# Fasting and Insulin Glargine in Individuals With Type 1 Diabetes

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T he Diabetes Control and Complications Trial demonstrated that intensive treatment of type 1 diabetes protected against the microvascular complications of diabetes (1). The results were obtained in a selected group of type 1 diabetic volunteers who received attentive clinical care and substantial diabetes education. Careful attention was paid to lifestyle issues, but optimal control of diabetes was still often difficult to accomplish (1,2). An important treatment barrier for many patients with type 1 diabetes was the need to eat, sleep, and take medication according to a consistent schedule. Insulin infusion pumps help provide flexibility in dealing with these issues (3,4). However, treatment with insulin pumps is expensive (4,5), and some people with type 1 diabetes are not good candidates for pump therapy (3,4). Other treatment methods that allow flexibility with lifestyle issues might improve both treatment outcomes and quality of life. Insulin glargine, a basal insulin, might be useful in this regard. To evaluate this possibility, we tested the hypothesis that glargine insulin would maintain euglycemia in type 1 diabetic subjects during an 18-h fast, such as would occur when a person with type 1 diabetes sleeps late or misses meals.

## RESEARCH DESIGN AND METHODS

— Fifteen subjects with type 1 diabetes participated. Eligibility criteria were age ≥18 years, type 1 diabetes according to standard criteria, treatment with glargine insulin at bedtime and rapid-acting insulin before meals, use of glargine insulin for at least 2 months be-

fore participation, and HbA$_{1c}$ ≤7.5%. This last criterion was used to demonstrate that insulin doses were adequately adjusted. Exclusion criteria were serum creatinine >1.5 mg/dl, pregnancy, and prior organ transplantation.

Once eligibility had been established and informed consent obtained, subjects were asked to report to the General Clinical Research Center in the afternoon for a 2-day inpatient stay. Research procedures commenced at 2100 on day 1, when the first sample for plasma glucose was obtained. At 2200 on study day 1, each subject received his or her usual dose of subcutaneous glargine insulin. A snack was provided at 2300 h, and each subject took presnack rapid-acting insulin according to his or her usual dosing practice. Plasma glucose was subsequently sampled every 2 h until 1700 on the next day, which was the end of day 1. These procedures were repeated in exactly the same fashion on day 2. On one day (control day), subjects received breakfast at 0800 and lunch at 1200 and administered rapid-acting insulin before both meals. The doses of rapid-acting insulin were determined by each subject based on his or her blood glucose values before the meals and his or her usual dosing practice. On the other day (fasting day), subjects did not receive breakfast or lunch and did not administer rapid-acting insulin at breakfast or lunch times. No midmorning or midafternoon snack was provided on either day. Glargine insulin was injected subcutaneously in one of the thighs of each subject by General Clinical Research Center nurses. Each subject received the same dose of glargine insulin on both

days. Subjects were asked not to participate in prolonged exercise during the study but were asked to take 30-min walks in the morning and afternoon of both days. The order of control and fasting days was randomly assigned in a balanced way such that seven subjects first completed the control day and eight subjects first completed the fasting day. Treatments within participants and within days were compared using paired $t$ tests. The protocol was approved by the University of Minnesota Institutional Review Board.

**RESULTS** — The 15 subjects consisted of 7 women and 8 men with mean age 41 years (range 19–67), mean duration of diabetes 21 years (range 2–43), mean HbA$_{1c}$ 6.7% (range 5.1–7.5, excluding 1 subject with autoimmune hemolytic anemia and HbA$_{1c}$ 3.4%), and mean dose of bedtime glargine insulin 26 units (range 13–60). Nine had evidence of retinopathy, two nephropathy, and seven neuropathy.

All subjects tolerated the fast without difficulty. Plasma glucose values on the control and fasting days are shown in Fig. 1. The plasma glucose values (in milligrams per deciliter) on the control and fasting days were at 0700 116 ± 22 and 125 ± 16 ($P = 0.72$), 0900 208 ± 25 and 138 ± 17 ($P = 0.006$), 1100 159 ± 22 and 140 ± 16 ($P = 0.52$), 1300 165 ± 19 and 121 ± 15 ($P = 0.09$), and 1700 124 ± 11 and 93 ± 11 mg/dl ($P = 0.11$), respectively (means ± SE). Mean plasma glucose on the fasting day declined slightly from a value of 125 ± 16 at 0700 to a value of 93 ± 11 at 1700 ($P = 0.055$). The 15 subjects collectively experienced two episodes of hypoglycemia on the fasting days and eight episodes of hypoglycemia on the control days. All episodes were mild and easily treated with oral glucose tablets.

**CONCLUSIONS** — Our data indicate that ambulatory type 1 diabetic patients treated with glargine insulin safely tolerated a fast of 18 h. There was no need for them to eat at defined times. Thus, postponing or skipping meals, eliminat-
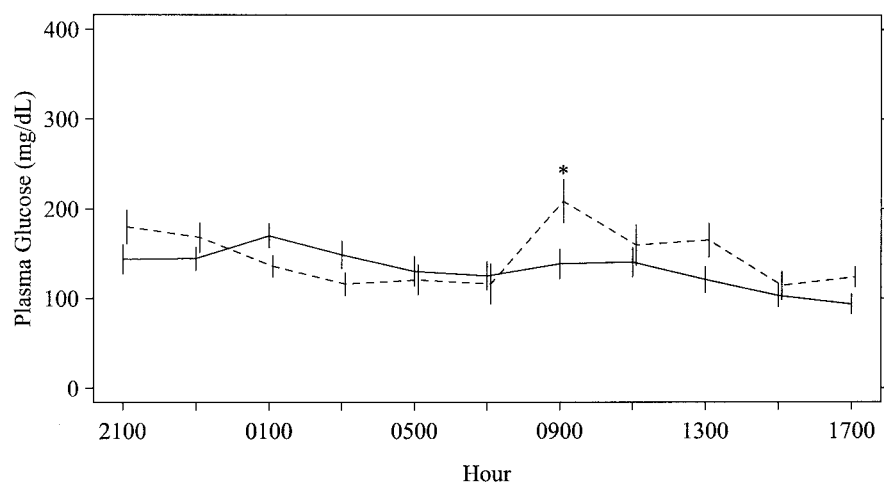
**Figure 1**—*Means ± SE plasma glucose values on control (- - - -) and fasting (——) days. *P < 0.05. To convert plasma glucose to millimoles per liter, multiply by 0.05551.*

ing unwanted snacks, and sleeping late when the opportunity presents itself should all be possible for patients treated with an appropriate dose of glargine insulin. This flexibility in lifestyle may improve quality of life and compliance with treatment programs.

We should point out that these results were obtained in nonexercising subjects and may not be applicable to type 1 diabetic individuals participating in aerobic exercise. Similarly, type 1 diabetic individuals who take rapid-acting insulin, then eat breakfast, and then skip lunch may become hypoglycemic if there is a mismatch between rapid-acting insulin and carbohydrate intake at breakfast. Finally, our results are only applicable to type 1 diabetic patients receiving an appropriate, carefully adjusted dose of glargine insulin.

**References**
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