CASE REPORT

Diabetes Management

Meal frequency and diabetes: A case study

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ABSTRACT

Research evidence as well as my own testing of it in connection with diabetes self-management has shown me three things with powerful glucoregulatory effects. These are circadian-friendly carbohydrate intake, making use of the second meal effect and higher meal frequency. As long as meal timing is optimal meal frequency can be flexible. Hypoglycemia or hyperglycemia may occur at very low meal frequency but satiety is better. Higher meal frequencies (4-7 meals a day) offer better glucose control.

Abbreviations: (TIR): Time-In-Range; (CGM): Continuous Glucose Monitoring; (MG): Mean Glucose; (PPG): Postprandial Glucose

KEYWORDS

- coronary artery
- vascular fistula
- coil
- coronary intervention

Introduction

Out of the three common meal habits, meal composition, meal timing and meal frequency, the importance of meal composition for people with diabetes is well established [1,2]. Meals are healthier when extra fiber, lean protein, non-starchy vegetables, and healthy fat are added to the plate with the appropriate amount of carbohydrates. Findings on meal timing are also supported by plentiful data [2]. There are, however, significant inconsistencies regarding meal frequency [3-10].

Studies in the early nineties showed that there were metabolic benefits-lower glucose levels, lipids, insulin, c-peptide and free fatty acids with higher meal frequencies [3,4]. Jenkins et al. found 17 meals, the 'nibbling diet', offered lower levels of lipids, insulin and c-peptide Bertelsen et al. noticed a two -meal had higher level glucose, insulin and free fatty acids compared to a six-meal diet [4]. Recent trials, on the other hand, have shown that lower meal frequency resulted in many benefits [5,6]. Jakubowicz et al. compared the effects of a three-meal a day diet (3Mdiet) with a six-meal a day diet (6Mdiet) for 12 weeks in type 2 diabetes patients [5]. The 3Mdiet where most of the carbs were eaten earlier in the day was better than the 6Mdiet in improving weight, A1C, fasting glucose, cravings, insulin dose and up regulation of clock genes. Kahleova et al. reported after a similar study that 2 meals, breakfast and lunch, were better than 6 meals a day, in improving weight, liver fat, fasting glucose, C-peptide, glucagon and oral glucose insulin sensitivity, although there were hypoglycemia episodes [6]. Other reports also showed that early eating offered metabolic benefits [7,8] and reduced systemic inflammation [9,10]. However, Pavoli et al. favored lower meal frequency and Marinac et al. favored higher meal frequency for general health.

The main message from these trials [5,6] is that when meal timing is skewed toward the earlier hours of the day the meals fall in phase with the circadian clock and many good things follow. The 6-Mdiet in these trials did not have circadian-friendly carb distribution. Meal timing was not optimal in the earlier studies. For example, the three-meal diet in the Jenkins study [3] had more calories at supper (30%: 30%: 40%). A late snack was included in the Bertelsen study [4].

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Blood glucose levels are sensitive to numerous variables. When more than one variable is present, the results may seem inconsistent depending upon the design of the study. It is not clear what the ideal meal frequency is when meal timing is optimal, especially in hypoglycemia-prone individuals. People with hypoglycemia risk are advised to eat small meals frequently. This report shows how a type 2 diabetes patient with CGM (Dexcom G6) resolved this issue for herself as part of diabetes self-management.

Case Study

A type 2 diabetes patient with history of hypoglycemia unawareness, I had been eating most of my carb servings in the early part of the day [2], but because of the hypoglycemia risk, my meal frequency had been 5-7 a day. After seeing these reports on meal timing [5-10,11], I wondered whether I could lower my meal frequency safely, thereby improving diabetes management. I sought to test the effects of different meal frequencies using identical meals for three days. Medications, metformin 1000 mg twice a day and semaglutide 1 mg by injection once a week, were continued. No elective physical activity was done on these days. Most of the carbs were consumed earlier in the day. The meals included 12 carbs (180 grams of carbohydrates) a day. These tests were performed as integral parts of diabetes self-management under the supervision of Dr. Christine Signore, my endocrinologist.

Results

Figure 1A shows the glucose profile of a 7-meal day (carb ratio ½: 3: 2½: 2: 1½: 1½: 1). Glycemic variability is low, Time-In-Range (TIR) is 100% and daily mean glucose (MG) is 116 mg/dL. Next, a 3-meal day was tried as the 3Mdiet in the Jakubowicz trial [5], with calorie distribution of 50%, 40% and 10% for breakfast, lunch and dinner, respectively (Figure 1B). Breakfast consisted of the first three meals of the 7-meal day, lunch was made up of the next three meals, and supper was one carb. The carb ratio for the day was 6: 5: 1. Figure 1B shows post-meal glucose peaks following breakfast and lunch exceeding 180 mg/dL: the PPGs are 190, 199 and 174 mg/dL, respectively. TIR goes down to 94% and MG rises to 121 mg/dL. But satiety is very good. Next, I tried splitting breakfast into two, a pre-breakfast snack (½ carb) in the morning and the rest (5½ carbs) 90 minutes later. The idea was to capitalize on the second meal effect [2,12,13]. Glucose tolerance is worse in the morning and a high protein low carb snack was expected to trigger the second meal effect with the next meal and thereby moderate the post-meal peak [12]. The 4-meal option Figure 1C has PPGs 161, 140, 161 and 151 mg/dL, TIR is 100% and MG 118 mg/dL.

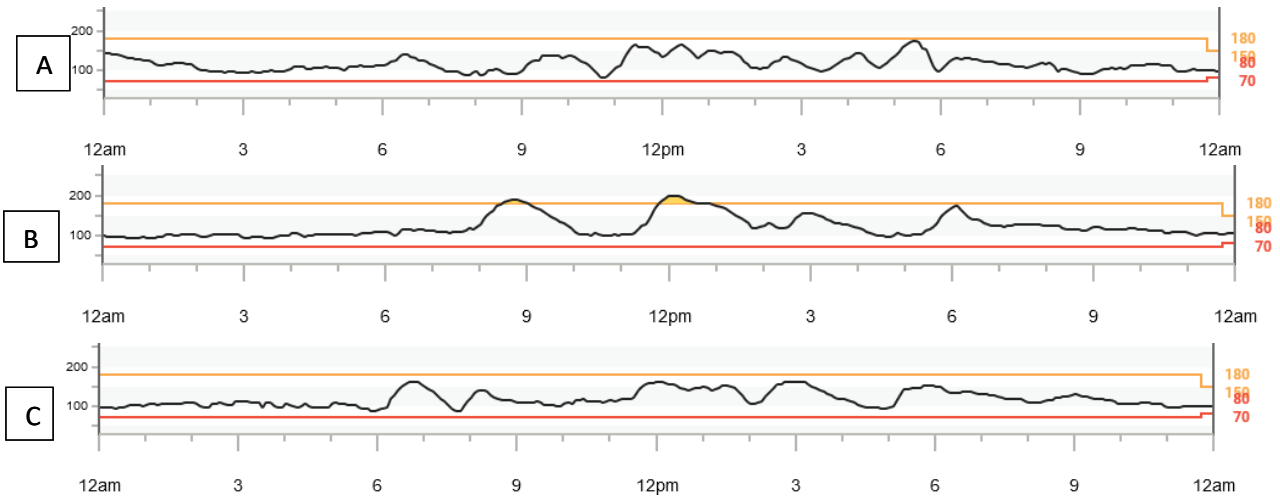

Figure 1. Early eating and different meal frequencies (a) meal day; carb ratio, ½: 3: 2½: 2: 1½: 1½: 1; TIR 100%; MG 116 mg/dL (b) 3-meal day; carb ratio, 6: 5: 1; post-meal peaks 190, 199 and 174 mg/dL; TIR 94%; MG 121 mg/dL 9 (c) 4-meal day; carb ratio ½: 5½: 5: 1; Post-meal peaks 161, 140.161 and 151; TIR 100%; MG 118 mg/dL

Discussion

When the bulk of the carbs are consumed earlier in the day, mean glucose is good (116-121 mg/dL) on all three days. The projected A1C values fall below 6%. The 3-meal day has more time spent in hyperglycemia (**Figure 1B**) and improved satiety as in the Jakubowicz trial [5]. The second meal effect from the morning snack improves post-meal glucose surge of the breakfast making the 4-meal day (**Figure 1C**) Better than the three-meal day (**Figure 1B**). Glycemic variability and mean glucose are best for the 7-meal day (**Figure 1A**). On the 4-meal day meals are bigger, the postprandial glucose surge is wider, the risk of hypoglycemia is low and satiety is a lot better than on the 7-meal day. The 2-meal diet triggered more post-meal hyperglycemia [4] and hypoglycemia [6]. On the basis of the existing data and my experiments, early eating [5-10,11], morning snack [12] and higher meal frequency [3,4,10] offer benefits to people with diabetes. This is because people with diabetes have poor glucose tolerance in the morning and evening [14,15]. The pre-breakfast snack definitely offers glycemia benefits for breakfast *via* the second meal effect. As long as most of the carbs were consumed in the early part of the day, meal frequency can be flexible: I could have 4, 5, 6, or 7 meals a day. Lower frequency may offer hyperglycemia [4], hypoglycemia [6] and satiety [5]. Higher meal frequency offers metabolic benefits in (Figure 1A), a result that is in agreement with multiple st--udies[3,4,10]. A good meal plan for me is a high-protein low-carb morning snack, a big breakfast in 90 to 120 minutes, moderate lunch and a light, early supper. If hypoglycemia is an issue it can be countered using one or two extra snacks as needed.

Conclusion

Circadian-friendly carb intake, taking advantage of the second meal effect and higher meal frequency without excessive carb intake is valuable lifestyle habits for people with diabetes If hypoglycemia is an issue it can be countered using one or two extra snacks as needed.

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Duality of interest

No potential conflicts of interest to this article were reported.

Author Contributions

The corresponding author is the guarantor of this work and, as such, had full access to all the data and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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