Is there a role for low carbohydrate diets in the management of type 2 diabetes?

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Introduction

Type 2 diabetes mellitus (DM) is associated with excess mortality and morbidity. Individuals with type 2 DM are at a significantly higher risk for both microvascular and macrovascular complications. The condition is also increasing in epidemic proportions in both developed and developing nations, with the global diabetic population predicted to rise from 118 million in 1995 to 220 million in 2010.1–3

Obesity associated diabetes accounts for the overwhelming majority of cases of type 2 DM, and obesity is the single most important modifiable risk factor for type 2 DM. Recent studies have demonstrated the powerful effect of intensive lifestyle modification on preventing or delaying the onset of type 2 DM.4,5 Furthermore, weight loss of 10 kg in an obese individual is associated with a 30% reduction in diabetes-related mortality.6 These benefits are more difficult to replicate in the free-living population, however where conventional dietary strategies are associated with only modest weight loss and poor long-term compliance.7

The traditional dietary approach for overweight diabetic patients is that of a reduced fat and high unrefined carbohydrate (CHO) intake, where weight loss is achieved through creating a negative energy balance; a 500 kcal/day deficit produces a weight loss of 0.5 kg/week.8 An opposite dietary approach is that of a low-CHO, high-protein intake, exemplified by the Atkins diet, which emerged in the early 1970s and has recently made a resurgence with the publication of Dr Robert Atkins' New Diet Revolution.9 This article will review the Atkins diet, compare it with current nutritional recommendations for type 2 DM patients, and discuss the possibility of adopting a modified version of the Atkins diet as an alternative viable dietary approach.

What is the Atkins diet?

The Atkins diet is based on the premise that dietary CHO is the main determinant of adverse glucose metabolism, inappropriate stimulation of insulin secretion and subsequent weight gain. Dr Atkins noted that despite the American obsession with low-fat foods, the population were paradoxically becoming ‘fatter’ as they consumed more simple carbohydrates. Atkins aims to break this cycle by reducing the carbohydrate intake to a ‘ketogenic level’, leading to benign dietary ketosis. There are four phases to the diet (Figure 1). Initially, CHO is restricted to 20 g/day, and then slowly added back into the diet until a person’s goal weight is achieved. The person then enters the Lifetime Maintenance stage, where typically 40–120 g CHO/day is consumed. Protein, fats and calories are unlimited, although individuals often self-restrict their energy intake, as their appetite is suppressed.

The attraction of the diet is that it is a simple regime, ‘forbidden’ foods are allowed, and it is often perceived to be more palatable than conventional slimming regimes. However, side-effects of headaches, tiredness, dizziness and GI upset can occur, and there are concerns regarding its nutritional adequacy.10 Supplements are recommended as a
1. Induction Phase - minimum of 2 weeks
   - Restrict CHO to 20g / day

   Typical menu:
   **Breakfast**
   Three-egg omelette with avocado
   Mozzarella cheese and tomato
   Decaffeinated coffee with cream
   **Lunch**
   Sirloin steak (8oz)
   Spinach and mixed lettuce salad with mushrooms, onions, celery and parmesan cheese
   **Dinner**
   Poached salmon (9oz)
   Kale or broccoli with garlic, lemon and sesame seeds

2. Second Phase
   - Increase net CHO intake by 5 g/wk until 5–10 lb from goal weight

3. Pre-Maintenance Phase
   - Increase net CHO intake by 10 g/wk until goal weight achieved
   - Maintain for 1 month

4. Lifetime Maintenance Phase
   - Typical CHO consumption 40–120 g/day

Figure 1. Phases of the Atkins diet.

key part of the Atkins regime; Dr Atkins himself reportedly took 60 or so nutritional supplements a day. It has generally been received by the medical establishment with scepticism, and potential links to atherogenicity, bone and renal disease have been documented. It therefore lay outside the parameters of conventional dietary practice, and until recently was unsupported by clinical trial data.

Clinical trials on Atkins diet and its clinical efficacy

A recent systematic review of published data by Bravata et al. indicated that there was insufficient evidence to make recommendations for or against the use of low-CHO, high-protein diets. However, in the last couple of years several larger studies, conducted over 6–12 months, have indicated that low-CHO diets may be more effective than low-fat diets for promoting weight loss and improving insulin sensitivity in the obese.

Samaha et al. randomized 132 severely obese patients (mean BMI 43) to either a low-CHO or a low-fat diet. Seventy-nine subjects completed the 6 month study, with similar attrition rates between the two groups. At 6 months, subjects on the low-CHO diet had a mean weight loss of 5.8 kg vs. 1.9 kg in the low-fat group ($p = 0.002$). Subjects who lost
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>5% base-line weight on the low-CHO diet had greater reductions in triglyceride levels than those who lost a similar amount of weight in the low-fat group. There was no significant difference in the total or HDL cholesterol. However, these advantages disappeared after one year, indicating that a low-CHO intake is difficult to sustain.

This was confirmed in a study of 53 healthy obese females by Brehm. Subjects randomized to the low-CHO group reduced carbohydrates to 15% of their total calorie intake at 3 months, and spontaneously restricted their energy intake to a level equal to the control subjects. However they began to add carbohydrates back into their diet, stating they could not live any longer without fruit, fruit juice, pasta and bread. This study’s results provided challenges to prevailing dietary practice, however. While subjects in both groups consumed similar calories (1200–1500 a day), those on the low-CHO diet experienced significantly more weight loss than the low-fat group at 3 and 6 months (p<0.001). They also maintained comparable levels of plasma lipids while consuming more than 50% of their calories as fat; 20% as saturated fat. This suggests a short-term reduction in total calorie intake with accompanying weight loss may have a greater impact on plasma lipids than the macronutrient constituents of the diet.

This was reinforced in Foster’s 12 month randomized trial of a low-CHO diet for obesity, in which 63 obese men and women were randomized to either a low-CHO or a low-fat diet. Professional contact was minimal, to replicate the approach used by most dieters, and this resulted in high attrition rates in both groups. Greater weight loss occurred in the low-CHO group than the low-fat group at 6 months (absolute difference approximately 4%), but the difference was not significant at one year. There was no significant difference in LDL-cholesterol concentration between the groups, suggesting that the increased weight loss associated with a low-CHO diet may offset the adverse effect of a high saturated fat intake on serum LDL-cholesterol concentrations.

The low-CHO group was also associated with greater reduction in serum triglycerides and greater increase in HDL-cholesterol levels. However, the overall effect of a low-CHO diet on the risk of CHD remains uncertain, and additional long-term studies are required to determine whether the improvement in the HDL-cholesterol–triglyceride axis has the same effect on CVD outcomes when consuming a diet high in saturated fat.

In a retrospective evaluation of data on 82 802 women in the Nurses’ Health Study, Halton et al. reported that diets low in CHO and higher in protein and fat were not associated with increased risk of coronary heart disease in women. In fact, when vegetable sources of fat and protein are chosen, these diets may moderately reduce the risk of coronary heart disease. In another study, a low-CHO diet had no significant effect on insulin, adiponectin, tumour necrosis factor alpha (TNF-α), or CRP compared to a low-fat diet at 3 months. There are also short-term data in which low-CHO diets did not increase bone turnover markers compared with controls at any time.

In summary, low-CHO diets of 6–12 months duration have no adverse effect on CVD risk factors, and show no major adverse effects to preclude their use. Meaningful weight loss is achieved, but this does not appear to be sustained beyond 6 months. Long-term trials are required to assess their safety, and studies are awaited to define the role of such diets within patients with diabetes. In the study by Samaha et al., 39% had diabetes, and the mean fasting glucose level decreased more in the low-CHO group than in the low-fat group (−9 ± 19% vs. 2 ± 7%, p = 0.02) at 6 months. A 16-week pilot diet intervention trial also demonstrated that a low-CHO, ketogenic diet can improve glycaemic control in obese type 2 DM patients (mean BMI 42), such that diabetes medications were discontinued or reduced in 17 of the 21 participants. However, to date there has been no randomized controlled trial in type 2 DM patients and health care professionals remain wary of their use, particularly as standard dietary advice from Diabetes UK does not support this approach.

Comparison of the Atkins Diet and nutritional recommendations for diabetes

Consensus-based recommendations for the nutritional management of diabetes were updated and published in September 2003, drawing upon technical reviews of the European Association for the Study of Diabetes and the American Diabetes Association. They aim to optimize metabolic and physiological outcomes in the diabetic patient, and maintain or improve health through the use of appropriate food choices. A low-fat diet, based on regular unrefined CHO foods, is encouraged; monounsaturated fat being the preferred dietary fat source, due to its lower susceptibility to lipid peroxidation. This contrasts with the CHO restrictions imposed by the Atkins diet and the free consumption of all types of fat. Consequently, a greater proportion of energy is provided by protein.
and saturated fat in the Atkins diet, and its macronutrient composition is contrary to that recommended for the diabetic population (Table 1). However, a conventional low-fat, high-CHO diet in combination with regular exercise does not always achieve a satisfactory level of weight reduction, and Diabetes UK recognizes that there is no blueprint strategy for weight-loss success. Certainly for some obese patients, the traditional approach does not work and it may be appropriate to consider a diet based on low-CHO, high-protein composition, although evidence for its long-term efficacy is lacking.22

Modified CHO diets

Until long-term safety data are obtained for low-CHO diets, a compromise may be appropriate, with the use of diets with lower CHO and modest protein intake. Such an approach has been trialled in a small-scale study led by the South-West Clinical Diabetes Research Group.23 Obese type 2 DM patients (n=102) were recruited and randomly allocated to follow either a CHO restriction diet or a low-fat diet; 79 completed the 3 month study, with similar attrition rates in each group. Weight loss was greater in the low-CHO group (−3.55±0.63 vs. −0.92±0.40 kg) and cholesterol: HDL-cholesterol ratio improved (−0.48±0.11 vs. −0.10±0.10 kg), despite a diet containing more protein, saturated fat and less fibre. On the basis of this, a two-year randomized controlled study of CHO-restriction versus a prescribed energy deficit diet, in 300 obese type 2 DM patients has been funded by Diabetes UK. The study is due to report this year, and will provide information regarding the long-term efficacy and any potential side-effects of a low-CHO diet in patients with type 2 DM.

A six-month interim report (abstract only) based on 259 type 2 DM patients revealed greater weight loss in the low-CHO group (−3.77(0.46) vs. −1.34 (0.32), p<0.0005) with no deleterious effect on glycaemic control, other risk factors or renal safety.24

Conclusion

Overall, there is growing body of evidence that low-CHO diet intervention is more effective, at least in the short term, in reducing weight and improving insulin sensitivity without significant adverse cardiovascular effects. However, more clinical trials need to be conducted to assess the effectiveness of varying degrees of low-CHO diet on weight, glycaemic control, hypertension and lipid profile in patients with type 2 DM, to resolve current controversies.

References


Table 1 Energy intake from macronutrients

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<thead>
<tr>
<th>Macronutrient</th>
<th>DUK guidelines</th>
<th>Atkins diet</th>
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<tr>
<td>Carbohydrate</td>
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<tr>
<td>Fat</td>
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<td>Protein</td>
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Data are percentages of daily energy intake. DUK, Diabetes UK.


