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Do preoperative oral carbohydrates improve postoperative outcomes in patients undergoing coronary artery bypass grafts?

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Background/aim: The aim of this prospective study was to determine whether the preoperative oral intake of carbohydrate-rich drinks by patients undergoing a coronary artery bypass graft attenuates postoperative insulin requirements, improves postoperative patient discomfort, provides inotropic support, shortens the length of the ICU stay, and shortens the duration of postoperative mechanical ventilation.

Materials and methods: This randomized prospective clinical study included 152 patients with coronary artery disease who were divided into 4 groups. Carbohydrates were administered to 3 groups at different hours and doses before operation. The fourth group had an 8-h preoperative fasting period. The inotropic and vasopressor requirements, ventilation time, and ICU stay time were recorded for all of the groups. Patient wellbeing, mouth dryness, hunger, anxiety, and nausea were assessed using VAS scores of 1–10.

Results: Mouth dryness and hunger were significantly higher in the control group ($P = 0.03$, $P = 0.02$). The increase in blood glucose level was significantly higher in the control group ($P = 0.04$). The exogenous insulin requirement was significantly higher in the control group than in the other groups ($P = 0.04$).

Conclusion: The administration of carbohydrates before elective cardiac surgery reduced insulin resistance. Based on the VAS scores, the intake of carbohydrates reduced mouth dryness and hunger. Overall, preoperative oral carbohydrate treatments can improve the postoperative outcomes of coronary artery bypass graft surgeries.

Key words: Coronary artery bypass graft, carbohydrate, wellbeing, mouth dryness, hunger, anxiety, nausea

1. Introduction

The exposure of the human body to surgical or other types of trauma creates a neurohumoral response in the body, activating catabolic processes (1). Postoperative insulin resistance is a characteristic feature of the catabolic response to surgical injury (2). Moreover, a more complex or lengthy surgery with regard to severity, tissue trauma, and/or blood loss leads to a more severe development of insulin resistance (3). An association with stress hyperglycemia is commonly observed, especially in critical illness, and can lead to an increase in postoperative complications (4).

In cardiopulmonary bypass (CPB)-guided cardiac surgery, the commonly associated systemic inflammatory response syndrome can lead to marked antiinsulinergic metabolic disorders and can be a major cause of peripheral insulin resistance (5). However, preoperative IV glucose treatments have been shown to benefit cardiac surgery patients. They have been associated with reduced postoperative impairment to the cardiac muscle, as suggested by a cardiac enzyme decrease, and fewer complications, such as serious arrhythmias, the need for vasopressor and inotropic agents, the duration of ventilator support required, and the length of stay in the intensive care unit (ICU) (6,7). Given that IV glucose infusions are costly, invasive, and labor-intensive, an oral carbohydrate drink was developed to provide a more efficient method of delivering this carbohydrate load (8). In patients undergoing surgery, the intake of oral carbohydrates the night before surgery or 2 h before anesthesia was found to decrease postoperative insulin resistance, with a slight decrease in insulin-stimulated glucose disposal (9). The intake of carbohydrates also decreases preoperative discomfort (thirst, hunger, and anxiety) (10) and postoperative discomfort, as demonstrated in colorectal patients, in addition to decreasing the length of the

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postoperative hospital stay (11). However, some studies have shown that the preoperative intake of carbohydrates did not decrease the length of the hospital stay or improve insulin resistance (12). Therefore, it remains unclear whether preoperative intake of carbohydrates is beneficial to patients.

The aim of this prospective study was to determine whether the preoperative oral intake of carbohydrate-rich drinks in patients undergoing a coronary artery bypass graft (CABG) attenuates postoperative insulin requirements, improves postoperative patient discomfort, provides inotropic support, shortens the length of the ICU stay, and shortens the duration of postoperative mechanical ventilation.

2. Materials and methods

This randomized prospective clinical study included 152 patients with coronary artery disease who were divided into 4 groups. The study protocol was approved by the regional ethics committee. The exclusion criteria consisted of the following: steroid treatment, American Society of Anesthesiologists (ASA) status of >IV, nonelective or emergent surgery, reoperations, impaired gastrointestinal motility, enhanced gastrointestinal reflux, diabetes mellitus I or II, enhanced HbA1c levels, obesity, infection, chronic obstructive pulmonary disease, renal disease, or liver disease.

The first group of patients (group 1, n = 38) received 800 mL of carbohydrates 8 h before the procedure and 400 mL of carbohydrates 2 h before the procedure. The second group of patients (group 2, n = 37) received 400 mL of carbohydrates 8 h before the procedure only. The third group of patients (group 3, n = 38) received 400 mL of carbohydrates 2 h before the procedure only. The fourth group of patients (group 4, control group, n = 39) had an 8-h preoperative fasting period. The carbohydrate-rich drink that was used included 12.5 g/100 mL of carbohydrates: 12% monosaccharides, 12% disaccharides, 76% polysaccharides, and 285 mOsm/kg of Nutricia PreOp (Pfrimmer Nutricia GmbH, Germany).

Preanesthetic evaluations included a hemogram (complete blood count), coagulation profile, echocardiography, electrocardiogram, and coronary angiography. A preoperative evaluation was performed the night before the surgery. In the operating room, the anesthesiologist applied an 18-gauge cannula via the radial artery, and standard monitoring was used (5-lead electrocardiogram and pulse oximetry). In all of the groups, anesthesia was induced using 0.05 mg/kg midazolam, 5 µg/kg fentanyl, 2 mg/kg propofol, and 0.6 mg/kg rocuronium. The patient was then intubated. After intubation, a central venous catheter was placed in the right internal jugular vein. Anesthesia was maintained with 2% sevoflurane, 2 µg/kg fentanyl, and 0.2 mg/kg of rocuronium. The nasopharyngeal temperature and urine output were monitored.

After performing a median sternotomy, a CPB was instituted with 1500 mL of crystalloid priming volume and mild hypothermia (28–32 °C). Systemic heparinization was carried out before the CPB with unfractionated heparin at an initial dose of 300 IU/kg. An activated clotting time above 400 was targeted. The effect of the heparin was reversed at the end of the CPB with 1–1.5 mg of protamine for every 100 IU of heparin. Myocardial protection was achieved with cold blood cardioplegia at 20 °C during the CPB. Homologous donor packed red blood cells were transfused if the hemoglobin fell below 6 g/dL. If the patient required inotropic and/or vasopressor treatment, it was prospectively defined as 5–10 µg/kg dobutamine and epinephrine (inotropic) and/or >10 µg/kg dobutamine and norepinephrine (vasopressor).

2.1. Primary endpoints

The insulin requirement was chosen deliberately as a surrogate marker to estimate the peripheral insulin resistance (13). A blood glucose level of lower than 180 mg/dL was expected. If necessary, bolus insulin injections were used: 5 IU of insulin for a blood glucose level of 200–250 mg/dL, 8 IU for a level of 300–350 mg/dL, 12 IU for a level of 350–400 mg/dL, and 20 IU for a level of 400–450 mg/dL.

2.2. Secondary endpoints

The inotropic and vasopressor requirements, ventilation time, and ICU stay time were recorded for all of the groups. Patient wellbeing, mouth dryness, hunger, anxiety, and nausea were assessed using visual analog scale (VAS) scores of 1–10. For all of the patients, the data were recorded at T0 (preoperative), T1 (preoperative, after inductions), T2 (postoperative, transferred to the ICU), T3 (6 h in the ICU), and T4 (postoperative first day).

2.3. Statistical analysis

The collected data were coded and statistically analyzed using SPSS 15.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were determined for the numerical parametric data as the mean ± standard deviation (SD), and for the categorical data as the number and percentage. For statistical testing, we used one-way analysis of variance and the Tukey honestly significant difference test for multiple comparisons of the parametric data. The differences were considered to be significant for values of $P < 0.05$.

3. Results

The demographic characteristics exhibited no significant differences among the study groups (Table 1). In addition, there were no significant differences among the study groups with regard to the operative characteristics (Table 2).

Table 1. Demographic characteristics.

	Group 1	Group 2	Group 3	Group 4	P
Age (years)	59 ± 11	58 ± 11	57 ± 10	57 ± 12	0.32
Sex (male), %	84.2	81	82	82	0.41
Weight (kg)	80 ± 12	77 ± 10	72 ± 4	80 ± 11	0.26
Height (cm)	164 ± 10	165 ± 8	165 ± 10	169 ± 8	0.34
BMI (kg/m^2)	28 ± 3	29 ± 3	28 ± 2	28 ± 3	0.45
EF %	50 ± 7.7	50 ± 11	35 ± 7	47 ± 8.7	0.61
EuroSCORE	2.1 ± 1.3	2.6 ± 1.5	2.1 ± 1.5	2.6 ± 1.1	0.32
SA	2.5 ± 0.7	2.9 ± 0.7	3.5 ± 0.7	2.6 ± 0.6	0.34

Table 2. Operation characteristics.

	Group 1	Group 2	Group 3	Group 4	P
Operation time (min)	208 ± 97	211 ± 60.2	194 ± 37.3	232 ± 77.3	0.08
CPB time (min)	88.8 ± 45.3	91 ± 26	87 ± 25	92 ± 32	0.07
ACC time (min)	49.3 ± 15.5	52 ± 19.1	49.9 ± 12.9	59 ± 25	0.06

The incidence of postoperative bleeding, any cardiac arrhythmias, inotropic and vasopressor requirements, the ventilation time, and the ICU stay time were evaluated (Table 3). It was determined that the inotropic requirements were significantly higher in the control group than in the other groups (P = 0.04), but the vasopressor requirements showed no significant differences among the groups. The ventilation time was not significantly different among the groups, but the ICU stay time was significantly longer in the control group than in the other groups (P = 0.03).

The results of the VAS score comparisons for the 4 parameters (mouth dryness, hunger, nausea, and anxiety) showed that nausea and anxiety were not significantly different among the groups, while mouth dryness and hunger were significantly higher in the control group than in the other groups (P = 0.03 and P = 0.02, respectively) (Figures 1 and 2). The increase in blood glucose level was significantly higher in the control group when compared to the other groups (P = 0.04) (Figure 3). The exogenous insulin requirement was significantly higher in the control group than in the other groups (P = 0.04) (Figure 4).

4. Discussion

In this prospective randomized clinical trial, those patients who received preoperative carbohydrate-rich fluids had a significantly reduced need for insulin. The carbohydrate treatment helped to maintain normoglycemia, reduce the length of the ICU stay, and reduce inotropic requirements.

Table 3. Postoperative characteristics.

	Group 1	Group 2	Group 3	Group 4	P
Postoperative bleeding (mL)	837 ± 501	920 ± 625	900 ± 524	785 ± 435	0.5
Cardiac arrhythmia, %	31.6	24.3	47.4	38.5	0.7
Inotropic requirements, %	63.2	73	68.4	84.6	0.04
Vasopressor requirements, %	68.4	75.7	86.8	69.2	0.06
Ventilation time (h)	11.9 ± 4.5	13.2 ± 4.3	11.8 ± 4.1	14.5 ± 18.5	0.07
ICU stay time (days)	2.3 ± 0.6	3 ± 1.6	2.63 ± 3.35	4.6 ± 4.5	0.03

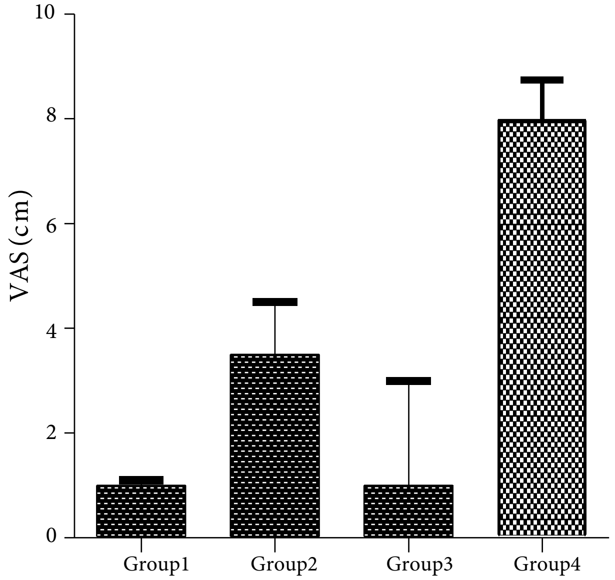

Figure 1. Evaluation of mouth dryness with a VAS.

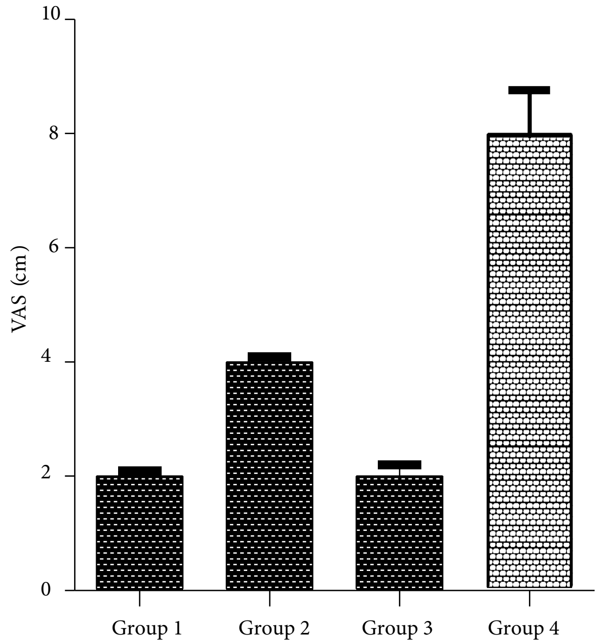

Figure 2. Evaluation of hunger with a VAS.

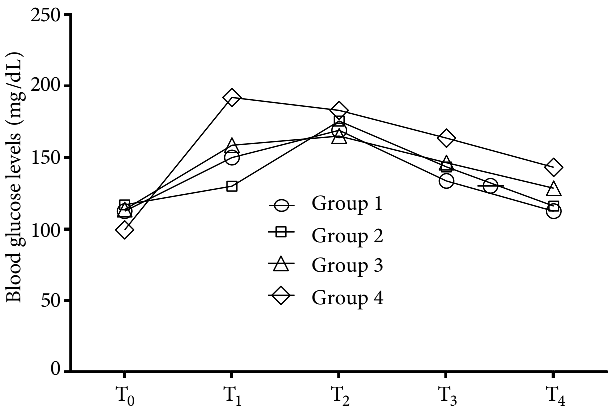

Figure 3. Evaluation of blood glucose levels among groups.

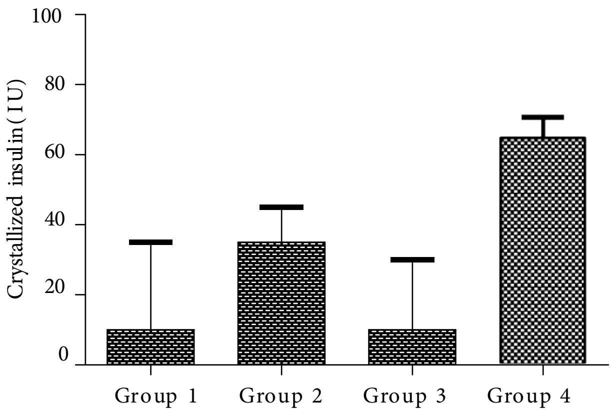

Figure 4. Evaluation of exogenous insulin requirements.

The need for insulin treatment in the nondiabetic CABG patients indicated increased insulin resistance. The VAS scores for mouth dryness and hunger were significantly reduced when compared to those patients undergoing preoperative fasting.

Surgical trauma produces a neuroendocrine response mediated by the release of proinflammatory cytokines and hormones (14). High concentrations of proinflammatory cytokines have been associated with hyperglycemia and insulin resistance under numerous physiological conditions (15). Low-grade inflammation associated with insulin resistance might be accentuated during surgery; in particular, patients undergoing cardiac surgery can experience aggravated inflammation and insulin resistance, which contributes to worsening endothelial dysfunction and glycemic control and an increased risk of postoperative adverse outcomes (16,17). Surgical time is directly proportional to the stress response; therefore, during open-heart surgery, which is classified as a major surgery, extracorporeal circulation and long duration of surgery cause a greater stress response. However, the effects of a preoperative oral carbohydrate treatment may not be strong enough to counteract the effects of the release of surgical trauma-related stress hormones in cardiac surgery (18). The preoperative intake of oral carbohydrates is related to a reduction in the inflammatory response to surgical stress, because insulin-stimulated glycogen synthase activity is attenuated by surgery, and glycogen stores in the liver, skeletal muscle, and adipose tissue decrease (19). The metabolic stress variables that are known to influence insulin resistance include the duration of surgery (9) and use of vasoactive medication (4), which did not differ significantly among the groups.

We assumed that any clinically relevant reductions in insulin resistance would be identifiable by decreased insulin requirements for maintaining comparable blood glucose levels. In our study, the oral carbohydrate treatments caused a significant reduction in the insulin requirements and therefore a reduction in insulin resistance and reduced length of stay in the ICU. Moreover, the need for inotropic support differed significantly among the study groups, with the carbohydrate treatment groups showing reduced inotropic support requirements (P = 0.04). ICU stay time may increase depending on increased inotropic requirement. Based on these data, we confirmed the results of Breuer et al. (20) with regard to the possible cardioprotective effects of a preoperative carbohydrate drink. In other studies, the preoperative IV administration of carbohydrates before cardiac surgery led to markedly improved cardiac performance (12,21). Additionally, Lazar et al. reported reduced inotropic scores postoperatively after the perioperative administration of glucose-insulin-potassium to patients undergoing urgent CABG surgery (12). During ischemia, the accumulation of free fatty acid end products may impair ventricular arrhythmia by increasing the level of oxygen-derived free radicals (22). Glucose esterifies intracellular free fatty acids by increasing the supply of alpha-glycerophosphate, thereby decreasing the toxic metabolic end products of free fatty acids including oxygen-derived free radicals (22,23). However, some studies including patients undergoing major abdominal or cardiac surgery (18) did not show improved clinical outcomes with preoperative carbohydrate intake. In our study, the preoperative intake of carbohydrates resulted in improved postoperative recovery. For example, in the carbohydrate treatment groups, the time in the ICU was shorter than in the control group (P = 0.03). Although the mechanical ventilation times in the ICU were not statistically significant, the times in the carbohydrate groups were shorter than in the control group (P = 0.07).

A subjective VAS was used to assess each patient's comfort using the following variables: nausea, anxiety, mouth dryness, and hunger. The carbohydrate preparation led to significant reductions in mouth dryness and hunger (P = 0.03 and P = 0.02, respectively), but the improvements in nausea and anxiety were similar for the fasting group and carbohydrate groups. Hausel et al. (24) used a VAS for a large sample size of ASA I–II patients undergoing abdominal surgery and found no difference in the thirst after the morning drink among the groups. In addition, Helminen et al. (25) used a VAS for abdominal surgery patients and found reduced thirst and hunger in the treatment groups. In contrast, Henriksen et al. (26) showed no differences between their study groups with regard to thirst, hunger, anxiety, wellbeing, fatigue, pain, and nausea. However, in that study, the patients given carbohydrates reported significantly decreased hunger and mouth dryness.

In conclusion, in this research we have provided evidence of the safety of an oral carbohydrate drink ingested before the induction of anesthesia for CABG surgery. Moreover, the administration of carbohydrates before elective cardiac surgery reduced insulin resistance. Based on the VAS scores, the intake of carbohydrates reduced mouth dryness and hunger. Overall, our data show that preoperative oral carbohydrate treatments can improve the postoperative outcomes of CABG surgeries, but further research is necessary to confirm our results.

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