

Feasibility of a Bihormonal Closed-Loop System to Control Postexercise and Postprandial Glucose Excursions

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Abstract

Background:

The aim of this pilot study was to test the feasibility of a bihormonal (glucagon and insulin) closed-loop (CL) system by challenging the system with two meals and 30 min exercise.

Methods:

Ten patients with type 1 diabetes treated with continuous subcutaneous insulin infusion underwent a standardized protocol on three different occasions: 40 g carbohydrate breakfast followed 2 h later by 30 min of moderate-intensity exercise, followed 1.5 h later by a standardized 60 g carbohydrate lunch. An open-loop (OL) day served as control, the first CL day as tuning experiment, and the second CL day to compare with OL.

Results:

The overall mean venous glucose was similar: 9 (5.4–13.5) mmol/liter in OL versus 8.7 (6.4–11.0) mmol/liter in CL, $p = .74$. The postbreakfast glucose concentrations tended to be lower in OL than in CL [9.5 (4.3–13.3) versus 11.4 (7–16.2) mmol/liter; $p = .07$] and higher in OL than in CL postlunch [9.4 (6.0–14.9) versus 7.7 (5.5–9.0) mmol/liter, $p = .15$]. The postexercise glucose concentrations were similar in OL and CL: 7.5 (4.6–13) versus 8.2 (5.5–13.1) mmol/liter; $p = .45$. In those patients coming in with baseline glucose above 7 mmol/liter, there was initial overinsulinization in CL. During OL, two hypoglycemic episodes occurred compared with four hypoglycemic episodes in three participants during CL. Glucagon seemed mostly effective in preventing hypoglycemia.

Conclusions:

Overall, CL glucose control was comparable to OL control, but there was overinsulinization in those patients with baseline glucose above 7 mmol/liter.

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Abbreviations: (AUC) area under the curve, (bpm) beats per minute, (CGM) continuous glucose monitoring, (CL) closed loop, (MAD) mean absolute difference, (MPC) model predictive control, (OL) open loop, (SMBG) self monitored blood glucose

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