deciding the acceptance and hence intake of food. A high CHO diet has poor palatability and tends to have an undesirably high intake of mono- and disaccharides instead of complex CHO (17). This occurs naturally in order to offset the overall poor taste. A high fat diet has good palatability and therefore results in increased intake of this nutrient. These factors pose impediments in adherence to diet prescriptions.

The overall metabolism cannot defend itself against a high surge of nutrients and food abundance. Also, typically human behavior has difficulty in dealing with abundance as compared to deprivation of food. The regulation of fat is poor and the neurotransmitters are not tightly regulated. Hence, a large intake of fat occurs before reaching satiety. On the whole, CHO's are more efficiently regulated and tends to give immediate satiety. Carbohydrates give immediate and short-term satiety, whereas fat gives a slow, but long-term satiety (18).

The first study comparing Atkins diet to the conventional diet was conducted by Foster and his colleagues as recent as two years ago (19). Obese individuals were put on the Atkins diet which is a high-protein, high-fat diet (<20 g CHO per day) and compared to individuals put on a conventional diet with 60% CHO, 25% fat and 15% protein. The diets are not severely hypocaloric. A higher rate and amount of weight loss is seen on the Atkin's diet at the end of six months. At the end of one year a similar weight loss is seen on both diets; as the Atkins group showed some weight regain. Atkins group showed a reduction in TG levels, an increase in HDL and unfortunately, an increase in LDL levels.

A similar study conducted a year ago shed further light on the Atkins diet (20). One group of overweight, hyperlipidemic individuals were administered the Atkins diet versus a high-CHO diet. The Atkins diet contained 8% CHO, 26% protein and 68% fat, with increased consumption of animal products. The CHO content of the diet starts at less than 20g per day and is escalated weekly by 5g per day. The high CHO diet contained 52% CHO, 19% protein, 29% fat with less than 300 mg cholesterol per day and less than 10% SFA. Results are similar to the earlier study at six months. Weight loss on the Atkins diet was faster and higher as compared to the high-CHO diet. The TG levels showed a favorable reduction, HDL showed a favorable increase and LDL remained stable. Possible short-term side-effects seen are ketonuria, constipation and headache. There was also a positive adherence to the Atkins diet.

Another analogous study conducted in severely obese individuals by Samaha and colleagues showed similar results as the earlier studies with an additional benefit on IR (21). Insulin sensitivity improved on the Atkins diet as compared to the high-CHO diet. This demands a need to analyse the Atkins diet more critically in its application to diabetes and weight management strategies.

Another aspect to be considered minutely is the low-CHO, high-protein diets in obesity. An interesting study was conducted on women with weight greater than 15% above the ideal body weight. They were given the following equicaloric diets (1700 kcal/d) (22). One group was on a high-protein, low-CHO diet (1.6 g/kg/d) i.e. 39% protein, 41% CHO, 29% fat diet. The other group was on a normal protein, high-CHO diet (0.8 g/kg/d) i.e. 16% protein, 58% CHO and 26% fat diet. At ten weeks a reduction was seen in the total cholesterol, TG and LDL levels. Unfortunately, there was also a reduction in the HDL levels. Overall the high-protein, low-CHO diet caused greater weight loss. This could be attributed to the heightened thermic effect of high protein food (post-meal thermogenesis). On the whole, a diet with 0.8 to 1.5 g/kg/d of protein is considered safe for normal renal function. The high-protein, low-CHO diet provided better satiety and retained lean body mass as compared to the normal protein, high-CHO diet.

Is high CHO content of the diet a friend or a foe in the nutritional management of diabetes and obesity? Ultimately, striking a fine balance is beneficial. A desirable increase or decrease in macronutrients from the patients' current intake seems a prudent step to take. Steering the amount and type of CHO appropriately is also crucial. We seem to have come a full circle since 1950 and can summarise the future recommendations for a diet for diabetes, obesity and hyperlipidemia.We can compare these recommendations with the current dietary practices (Table 1)

Table 1: Current Nutritional Recommendations

	CHO (%)	FAT (%)	PROTEIN (%)
CURRENT INDIAN DIET (DENMARC DATA)	52	35 (low MUFA)	13
CURRENT INDIAN DIET*	62	26	12
OBESITY	Moderate (35-50)	Low (15-20)	High (20-40)
TYPE 2 DM	40	40 (MUFA & N-3)	20
HYPERLIPIDEMIA	50	30	20

*NNMG Survey, 1990

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