ELSEVIER

Use of Uncooked Cornstarch to Avert Nocturnal Hypoglycemia in Children and Adolescents With Type I Diabetes

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ABSTRACT

Intensive management of type I diabetes mellitus may lead to a significant increase in hypoglycemia. This study evaluated the use of uncooked cornstarch to avert hypoglycemia in 13 patients, ages 3.0–17.5 years, with diabetes and a history of nighttime hypoglycemia. The usual bedtime snack (Standard Snack Period) was given for 14 days followed by 14 days in which 25%–50% of the carbohydrate content was given as uncooked cornstarch in milk (Test Snack Period). Blood glucose levels were obtained at 0200 and before breakfast during the 28-day study. No difference was found between the mean (± SD) before breakfast blood glucose levels during the two periods; however, the mean (± SD) number of hypoglycemic episodes (blood glucose <60 mg/dL or 3.3 mmol/L) was reduced significantly during the Test Snack Period at both 0200 ($p < 0.025$) and before breakfast ($p < 0.01$) compared to Standard Snack Period (Standard Snack 2.00 ± 2.12 versus Test Snack 0.61 ± 0.87 at 0200, Standard Snack 2.61 ± 2.25 versus Test Snack 0.69 ± 1.03 before breakfast). In addition, in four children who were evaluated with every-2-h glucose levels through the night, stable glycemia was achieved after cornstarch ingestion. Our results suggest that uncooked cornstarch may be useful to decrease the frequency of nocturnal hypoglycemia in type I diabetes patients. This low-cost, simple intervention might be considered as an adjunctive therapy to diminish the risk of intensive diabetes management. (Journal of Diabetes and Its Complications 10;2: 84–87, 1996.)

INTRODUCTION

Recent studies, particularly the Diabetes Control and Complication Trial (DCCT), have demonstrated that meticulous glycemic control can markedly decrease the incidence and progression of the chronic complications of type I diabetes mellitus, including retinopathy, nephropathy and neuropathy. [1-3] Yet the implementation of intensive therapy and careful glycemic control confers a threefold increase in risk of severe hypoglycemia, particularly that which occurs at night. The risk of hypoglycemia is the major limiting factor in the attainment of glycemic control in type I diabetes.[4-6] Therefore, it is imperative to develop clinical strategies aimed at diminishing the hypoglycemia that complicates intensive diabetes management.

Uncooked cornstarch has been used effectively to combat hypoglycemia associated with glycogen storage disease.[7,8] By ingesting up to 1.75–2.5 g/kg ideal body weight of uncooked cornstarch every 6 h, patients with this rare inborn error of metabolism have

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had marked improvement in their blood glucose levels and overall metabolic status. Normalization of the blood glucose level (>70 mg/d or >3.9 mmol/L) is maintained for up to 6 h. This intervention has allowed for most patients to discontinue nocturnal gastrostomy or nasogastric feedings, while still maintaining euglycemia.

In 1993, Ververs et al,[9] evaluated the effectiveness of uncooked cornstarch in subjects with diabetes mellitus. A standard evening snack was compared to a test snack of uncooked cornstarch in water with flavor additives. The total carbohydrate content was the same but the test snack did not contain mono or disaccharides. However, in this study cornstarch did not completely prevent hypoglycemia (although there was a reduction in hypoglycemic episodes), possibly because it was given as the entire evening snack without simple or semi complex carbohydrate.

The present study was undertaken to determine if uncooked cornstarch, given at a dosage of 25% - 50% of the carbohydrate component of the evening snack, could diminish the incidence and severity of low blood glucose in children and adolescents with a previous history of nocturnal hypoglycemia, and whether this could be accomplished without deteriorating overall glycemic control.

STUDY DESIGN

Thirteen subjects followed at Childrens Hospital Los Angeles, between the ages of 3.0 and 17.5 years, and with type I diabetes for 1-10.5 years, participated in this study (**Table 1**). Patients were selected to participate if they had a history of hypoglycemia and successfully followed the prescribed intensive diabetes regimen. The regimen consisted of 2-3 insulin injections per day or continuous subcutaneous insulin infusion, a standard meal plan, a minimum of five fingerstick glucose determinations per day with a glucose reflectance meter, including obtaining a glucose level at 0200 hours, and successfully utilizing an insulin dosage-adjustment algorithm.

Subjects recorded 14 days of fingerstick blood glucose levels before breakfast, lunch, dinner, bedtime, and 0200 hours while ingesting their standard meal plan (Standard Snack Period), which consisted of approximately 2000 calories per square meter, divided as 50% carbohydrate, 30% fat, and 20% protein. The distribution was as three meals and two to three snacks per day, a snack being 10% of the daily calories. During the following 14 days, subjects ingested 25%-50% of the carbohydrate component of the evening snack as uncooked cornstarch (5-15 g of cornstarch) added to milk (Test Snack Period), with no other change in dietary plan. The dosage of cornstarch was determined by age, so that subjects younger than 12 years used 50% and subjects 12 years and older used 25% of the snack carbohydrate component as cornstarch. Blood glucose monitoring was done as it had been during the standard meal plan. Subjects were asked to record any gastrointestinal or other side effects during the Test Snack Period.

The 14-day periods were compared with student's *t* test.

In addition, four other subjects were evaluated as to the effect of uncooked cornstarch on an 8-h blood glucose profile. These patients, between the ages of 4

TABLE 1. PATIENT DEMOGRAPHICS

Patient Number	Age	Sex	yrs DM	Injections/ day	HbA_{1C}%
1	14.5	M	6	3	7.8
2	3	M	1	2	6.3
3	12.5	F	4	3	5.7
4	17.5	F	10.5	CSII	7.6
5	5.75	M	3.5	2	7.4
6	6.5	M	3	3	6.2
7	11	F	4	2	7.1
8	14.5	M	3	2	7.8
9	17.5	M	5	3	7.1
10	9	M	3	2	7
11	12	M	7	3	5.9
12	4	F	2	2	6.8
13	5.5	F	1	2	6
Means	10.3 ± 5	4 F; 9 M	4.1 ± 2.6	2.5 ± 0.5	6.8 ± 0.7

TABLE 2. MEAN BEFORE BREAKFAST BLOOD GLUCOSE LEVELS FOR THE 2 WEEKS OF STANDARD AND THE 2 WEEKS OF TEST SNACK (CORNSTARCH)

Patient Number	2 Weeks Standard		2 Weeks Test	
	(mg/dl)	(mmol/L)	(mg/dl)	(mmol/L)
1	184 ± 80	10.1 ± 4.4	143 ± 41	7.9 ± 2.3
2	169 ± 92	9.3 ± 5.1	148 ± 31	8.1 ± 1.7
3	61 ± 11	3.3 ± 0.6	77 ± 31	4.2 ± 1.7
4	188 ± 59	10.3 ± 3.2	124 ± 68	6.8 ± 3.7
5	141 ± 92	7.8 ± 5.1	168 ± 77	9.2 ± 4.2
6	182 ± 81	10.0 ± 4.5	151 ± 40	8.3 ± 2.2
7	116 ± 52	6.4 ± 2.9	125 ± 62	6.9 ± 3.4
8	126 ± 52	6.9 ± 2.9	165 ± 69	9.1 ± 3.8
9	82 ± 39	4.5 ± 2.1	150 ± 73	8.3 ± 4.0
10	129 ± 51	7.1 ± 2.8	135 ± 62	7.4 ± 3.4
11	144 ± 85	7.9 ± 4.7	125 ± 67	6.9 ± 3.7
12	133 ± 39	7.3 ± 2.1	141 ± 23	7.8 ± 1.3
13	145 ± 40	8.0 ± 2.2	207 ± 74	11.4 ± 4.1
Means	138 ± 38	7.6 ± 2.1	143 ± 30	7.9 ± 1.7
		$p > 0.10$		

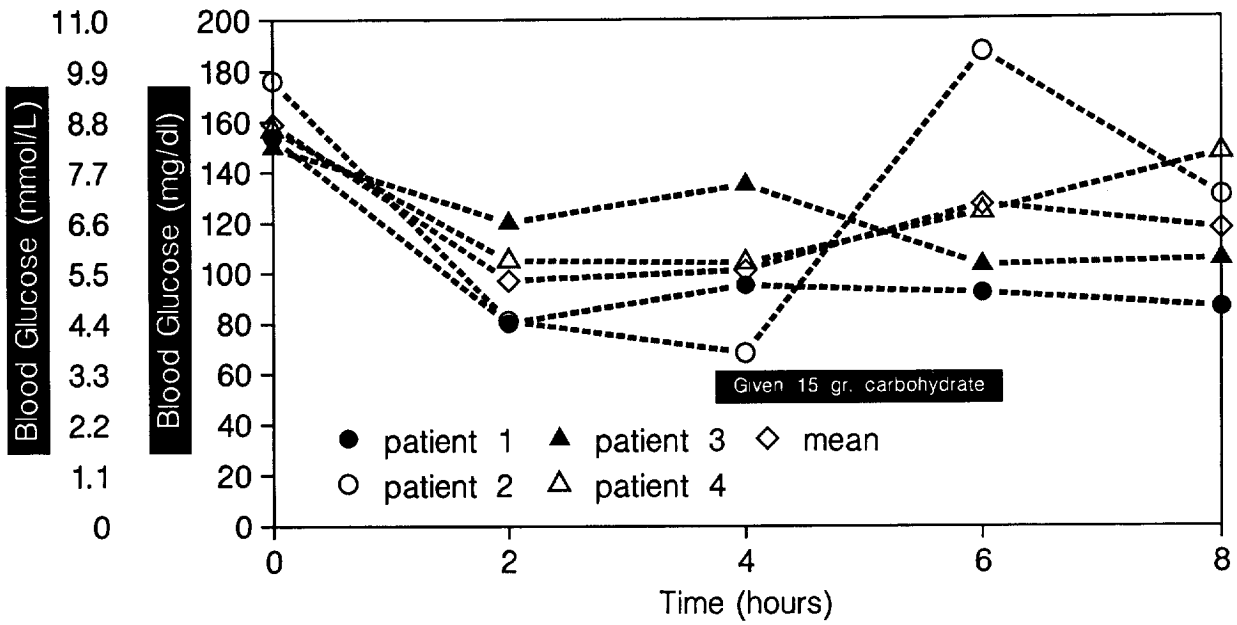

FIGURE 1 *Individual and group mean blood glucose levels q 2 h × 8 in four patients after Test Snack (cornstarch).*

and 16 years, were studied after recovery from diabetic ketoacidosis in the inpatient diabetes unit at Childrens Hospital Los Angeles. On the night prior to discharge, after resolution of ketosis and dehydration with near normalization of blood glucose levels, and while receiving an appropriate subcutaneous insulin regimen, they were given their evening snack with 25% of the carbohydrate component as uncooked cornstarch (added to milk). Fingerstick blood glucose levels were monitored every 2 h through the night by nursing staff with a glucose reflectance meter. Informed consent was obtained from the patient and/or parents prior to entry into this study.

TABLE 3. NUMBER OF HYPOGLYCEMIC EPISODES (BLOOD GLUCOSE LESS THAN 60 mg/dL OR 3 mmol/L) AT 0200 AND BEFORE BREAKFAST FOR THE STANDARD AND TEST SNACK PERIODS

	At 0200		Before Breakfast	
Patient	2 Weeks		2 Weeks	
Number	Standard	Test	Standard	Test
1	2	0	0	0
2	2	0	7	0
3	7	2	3	3
4	0	0	0	0
5	3	2	3	2
6	0	0	0	0
7	2	0	4	0
8	1	1	0	0
9	3	0	1	0
10	0	1	5	1
11	5	2	4	2
12	1	0	3	0
13	0	0	4	1
Means	2 ± 2.12	0.61 ± 0.87	2.61 ± 2.25	0.69 ± 1.03

$p < 0.025$; $p < 0.010$.

RESULTS

As shown in **Table 2**, there was no significant difference ($p > 0.1$) between the mean (± SD) before breakfast blood glucose levels during the Standard (138 ± 38 mg/d or 7.6 ± 2.1 mmol/L) and the Test Snack Periods (143 ± 30 mg/d or 7.9 ± 1.7 mmol/L). These values were within the range of targeted glycemia for our clinic, which for before breakfast is 80–150 mg/d or 4.4–8.3 mmol/L. Only one subject during the Test Snack and one subject during the Standard Snack Periods had mean glucose levels that exceeded this range, while one subject in each group had mean glucose levels before breakfast in the hypoglycemic range.

There were significantly fewer mean number of hypoglycemic episodes (blood glucose less than 60 mg/d or 3.3 mmol/L) at 0200 for the Test (0.61 ± 0.87) as compared to the Standard Snack Period (2.0 ± 2.12) ($p < 0.025$). There were also fewer mean number of hypoglycemic episodes before breakfast for the Test (0.69 ± 1.03) as compared to the Standard Snack Period (2.61 ± 2.25) ($p < 0.010$).

As seen in **Figure 1**, in four patients recovering from diabetic ketoacidosis, stable blood glucose levels were achieved for 8 h post-Test Snack ingestion. There was

a decrease in the blood glucose level at 2 h, with stabilization of the level by 4 h and a slight increase at 6–8 h. One patient had a blood glucose nadir of 68 mg/d or 3.8 mmol/L and was given oral simple carbohydrate. This resulted in transient elevation of the blood glucose to 187 mg/d or 10.3 mmol/L.

No gastrointestinal or other side effects were reported during this study.

CONCLUSIONS

This preliminary study showed that uncooked cornstarch given orally as 25%–50% of the carbohydrate component of the evening snack decreased the frequency of nocturnal and before breakfast hypoglycemia in children and adolescents with diabetes practicing intensive diabetes management. This significant reduction in hypoglycemia was achieved without apparent deterioration of overall glycemia, as evidenced by mean before-breakfast blood glucose levels that were similar for the Standard and Test Snack periods.

In the four subjects evaluated with 2-hourly glucose profiles through the night, only one had a decrease in blood glucose after Test Snack ingestion. Because the patient was given oral glucose, it is not known whether there would have been a further decrease in glucose level or whether there might have been spontaneous recovery due to cornstarch. In the other subjects, however, it appears as if cornstarch, probably due to its slow absorption, is capable of stabilizing the glucose level for up to 6–8 h.

Cornstarch dissolved in water or milk is a source of complex carbohydrate and allows for the slow release of glucose over many hours.[10] Cornstarch is broken down under hydrolytic activity by pancreatic amylase. The side effects of cornstarch ingestion that have been described in glycogen storage disease include transient diarrhea, abdominal distention, and increased flatulence.[7] These side effects, however, were not seen in our subjects perhaps due to the lower dosage used, compared to what is ingested by patients with glycogen storage disease.

The subjects that participated in this study followed an intensive management protocol and had low glycated hemoglobin levels. They were historically and as evidenced by the glucose levels obtained during this study prone to hypoglycemia. Therefore, modalities aimed at lessening hypoglycemia would be of benefit to this group. It is knot known whether a similar benefit would be appreciated in a cohort of subjects with poor glycemic control who do not adhere to the diabetic regimen. However, this study does suggest that uncooked cornstarch may be an inexpensive, adjunctive treatment for patients attempting to achieve intensive diabetes management at risk for hypoglycemia.

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