Original Article

Effects of preoperative oral carbohydrate therapy on perioperative glucose metabolism during oral–maxillofacial surgery: randomised clinical trial

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Background and Objectives: Preoperative oral carbohydrate therapy has been suggested to attenuate postoperative insulin resistance. The purpose of this study was to investigate the effect of a carbohydrate-rich beverage given preoperatively on intraoperative glucose metabolism. **Methods and Study Design:** This study was a randomised, open-label, placebo-controlled trial. Patients undergoing oral–maxillofacial surgery were divided into two groups. In the glucose group, patients took glucose (50 g/278 mL, p.o.) 2 h before anaesthesia induction after overnight fasting; control-group patients took mineral water. Primary outcome was blood concentrations of ketone bodies (KBs); secondary outcomes were blood concentrations of free fatty acids, insulin and glucose. Concentrations were measured 2 h before anaesthesia (T0), induction of anaesthesia (T1), and 1 h (T2), 3 h (T3), and 5h after anaesthesia start (T4). **Results:** In the control group (n=11), KBs increased continuously from anaesthesia induction. In the glucose group (n=12), KBs were maintained at low concentrations for 3h after beverage consumption but increased remarkably at T3. At T1 and T2, concentrations of KBs in the glucose group were significantly lower than those in the control group (T1, p=0.010; T2, p=0.028). In the glucose group, glucose concentrations decreased significantly at T2 temporarily, but in the control group, glucose concentrations were stable during this study (T2, p<0.001: glucose vs control). **Conclusions:** Preoperative intake of glucose (50 g, p.o.) can alleviate ketogenesis for 3 h after consumption but can cause temporary hypoglycaemia after anaesthesia induction.

Key Words: anaesthesia, carbohydrate, ERAS, ketogenesis, blood glucose management

INTRODUCTION

From the 1970s to 1990s, administration of glucose-free infusions during anaesthesia was common because hyperglycaemia elicited poor outcomes (especially for craniotomy).[1,2] However, overnight fasting causes gluconeogenesis from glycogen, hastens decomposition of fat and protein, and results in increases in concentrations of ketone bodies (KBs) and free fatty acids (FFAs). Collapse of muscle protein by gluconeogenesis contributes to inhibition of wound healing and early recovery from surgery. Increases in concentrations of FFAs by fat decomposition cause myocardial damage (e.g., systolic dysfunction).[3] Hence, even on the day of surgery, a small amount of glucose loading is necessary to suppress catabolism.[4]

Preoperative oral carbohydrate therapy (POCT) is a useful tool for glucose management. A total of 50.4 g/12.6% carbohydrate given via the oral route 2 h before anaesthesia is recommended in the Enhanced Recovery After Surgery (ERAS) protocol.[5] POCT prevents reductions in concentrations of nitrogen and protein[6,7] to maintain lean body mass[8] and muscle strength.[9] In addition, POCT attenuates postoperative insulin resistance.[10,11] However, metabolic changes during anaesthesia have not been investigated thoroughly. The concentration of glucose in blood would change immediately after taking a preoperative carbohydrate-rich beverage. Glucose shortage accelerates gluconeogenesis, thereby leading to catabolism. However, the effect of POCT on catabolism and blood glucose concentrations has not been investigated in detail.

We conducted this study to answer two questions during elective oral–maxillofacial surgery: (i) to what extent and for how long can POCT suppress ketogenesis during anaesthesia; and (ii) can POCT elicit major changes in blood glucose concentrations during anaesthesia.

METHODS

Study design

The study protocol was approved by the ethics committee of Kyushu University Hospital (Fukuoka, Japan) and registered in the University Hospital Medical Information Network as a 'clinical intervention study' (approval number 000010742). All patients provided written informed

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consent to participate in the study. This was a single-centre, open-label, randomised, placebo-controlled, parallel-arm, prospective clinical trial.

Patients who had an American Society of Anesthesiologists (ASA) physical status of I or II, were aged 20–64 years, and were about to undergo oral–maxillofacial surgery were enrolled into the present study between May 2013 and January 2014. We excluded patients who: had not eaten sufficiently owing to a jawbone fracture; received a diagnosis of diabetes mellitus; were found to have a fasting blood glucose concentration >6.1 mmol/L preoperatively; had been administered corticosteroid hormones; had a body mass index <18 or >30 kg/m^2; were expected to have difficulties undergoing intubation; or could not follow the protocol because of mental deficiency.

A random allocation sequence was generated by a research assistant in our department using random permuted blocks without stratification. Enrolment of participants was done by the principal investigator. The research assistant assigned each participant a group based on the random allocation sequence and prepared beverages for each group. Allocation was concealed from patients, the anaesthesiologist and clinical investigator until the end of anaesthesia. Subsequently, the clinical investigator analysed the data. However, if a patient noticed the allocation group by tasting the test beverage, the allocation was deemed 'open'. One of the two groups consumed a beverage containing 50 g/18% glucose and mineral water (glucose group), and the other group consumed the same amount of mineral water (control group). In our study, glucose content was designed to involve the same amount of carbohydrate in beverages as the protocol recommended by ERAS. Patients in both groups were fasted from midnight of the day before surgery and took each beverage in its entirety during 5–10 min at 2 h before the induction of anaesthesia on the day of surgery. Patients were not given an intravenous drip until the induction of anaesthesia.

Study procedure

Anaesthesia was induced with fentanyl (4 μg/kg body weight) and midazolam (0.1 mg/kg). Vecuronium (0.1 mg/kg) was administered after loss of consciousness. Tracheal intubation was done with a cuffed RAE tube. Anaesthesia was maintained with sevoflurane (1.0–2.0%), remifentanil (0.1–1.0 μg/kg/min) and one dose of fentanyl (50 or 100 μg). Values of the Bispectral Index (which is used to indicate the depth of anaesthesia by analyses of electroencephalogram) were maintained at 40–60. Mechanical ventilation was undertaken with tidal volumes of 8–10 mL/kg and respiratory rate of 6–10/min. Circulatory dynamics were maintained at ±20% of preoperative resting blood pressure, and hypertensors were administered to patients as needed. Body temperature was controlled by a warming blanket (Bair Hugger®; 3M, Maplewood, MN, USA) so that rectal temperature remained ≥36°C. Acetated Ringer's solution without glucose was transfused throughout our study. A nonsteroidal anti-inflammatory drug (diclofenac sodium (Voltaren SUPPO®), 50 mg; Novartis Japan, Tokyo, Japan) was administered (p.r.) at the end of surgery for pain relief.

Blood samples were obtained from a vein in the forearm or dorsum of the hand at five time points: 2 h before the induction of anaesthesia (T0), induction of anaesthesia (T1), 1 h after the start of anaesthesia (T2), 3 h after the start of anaesthesia (T3), and 5 h after the start of anaesthesia (T4). An intravenous catheter was placed in the forearm or dorsum of the hand at T0, and blood samples obtained at the five time points mentioned above. Blood concentrations of cortisol, noradrenaline, glucose, insulin, FFAs and KBs were measured at these five time points. Concentrations of cortisol and noradrenaline were measured because they are considered to reflect surgical stress. Blood concentrations of glucose, insulin, FFAs and KBs were measured to evaluate metabolism. These results were reported several days after the induction of anaesthesia. The respiratory quotient (RQ = expired CO_2 /inspired O_2) was measured continuously during intubation using a respiratory gas analyser (V-MAX®; Nihon Kohden, Tokyo, Japan). This device could calculate the RQ during mechanical ventilation using a sensor connected to an expiration inlet on an anaesthesia machine. For patients intubated for longer than T3, we measured the RQ at T2, 2 h after the start of anaesthesia, and T3.

Statistical analysis

The sample size was calculated based on a report in which the mean increase in blood concentrations of acetoacetic acid between baseline and 4 h after the start of infusion was 84% and 300% in comparison with the glucose-loading group (1% glucose infusion) and control group (no glucose), respectively.[12] A sample size of 12 patients per group was calculated to detect a difference in the concentration of KBs at which the suppressive effect upon ketogenesis by preoperative carbohydrate loading would be 60% of glucose infusion, in consideration of patient dropouts (α=0.05, β=0.8, two-tailed test).

Data are the mean (SD). A datum shown as the RQ at a particular time was the weighted value, and was calculated from the raw data of RQ measured every 10s. The unpaired t-test or χ^2 test was used to compare values in the control group with those from the glucose group. One-way repeated ANOVA with the Greenhouse-Geisser modification was used, and the Bonferroni test was employed as a post hoc comparison to detect differences in the control group or glucose group. SPSS v21.0 (IBM, Armonk, NY, USA) was used for statistical analyses. A value of p<0.05 was considered significant.

RESULTS

Before elective oral–maxillofacial surgery, 197 patients were eligible for the present study, and 173 patients were excluded. These patients were excluded due to: unmatched age (<18 or >64 years) (n=136); mental deficiency (n=8); jawbone fracture (n=5); body mass index <18 or >30 kg/m^2 (n=4); administration of corticosteroid hormones (n=3); diabetes mellitus (n=2); other medical reasons why the study protocol could not be carried out (n=2); refusal to participate (n=13). The remaining 24 patients were divided randomly into the glucose group or control group. The glucose group and control group contained 12 patients each. One patient in the control group left the study for surgical treatment of ischaemic heart

disease. Finally, 12 patients in the glucose group and 11 patients in the control group were evaluated (Figure 1). There were no significant differences in patient characteristics or operative data between the groups (Table 1).

There were no significant differences in the blood concentration of cortisol or noradrenaline at each of the five measurement times between the groups (Table 2).

There was no significant difference in the blood concentration of glucose 2 h before the induction of anaesthesia (T0) between the groups. Subsequently, the blood concentration of glucose in the glucose group decreased temporarily 1h after the start of anaesthesia (T2) and recovered to a normal concentration at the remaining measurement times. In the glucose group, the blood concentration of glucose was significantly lower than that in the control group at T2 (Table 2). All patients in the control group had a stable, within-normal concentration of glucose.

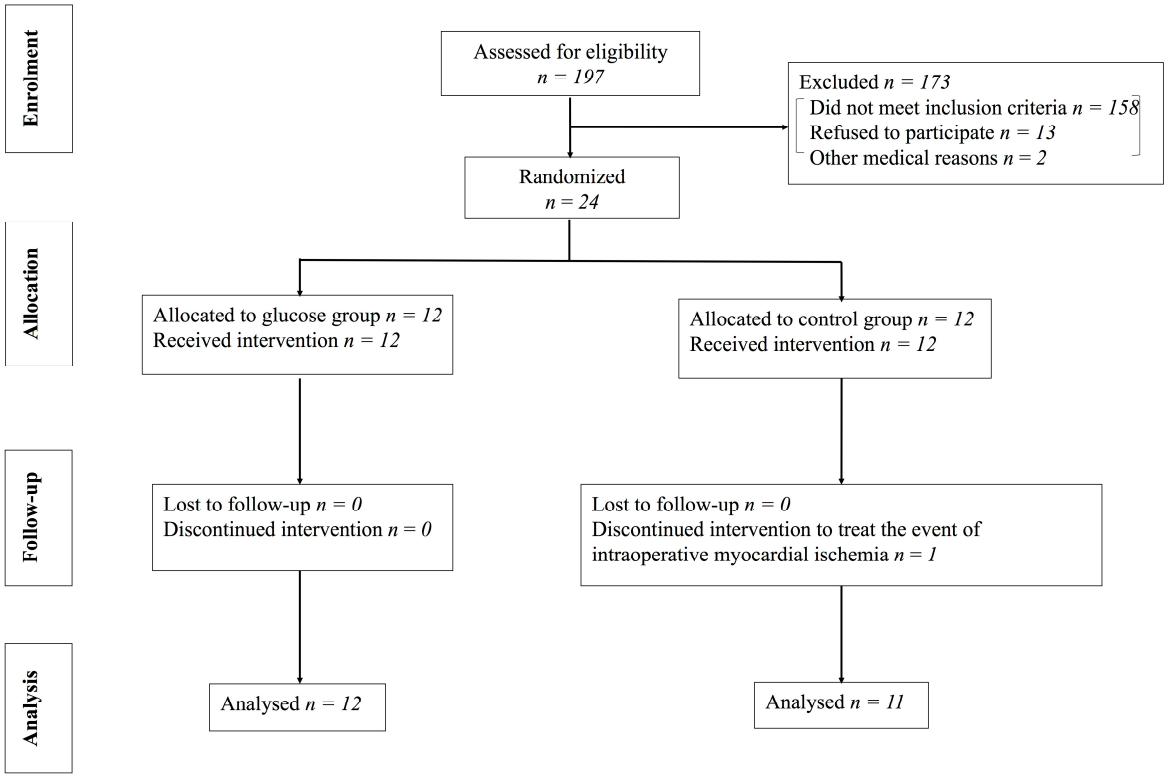

Figure 1. CONSORT diagram for this study

Table 1. Demographics and characteristics of patients

	Glucose group (n=12)	Control group (n=11)	p
Gender (M/F)†	5/7	5/6	0.855
Age (years)‡	43±13	42±13	0.741
BMI (kg/m^2)‡	24±3.0	22±3.6	0.339
Duration of general anesthesia (min)‡	355±172	258±108	0.126
Duration of surgery (min)‡	252±153	148±86	0.060
Amount of bleeding (mL)‡	319±535	249±550	0.758
Fentanyl (μg/kg/h)‡	1.7±0.4	1.9±0.4	0.313
Remifentanil (μg/kg/min)‡	0.16±0.08	0.13±0.06	0.250
Operative procedures†			
Removal of oral cancer	0	2	0.823
Neck dissection	1	1	
Extraction of oral cancer with neck dissection	1	0	
Iliac bone graft	2	1	
Orthognathic of jaw	2	1	
Removal of plates and screws	2	3	
Extraction of teeth, extraction and fenestration of the cyst	3	2	
Removal of sequestrum	0	1	
The milling surgery of bone prominence	1	0	

Data are mean±SD or number of patients.
†χ^2 test.
‡Unpaired t-test. There were no significant differences.

Table 2. Alterations in concentrations of stress hormones, glucose and insulin

		T0	T1	T2	T3	T4
Cortisol (μg/dL)	Glucose	21.9±6.23	13.6±7.71	6.93±2.60	3.13±1.80	4.53±7.39
	Control	20.8±4.42	18.4±4.69	8.59±2.53	5.91±4.75	10.4±11.3
	p	0.669	0.100	0.148	0.108	0.162
Noradrenaline (pg/mL)	Glucose	318±123	287±114	133±86.2	150±91.6	173±133
	Control	275±108	262±85.8	119±61.9	195±97.8	189±55.0
	p	0.393	0.573	0.664	0.279	0.729
Glucose (mmol/L)	Glucose	5.04±0.540	5.08±0.982	3.82±0.858	5.25±1.17	5.22±1.42
	Control	4.75±0.547	4.92±0.392	5.13±0.405	5.11±0.425	4.91±0.495
	p	0.206	0.626	<0.001**	0.709	0.504
Insulin (μU/mL)	Glucose	5.77±2.83	13.4±10.0	1.82±1.01	3.32±1.60	3.95±1.95
	Control	6.41±2.90	4.70±2.44	2.38±1.15	5.07±3.64	2.97±2.13
	p	0.599	0.013*	0.229	0.166	0.262

Data are mean±SD.
T0, 2 h before anaesthesia; T1, induction of anaesthesia; T2, 1 h after the start of anaesthesia; T3, 3 h after the start of anaesthesia; T4, 5 h after the start of anaesthesia.
p-value: Unpaired t-test between the glucose group and the control group (*$p<0.05$, **$p<0.001$)

With regard to the blood concentration of insulin, there was no significant difference 2 h before the start of anaesthesia (T0) between the groups. In the glucose group, the blood concentration of insulin increased temporarily upon the induction of anaesthesia (T1). At T1, the blood concentration of insulin was significantly higher than that in the control group (Table 2).

There was no significant difference in the blood concentration of KBs 2 h before the start of anaesthesia (T0) between the groups (mean and standard deviation; glucose group: T0, 36.3 (13.0); control group: T0, 37.1 (16.1) μmol/L, p=0.902, t-test). At the induction of anaesthesia (T1), the blood concentration of KBs in the glucose group was significantly lower than that in the control group (glucose group: T1, 183 (4.9); control group: T1 64.0 (48.3) μmol/L, p=0.010, t-test). One hour after the start of anaesthesia (T2), the blood concentration of KBs in the control group increased above the normal concentration, but the blood concentration of KBs in the glucose group was within normal concentrations. The blood concentration of KBs in the glucose group was significantly lower than that in the control group (glucose group: T2, 36.9 (10.9); control group: T2, 148.7 (144.0) μmol/L, p=0.028, t-test). From 3 h after the start of anaesthesia (T3), the blood concentration of KBs in the glucose group increased obviously, and significant differences in the concentration of KBs were not found between the groups (glucose group: T3, 152.4 (95.1); T4, 101.7 (51.7); control group: T3, 179.6 (110.7); T4, 165.8 (125.0) μmol/L, p=0.533 (T3); 0.137 (T4), t-test) (Figure 1a). In the control group, the blood concentration of KBs increased significantly from T0 to T3 (T0, 152.4 (95.1); T3, 179.6 (110.7) μmol/L, p=0.047, Bonferroni test). In the glucose group, the blood concentration of KBs decreased significantly from T0 to T1 (T0, 36.3 (1.3); T1, 18.3 (4.9) μmol/L, p=0.004, Bonferroni test), and increased significantly from T0 to T3 and T4 (T0, 36.3 (1.3); T3, 152.4 (95.1); T4, 101.7 (51.7) μmol/L, p=0.024 (T3); 0.018 (T4), Bonferroni test) (Figure 2a).

There was no significant difference in the blood concentration of FFAs 2 h before the start of anaesthesia (T0) between the groups (mean and standard deviation; glucose group: T0, 454.6 (186.6); control group: T0, 468.1 (176.7) μmol/L, p=0.861, t-test). At 3 h after the start of anaesthesia (T3) only, the concentration of FFAs in the glucose group was significantly higher than that in the control group (glucose group: T3, 993.3 (315.1); control group: T3, 1402.6 (1052.6) μmol/L, p=0.047, t-test) (Figure 1b). In the control group, the blood concentration of FFAs increased significantly from T0 to T2 (T0, 468.1 (176.7); T2, 1754.2 (1237.9) μmol/L, p=0.043, Bonferroni test). In the glucose group, the blood concentration of FFAs increased significantly from T0 to T3 and T4 (T0, 454.6 (186.6); T3, 933.3 (315.1); T4, 788.0 (306.6) μmol/L, p=0.003 (T3); 0.009 (T4), Bonferroni test) (Figure 2b).

The RQ were measured for the 15 out of 23 patients who were maintained on intubation until 3 h after the start of anaesthesia, and were assessed 1, 2 and 3 h after the start of anaesthesia. Eight patients formed the glucose group and seven patients formed the control group, and there were no significant differences in patient characteristics or operative data. At 1 and 2 h after the start of anaesthesia, the RQ in the glucose group was higher than that in the control group (glucose group: 1 h, 0.93(0.18); control group, 1 h, 0.87 (0.12), p=0.527, t-test; glucose group: 2 h, 0.85 (0.15); control group, 2 h, 0.78 (0.08), p=0.295, t-test). At 3 h after the start of anaesthesia, the RQ in both groups was comparable (glucose group: 3 h, 0.78 (0.13); control group, 3 h, 0.80 (0.13), p=0.789, t-test) (Figure 3).

DISCUSSION

Glucose intake is important for suppression of catabolism even on the day of surgery because glucose is essential for biological activity as a 'metabolic fuel'. Red blood cells consume only glucose as an energy source. In the brain, ≥80% of the energy requirement must be supplied by glucose during acute starvation. Glucose is supplied mainly from the liver by glycogen decomposition, and is supplied subsequently by gluconeogenesis using glycogenic amino acids mainly from skeletal muscles if external glucose is not administered. However, total storage of glycogen is much less than basal energy consumption for

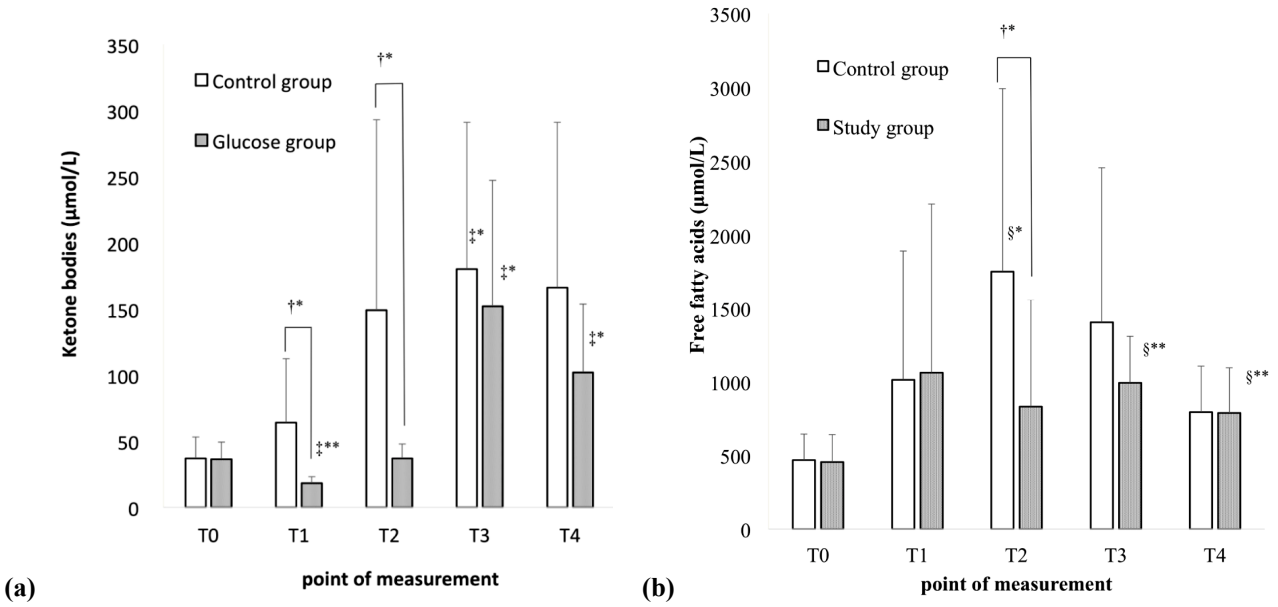

Figure 2. Change in blood concentrations of ketone bodies and free fatty acids in patients undergoing elective oral–maxillofacial surgery: a, ketone bodies; b, free fatty acids. T0, 2 h before anaesthesia; T1, induction of anaesthesia; T2, 1 h after the start of anaesthesia; T3, 3 h after the start of anaesthesia; T4, 5 h after the start of anaesthesia. Values are mean±SD. †Unpaired t-test (control group versus glucose group). ‡Blood ketone bodies; One-way repeated ANOVA followed by Bonferroni test (versus T0 in the control group or in the glucose group). §Blood free fatty acids; One-way repeated ANOVA followed by Bonferroni test (versus T0 in the control group or in the glucose group). *p*-value: $^{*}p<0.05$, $^{**}p<0.01$.

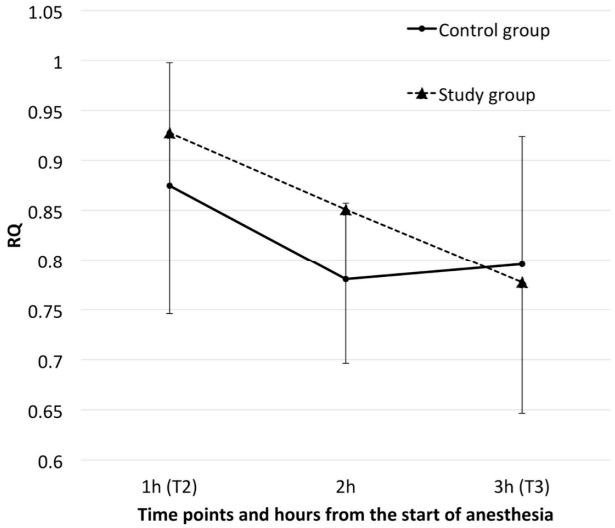

Figure 3. Change of RQ in patients undergoing elective oral–maxillofacial surgery. Values are mean±SD. The black solid line represents the RQ change of the control group, and the black dashed line represents the RQ change of the glucose group. There were no significant differences between the groups at each hour (unpaired t-test).

1 day.[13] Therefore, energy shortages are covered almost completely by fat oxidation. FFAs from adipose tissue are released into blood, and many tissues take them up as an energy substrate. KBs are synthesised from FFAs in the liver, and skeletal and cardiac muscle use them as an energy substrate. Increases in concentrations of KBs in blood suggest that acceleration of fat oxidation and breakdown of proteins may be occurring simultaneously.

Anaesthetic management is also important to control surgical stress and to suppress catabolism. It has been shown that remifentanil can suppress surgical stress under general anaesthesia.[14] In the present study, anaesthesia was maintained with sevoflurane, remifentanil and fentanyl. We measured concentrations of cortisol and norepinephrine because these hormones are released during stress. Cortisol and noradrenaline were maintained at lower concentrations during anaesthesia than that before anaesthesia, and there were no significant differences between groups at all time points (Table 2). Therefore, we suggest that surgical stress was suppressed sufficiently in both groups.

Our first question was ‘to what extent and for how long can POCT suppress ketogenesis during anaesthesia?’ We showed that oral intake of glucose (50 g) suppressed ketogenesis, but the suppressive effect upon ketogenesis was observed for 3 h. Blood concentrations of KBs in the glucose group 1 h after the start of anaesthesia were sustained at normal levels, but those in the control group became significantly higher and beyond the upper limit (Figure 2a). However, blood concentrations of KBs in-

creased significantly 3 h after the start of anaesthesia, and blood concentrations of KBs in both groups became comparable. Blood concentrations of FFAs 1h after the start of anaesthesia in the glucose group were significantly lower than those in the control group, and there were no significant differences between the groups 3 h after the start of anaesthesia (Figure 2b). Some FFAs might have been metabolised to KBs 3 h after the start of anaesthesia. In our study, 50 g glucose (p.o.) suppressed fat oxidation effectively for 3 h. These results are in accordance with a report in healthy volunteers.[15] The mean basal metabolic rate was 1380 kcal/day, which was calculated from the Harris–Benedict equation. Interestingly, 50 g of glucose (200 kcal) was nearly equivalent to the basal metabolic rate for 3.5 h, which corresponds to the effective time of glucose loading (50 g, p.o.) in our study.

Metabolic substrates can be estimated from RQ results. In the present study, RQ results suggested that oral intake of glucose (50 g) suppressed catabolism for 3 h after intake. In the glucose group, the RQ at 1 h after the start of anaesthesia was 0.93, which suggested that carbohydrate was used mainly as the energy substrate. The RQ at 3 h after the start of anaesthesia decreased to 0.78, which suggested that the main substrate might have changed to fat. In the control group, the RQ from 1 h to 3 h after the start of anaesthesia had been ≈0.8, which might suggest that fat and protein had been used as substrates from the start of anaesthesia. In both groups, the RQ was ≤1.0, which may suggest that glucose (50 g, p.o.) did not cause unnecessary nutritional overfeeding.[16,17]

Our second question was 'can POCT cause major changes in blood glucose concentrations during anaesthesia?' In the glucose group, six of 12 patients had reductions in blood concentrations of glucose temporarily 3 h after oral intake of 50 g of glucose (i.e., 1h after the start of anaesthesia). The reduction of glucose concentrations in blood might have been related to increases in insulin concentrations in blood. In the glucose group, blood concentrations of insulin were significantly higher upon the induction of anaesthesia than that in the control group (Table 2). Awad et al measured blood concentrations of glucose and insulin every 20 min in healthy volunteers who did not have general anaesthesia, and temporary reduction of the blood concentration of glucose was not observed for 6 h after oral intake of 50 g of carbohydrate.[15] Therefore, anaesthesia may be an important factor in temporary reduction of glucose concentrations in blood after oral intake of carbohydrate. Three mechanisms of action may be related to this phenomenon. First, insulin is secreted in a biphasic manner.[18] The first phase is transient (lasting 10 min), but the second phase is sustained. Moreover, if glucose is taken via the oral route, incretins are secreted along with absorption of glucose in the intestine, and incretins promote insulin secretion in the pancreas.[19] Oral intake of glucose increases blood glucose concentrations more readily in comparison with maltodextrin.[20] That is, oral intake of 50 g of glucose might excessively increase and prolong insulin secretion, which might result in a temporary reduction in the blood concentration of glucose after the induction of anaesthesia. In this context, maltodextrins or starch might be more suitable than glucose as a carbohydrate given before surgery. Second, insulin secretion due to carbohydrate loading using 50 g of glucose (p.o.) can inhibit the glucose supply from glycogen.[21] Glucose uptake into the liver might increase, and/or glucose supply and glucose release in the liver might be reduced. Third, hemodilution due to an initial infusion at the induction of anaesthesia might contribute to a temporary reduction in blood concentrations of glucose.

Hypoglycaemia during anaesthesia may be harmful and difficult to detect because patients cannot complain its symptoms. The Normoglycemia in Intensive Care Evaluation and Surviving Using Glucose Algorithm Regulation (NICE-SUGAR) study reported that hypoglycaemia (blood sugar <2.2 mmol/L) caused by intensive insulin therapy is a risk factor for mortality in the intensive care unit.[22] In that study, no patients had severe hypoglycaemia (<2.2 mmol/L), but 50% of patients in the glucose group had a significant decrease in blood concentrations of glucose temporarily (<3.8 mmol/L) after the induction of anaesthesia. In the case of preoperative administration of 50 g of glucose via the oral route without intraoperative glucose infusion, a temporary decrease in blood concentrations of glucose must be monitored carefully. Furthermore, variability in blood glucose concentrations leads to an increase in postoperative mortality,[23,24] so stable and strict management of blood glucose in the perioperative period is required. Infusion of 1% glucose can increase blood glucose concentrations temporarily 1h after the induction of anaesthesia.[12] Yokoyama et al reported the advantages of using a solution of 1% glucose during anaesthesia for orthopaedic surgery. In their study, patients received 25 mL/kg of fluid during the first 1h after the start of anaesthesia as an initial infusion, and the infusion rate was changed subsequently to 4 mL/kg/h. Administration of a solution of 1% glucose increased the blood glucose concentration to 9.4 mmol/L temporarily at 1 h after the start of anaesthesia, but recovered to ≈6.6 mmol/L after changing the infusion rate to 4 mL/kg/h. Intraoperative infusion with low-dose glucose has increased in popularity, and this strategy may spare the shortage of sugar in the body and suppress gluconeogenesis. Therefore, a combination of preoperative oral carbohydrate loading and glucose infusion during anaesthesia might be useful to maintain blood glucose concentrations.

The present study had two main limitations: (i) the study cohort was small; (ii) patients underwent only elective oral–maxillofacial surgery.

In conclusion, in patients undergoing elective oral–maxillofacial surgery, preoperative administration of 50 g of glucose via the oral route is very useful. This method was shown to alleviate ketogenesis significantly for 3 h after its intake. Preoperative administration of 50 g of glucose via the oral route caused a significant decrease in blood glucose concentration temporarily after the induction of anaesthesia, but no patient suffered severe hypoglycaemia (blood glucose <2.2 mmol/L).

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AUTHOR DISCLOSURES
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