Perioperative Medicine

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Effect of preoperative oral carbohydrate on the postoperative recovery quality of patients undergoing daytime oral surgery: a randomized controlled trial

Weixiang Tang[1†], Gaige Meng[1†], Chen Yang[1], Yue Sun[1], Weiwei Zhong[1*] and Yao Lu[1*]

Abstract

Background Preoperative oral carbohydrate intake can improve the postoperative recovery of fasting patients in many kinds of surgeries; however, the effect of carbohydrates on patients undergoing daytime oral surgery is still unclear. This study was designed to evaluate the effect of preoperative oral carbohydrate intake on the quality of recovery of patients undergoing daytime oral surgery using the quality of recovery-15 (QoR-15) questionnaire.

Methods Ninety-two patients scheduled for daytime oral surgery were randomly allocated to the midnight fasting group (F group, $n=45$) or the carbohydrate-Outfast loading group (O group, $n=47$). Participants in the F group fasted from midnight the day before surgery. Patients in the O group also fasted but received the Outfast drink (4 ml/kg) 2–3 h before the induction of anesthesia. QoR-15 questionnaire, patient well-being, and satisfaction were assessed before anesthesia induction and 24 h after surgery. Perioperative blood glucose, postoperative exhaust time, and adverse events were also recorded.

Results The QoR-15 scores were significantly higher in the O group than in the F group preoperatively and postoperatively. Seven parameters representing patient well-being evaluated on a numeric rating scale (NRS, 0–10) were lower in the O group than in the F group postoperatively, except for the hunger and sleep quality scores. Patient satisfaction scores on a 5-point scale were higher in the O group than in the F group preoperatively and postoperatively. Meanwhile, the postoperative exhaust time was significantly shorter in the O group compared to the F group, while there were no significant differences in blood glucose concentrations between two groups.

Conclusions Preoperative oral carbohydrate intake could improve postoperative recovery quality, well-being, and satisfaction of patients undergoing daytime oral surgery 24 h after surgery, and may serve as a treatment option for patients undergoing daytime oral surgery.

Trial registration This trial was registered in the Chinese Clinical Trial Registry (ChiCTR2100053753) on 28/11/2021.

Keywords Preoperative oral carbohydrate, Quality of recovery-15, Daytime oral surgery

†Weixiang Tang and Gaige Meng contributed equally to this work.

*Correspondence:
Weiwei Zhong
0511@hotmail.com
Yao Lu
luyao@ahmu.edu.cn
Full list of author information is available at the end of the article

Background

Fasting from midnight before surgery is a standard practice among patients undergoing elective surgery to reduce the risk of pulmonary aspiration under anesthesia (Li et al. 2012). In China, the rising number of surgical patients, coupled with limitations on the availability of operating rooms, has resulted in an increasing number of follow-up surgeries. The unpredictability of scheduling these follow-up procedures has led to prolonged fasting and water deprivation periods for patients awaiting surgery. However, accumulated evidence revealed that midnight fasting does not decrease the volume and acidity of stomach content related to perioperative complications (He et al. 2021). Conversely, long-term fasting could lead to insulin resistance and postoperative discomforts such as thirst, hunger, and anxiety (He et al. 2021; Wu et al. 2022a; McCracken and Montgomery 2018), which has an association with prolonged length of hospital stay. Additionally, as patients receiving daytime oral surgery often have difficulty opening their mouths and chewing after the operation, the fasting time is even longer. As a result, excessive fasting may reduce the quality of postoperative recovery of patients undergoing daytime oral surgery.

Preoperative carbohydrate intake is implemented as part of enhanced recovery after surgery (ERAS) and has been shown to alleviate some of the discomforts associated with fasting during the perioperative period (Ljungqvist et al. 2017). However, certain studies suggest that preoperative carbohydrate intake may not significantly improve postoperative recovery or may have a minimal effect. The variability in results could be attributed to inadequate blinding and differences in patient populations (Asakura et al. 2015; Lee et al. 2018; Smith et al. 2014). Outfast is a kind of carbohydrate (osmotic pressure 280–300 mmol/L, pH 3.8–4.3, contents per 100 ml: 14.2 g carbohydrate, 45 mg sodium, 0.24 mg vitamin B1, 0.13 mg vitamin B6, 0.14 mg vitamin B12, and 1.48 mg zinc) used for the perioperative fasting of patients under general anesthesia to provide energy and a nutritional supplement. Despite some promising effects, few randomized controlled trials have been conducted to study the effect of preoperative carbohydrate intake on the quality of recovery in patients undergoing daytime oral surgery.

In this study, we aimed to evaluate the effect of preoperative oral carbohydrate (Outfast) intake on the postoperative outcome and quality of recovery (QoR) of patients undergoing elective daytime oral surgery. The purpose of this study was to compare the QoR-15 questionnaire outcomes of patients undergoing daytime oral surgery. We hypothesize that preoperative oral carbohydrate intake could improve the postoperative recovery quality of patients undergoing daytime oral surgery.

Methods

Study design and participants

This study was approved by the Ethical Committee of The First Affiliated Hospital of Anhui Medical University, Hefei, China (Approval No. PJ2022-01–19) and registered in the Chinese Clinical Trial Registry (www.chictr.org.cn; ChiCTR2100053753) on 28/11/2021. All participants were from The First Affiliated Hospital of Anhui Medical University. Informed consent forms were signed by all participants. Patients aged 18 to 65 years with an American Society of Anesthesiologists (ASA) physical status of I–II and body mass index (BMI) of 18 to 30 kg/m^2 who were scheduled for day-stay oral–maxillofacial surgery were enrolled in this study between August 2022 and December 2022. Patients with the following conditions were excluded: type 1 or 2 diabetes and other endocrine system diseases, a gastric emptying disorder, psychical and psychological disease, hepatic or renal insufficiency, and inability to communicate. Exit criteria were as follows: a procedure lasting less than 1 h or more than 3 h, the occurrence of severe adverse events during operation, and patients' refusal to follow-up. The specific aims of the study were to (1) evaluate the QoR-15 questionnaire outcomes and (2) compare the patient well-being and satisfaction with or without Outfast drink 2–3 h before the induction of anesthesia.

Randomization

The patients were randomly divided into two groups using a random number generator website (https://www.powerandsamplesize.com/) in a 1:1 ratio and either administered the preoperative oral carbohydrate Outfast (O group, Yichang Humanwell FSMP CO., LTD, Yichang, China) or made to fast before surgery (F group). In the afternoon of the day before surgery, a study coordinator independent of the clinical team from the hospitals opened the numbered, opaque, and sealed randomization envelopes and managed participants according to the group allocation. Participants in the F group fasted from midnight the day before surgery. Participants in the O group also fasted but received Outfast (4 ml/kg) 2–3 h before the induction of anesthesia. The same nurse not involved in the study provided patient education which included the day surgery process, surgical precautions, postoperative rehabilitation plan, and psychological care.

Clinical protocol

Once the patient entered the operating room, an intravenous line was placed. Sodium lactate Ringer's injection was infused at 6–8 ml/kg before the induction of anesthesia and at a rate of 5–7 ml/kg/h during the surgery. Peripheral capillary oxygen saturation (SpO_2), noninvasive blood pressure, electrocardiography (ECG), and bispectral index (BIS) were monitored. Anesthesia was induced with sufentanil (0.3–0.4 μg/kg), propofol (1.5–2.5 mg/kg)/etomidate (0.2–0.3 mg/kg), and cisatracurium (0.2–0.4 mg/kg). After endotracheal intubation, mechanical ventilation with tidal volumes of 8–10 ml/kg and a respiratory rate of 10–12/min was undertaken. Anesthesia was maintained with propofol (4–6 mg/kg/h), remifentanil (0.1–0.2 μg/kg/min), sufentanil (5–10 μg), and cisatracurium (0.2 mg/kg). BIS values were adjusted to 40–60. End-tidal carbon dioxide concentration (EtCO2) was maintained at 35–45 mmHg. Heart rate (HR) was controlled between 50 and 90 beats/min, and circulatory dynamics were maintained at ± 20% of preoperative blood pressure. At the end of the surgery, flurbiprofen axetil (50 mg) was given for pain relief.

Outcomes

In this study, the primary outcome was the QoR-15 score. The QoR-15 ranges from 0 (the poorest quality of recovery) to 150 (the best quality of recovery) and is widely used to assess postoperative recovery. It includes 15 items evaluating five dimensions: physical comfort (five items), emotional state (four items), physical independence (two items), psychological support (two items), and pain (two items) (Stark et al. 2013). The QoR-15 was measured before anesthesia induction and 24 h after surgery.

Secondary outcomes included the assessment of patient well-being and satisfaction, which were measured before anesthesia induction and 24 h after surgery. Seven parameters representing patient well-being (thirst, hunger, mouth dryness, nausea and vomiting, fatigue, anxiety, and sleep quality) were evaluated with a numeric rating scale (NRS; 0—no discomfort, 10—worst imaginable discomfort) (Sada et al. 2014). Patient satisfaction was assessed via a 5-point scale (5—very satisfied, 4—somewhat satisfied, 3—neutral, 2—somewhat dissatisfied, 1—very dissatisfied) (Bopp et al. 2011).

Heterogenous predictor variables included demographic variables and perioperative variables, such as age, gender male (M)/female (F), height, weight, ASA I/II, type of surgery, duration of anesthesia, duration of surgery, dose of propofol, dose of remifentanil, fluid volume, fasting time, hospital length of stay, postoperative exhaust time, and adverse events (defined as aspiration, readmission, return to the operating room, increased length of stay due to medical necessity). We also recorded mean arterial pressure (MAP) and HR at the following time points: before anesthesia (T0), 5 min after endotracheal intubation (T1), surgery finish (T2), and tracheal extubation (T3). Blood glucose concentrations were measured at baseline level, anesthesia induction (Ta), surgery finish (Tb), and postanesthesia care unit (PACU) discharge (Tc), respectively.

Sample size

A previous study recommended that the minimal clinically important difference (MCID) for the QoR-15 scale was 6.0 with a standard deviation (SD) ± 8.77 (Myles and Myles 2021). In our study, sample size calculation was performed with an online power sample size calculator (https://www.powerandsamplesize.com/). A sample size of 45 patients in each group was estimated necessary to detect such a difference with a power of 90% and an α-error of 5% based on the results of our pilot study ($\sigma = 8.77$). Considering potential dropouts and incomplete follow-up, a total of 102 patients were finally enrolled.

Statistical analysis

All data were analyzed using SPSS version 25.0 (IBM Corporation, USA). The Shapiro–Wilk test was used to determine the normality of the data distribution. Continuous variables are summarized as mean (SD) or median (interquartile range [IQR]), as appropriate. Demographic and baseline data such as age, height, weight, duration of anesthesia, duration of surgery, dose of propofol, dose of remifentanil, fluid volume, fasting time, length of hospital stay, and postoperative exhaust time were compared using the Student t-test. Repeated measures ANOVA was used to compare differences in repeated measures of QoR-15 scores, well-being and satisfaction scores, blood glucose levels, MAP, and HR between the two groups. When a statistically significant group effect was found, the LSD post hoc test was used to compare differences in the distributions of observed indicators between the two groups at different time points. The chi-square test was used to examine the relationship between qualitative variables and independent samples (gender M/F, ASA I/II, and type of surgery). A P value < 0.05 was considered statistically significant.

Results

A total of 102 patients were enrolled in this clinical trial. A total of 10 patients were excluded from the study: 1 patient was suspected to have diabetes mellitus, 1 patient had surgery canceled, 2 patients had an operation duration of longer than 3 h (F group: $n = 1$, O group: $n = 1$), and 6 patients had an operation duration of less than 1 h (F group: $n = 4$, O group: $n = 2$). Thus, 92 patients were included in the data analyses (F group: $n = 45$, O group: $n = 47$). The flow diagram of the study is shown in Fig. 1.

The demographic characteristics of the patients are presented in Table 1. There were no statistically

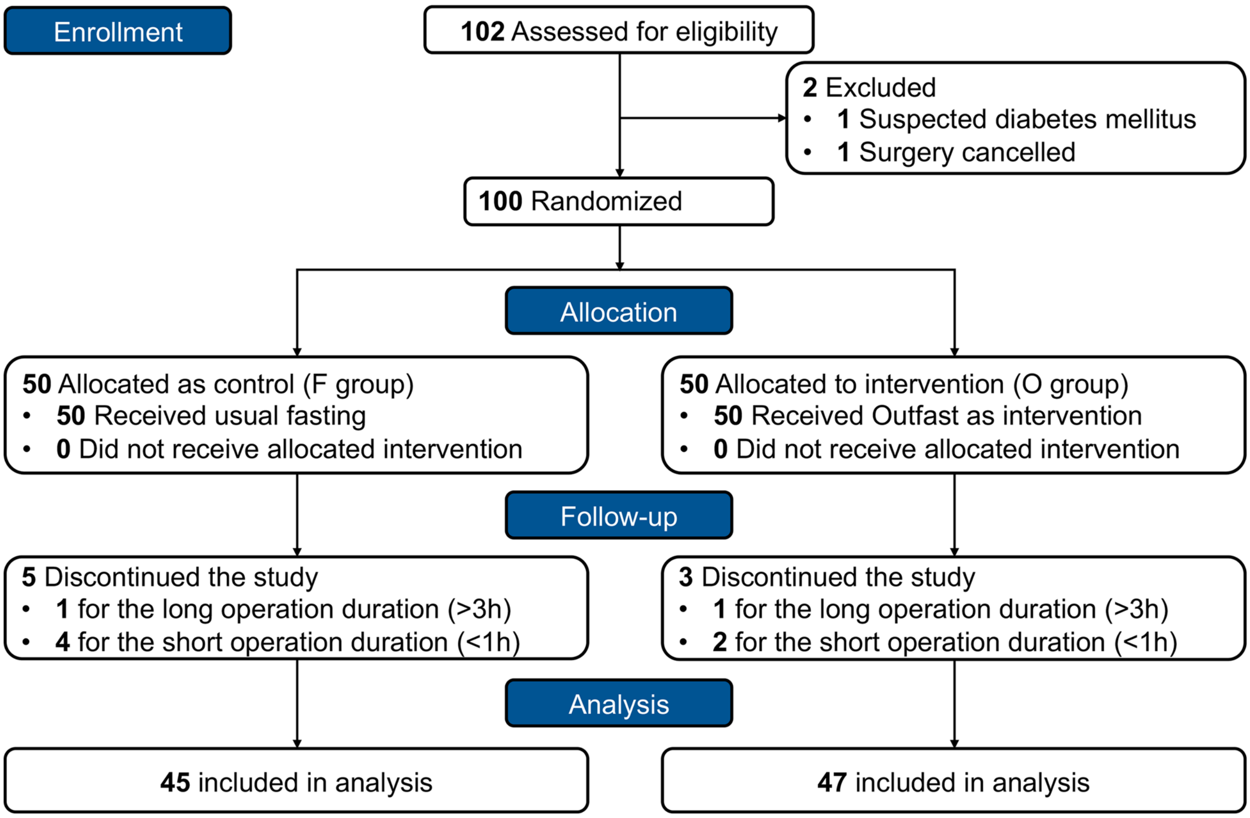

Fig. 1 CONSORT flow diagram of day-stay oral–maxillofacial patients

Table 1 Patient characteristics and perioperative clinical data

Variables	F group ($n = 45$)	O group ($n = 47$)	*P*
Age (year)	28.16 ± 7.43	29.15 ± 9.32	0.573
Gender (M/F)	20/25	19/28	0.697
Height (cm)	168.29 ± 8.36	168.06 ± 8.19	0.900
Weight (kg)	62.64 ± 11.73	61.43 ± 13.89	0.650
ASA (I/II)	13/32	12/35	0.717
Type of surgery			1.000
Extraction of impacted tooth	41	43	
Other intraoral surgery	4	4	
Duration of surgery (min)	84.31 ± 24.79	90.04 ± 26.55	0.287
Duration of anesthesia (min)	102.51 ± 24.34	106.09 ± 28.63	0.520
Dose of propofol (mg)	426.76 ± 142.09	436.95 ± 152.03	0.740
Dose of remifentanil (μg)	0.86 ± 0.27	0.92 ± 0.37	0.292
Fluid volume (ml)	431.00 ± 163.80	447.77 ± 176.70	0.638
Solid food fasting time (hour)	15.14 ± 3.53	16.53 ± 3.09	0.052
Hospital length of stay (hour)	24.27 ± 4.48	23.62 ± 3.51	0.443
Postoperative exhaust time (hour)	25.92 ± 8.26	17.06 ± 8.43	< 0.001

M male, *F* female, *ASA* American Society of Anesthesiologists significant differences between the two groups in terms of age, gender, body weight, height, and ASA classification. The perioperative profiles of the patients, such as type of surgery, duration of surgery and anesthesia, doses of propofol and remifentanil, fluid volume, fasting time, and length of hospital stay, were not significantly different between the two groups (Table 1). Compared with the F group, the postoperative exhaust time was significantly shorter in the O group ($P < 0.001$, Table 1).

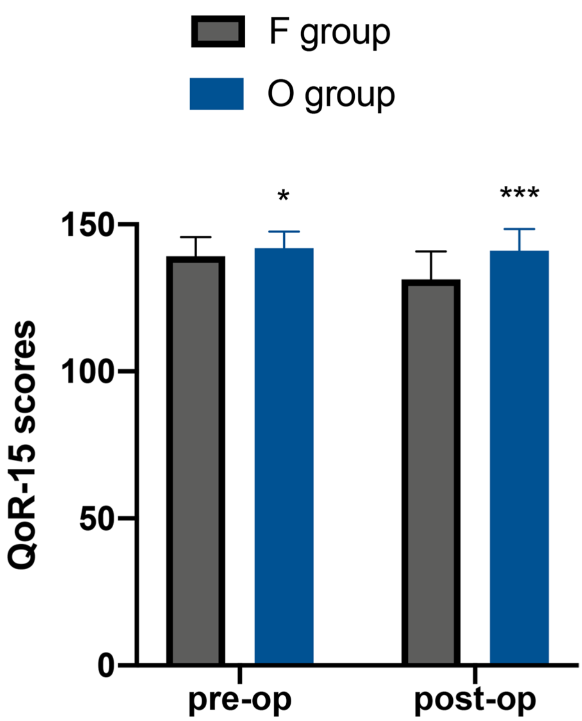

Fig. 2 Perioperative changes of QoR-15 score according to groups. QoR-15: 15-item quality of recovery score; pre-op: preoperative QoR-15 score; post-op: postoperative QoR-15 score. $^{*}P < 0.05$. $^{***}P < 0.001$

The total QoR-15 scores in the O group were significantly higher than those in the F group preoperatively and postoperatively (Fig. 2). The satisfaction and well-being of patients are displayed in Table 2. The NRS scores regarding thirst, hunger, mouth dryness, and anxiety were statistically significantly lower in the O group than in the F group preoperatively. The postoperative scores for thirst, mouth dryness, nausea and vomiting, fatigue, and sleep quality were statistically significantly lower in the O group than in the F group. Compared with the F group, significantly higher satisfaction was observed in the O group based on the 5-point scale.

No statistically significant differences were found in the MAP and HR between the F group and the O group at each observing time points, i.e., T0, T1, T2, and T3 (Table 3). There were no significant differences in blood glucose concentration at baseline, Ta, Tb, and Tc between the two groups (Fig. 3).

No adverse events were reported in either group.

Discussion

The diseases treated via ambulatory surgery in oral and maxillofacial consisted mainly of impacted teeth, odontogenic cysts, and supernumerary teeth (Wang et al. 2023). In these oral and maxillofacial surgery, due to the nature of the operation site, the time to first oral feeding is often postponed after surgery, which also affects their postoperative recovery. ERAS is an evidence-based care improvement process for surgical patients, which has been widely used in clinical practice. ERAS started mainly with colorectal surgery but has been shown to improve outcomes in almost all major surgical specialties. It can shorten the length of

Table 2 Assessment of patients' perioperative well-being and satisfaction

	Preoperative well-being Median (IQR)		*P*	Postoperative well-being Median (IQR)		*P*
	F group ($n = 45$)	O group ($n = 47$)		F group ($n = 45$)	O group ($n = 47$)	
Thirst	5(3–7)	3(2–5)	0.002	3(2–5)	2(0–3)	0.002
Hunger	4(2–6)	3(1–5)	0.016	4(1.5–4)	2(0–4)	0.129
Mouth dryness	5(3–7)	3(2–5)	0.003	5(4–8)	2(0–4)	< 0.001
Nausea and vomiting	0(0–0)	0(0–0)	0.095	0(0–0.5)	0(0–0)	0.026
Fatigue	0(0–2)	0(0–2)	0.326	3(2–4)	0(0–1)	< 0.001
Anxiety	2(1–3)	0(0–2)	0.002	0(0–1)	0(0–0)	0.102
Sleep quality	2(0.5–6.5)	2(0–5)	0.103	3(2.5–5.5)	1(0–2)	< 0.001
Patient satisfaction*	5(4–5)	5(5–5)	0.008	5(4–5)	5(5–5)	0.002

Seven parameters representing patient well-being (thirst, hunger, mouth dryness, nausea and vomiting, fatigue, anxiety, and sleep quality) were assessed using a numeric rating scale (0–10). *Patient satisfaction was measured by a 5-point scale (5—very satisfied, 4—somewhat satisfied, 3—neutral, 2—somewhat dissatisfied, 1—very dissatisfied). *IQR* interquartile range

Table 3 Perioperative MAP and HR changes

	MAP (mmHg)		*P*	HR (beats/min)		*P*
	F group($n=45$)	O group($n=47$)		F group($n=45$)	O group($n=47$)	
T0	89.91 ± 12.32	84.68 ± 13.61	0.057	79.29 ± 12.09	79.74 ± 11.57	0.854
T1	77.78 ± 9.11	76.09 ± 11.15	0.429	65.80 ± 12.34	66.64 ± 10.16	0.722
T2	76.87 ± 10.09	76.17 ± 12.58	0.771	69.56 ± 10.58	68.30 ± 10.15	0.562
T3	91.00 ± 12.91	88.57 ± 12.18	0.356	86.04 ± 14.67	81.15 ± 9.53	0.060

MAP mean arterial pressure, *HR* heart rate. The indicated time points were as follows: *T0* before anesthesia; *T1* 5 min after endotracheal intubation, *T2* surgery finish, *T3* tracheal extubation

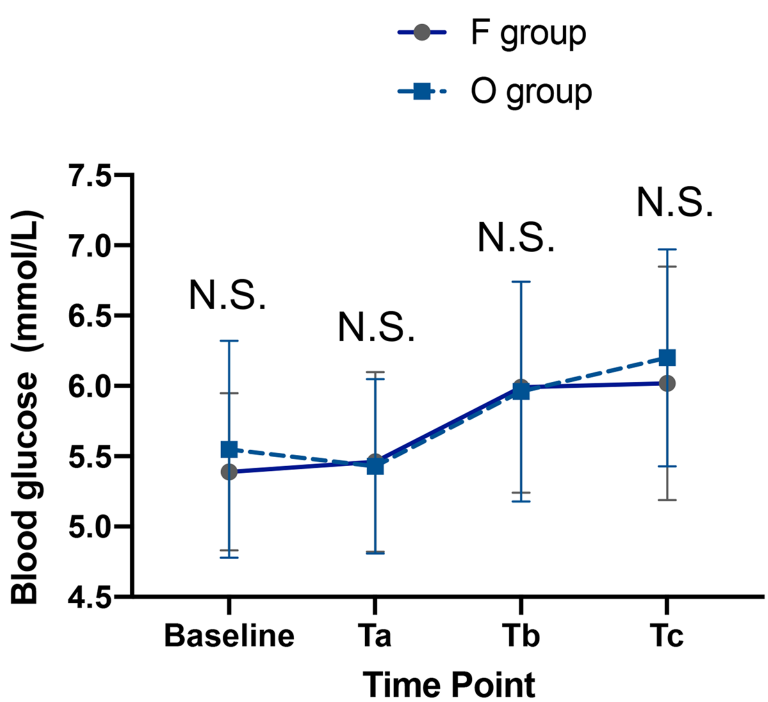

Fig. 3 Perioperative changes in blood glucose according to groups. ns: no significant difference. The indicated time points were as follows: Baseline: fasting blood glucose; Ta: anesthesia induction, Tb: surgery finish; Tc: PACU discharge

hospital stays (Ljungqvist et al. 2017; Lin et al. 2019), improve the effectiveness and safety of the procedure (Wu et al. 2022b), and reduce hospitalization costs (Lin et al. 2019). Preoperative oral carbohydrate intake, as part of ERAS protocols, is recommended for patients in several kinds of surgery (Cheng et al. 2021; Zhou and Luo 2019). However, few studies have examined the effect of preoperative carbohydrate intake on patients undergoing daytime oral surgery. This study revealed that preoperative oral carbohydrate intake can increase QoR-15 scores, improve well-being and satisfaction, and accelerate the postoperative intestinal exhaust of patients.

In this study, preoperative and postoperative QoR-15 scores were statistically significantly improved with carbohydrate intake before surgery. However, there are still contradictions regarding the effect of preoperative oral carbohydrate intake on postoperative recovery in different studies (Wang et al. 2021; Cho et al. 2021a; Mousavie et al. 2021). In a study by Cho et al., preoperative oral carbohydrate intake did not significantly increase the QoR-15 scores (Cho et al. 2021a). This discrepancy may be explained by the different carbohydrate beverage intake times compared to our study. Additionally, all participants were infused with Ringer's lactate solution from midnight until surgery in that study, which may have been sufficient for the enhanced postoperative recovery of patients. Our results were concurrent with a study by Wang et al., which had a similar carbohydrate beverage intake time

(Wang et al. 2021). Thus, it is appropriate to consume a carbohydrate beverage 2 and 3 h before the induction of anesthesia.

The effects of preoperative carbohydrate intake on patient well-being and satisfaction were also examined. This study revealed that, compared with the fasting group, preoperative oral carbohydrate intake could improve four out of seven patient well-being parameters (thirst, hunger, mouth dryness, and anxiety) before surgery and five out of seven parameters (thirst, mouth dryness, nausea and vomiting, fatigue, and sleep quality) postoperatively. Patients who received oral carbohydrates preoperatively also showed better satisfaction than patients fasting from midnight. In contrast to our data, Doo et al. reported no significant improvements in patient well-being and the satisfaction of patients undergoing thyroidectomy with preoperative carbohydrate intake (Doo et al. 2018). However, their study only enrolled participants scheduled for surgery at 8:30 am. Patients were asleep for most of the fasting period and thus maintained a physiological state without feeling hunger or thirst. Therefore, our findings are suitable for most patients and are in accordance with previous reports (Wu et al. 2022a, 2022b; Zhang et al. 2020; Rizvanović et al. 2019).

Insulin resistance is a catabolic state involving the degradation of stored glycogen via glycogenolysis along with muscle protein loss and lipolysis, which subsequently leads to hyperglycemia and hyperinsulinemia. It is proportional to the length of fasting time and the intensity of surgical trauma and can prolong the recovery time, increase the incidence of postoperative wound infection, and even increase the mortality risk in surgical patients (Wu et al. 2022a; Mousavie et al. 2021; Rizvanović et al. 2019). Carbohydrate-rich drinks are administrated preoperatively in more and more kinds of operations to reduce insulin resistance and maintain blood glucose homeostasis thereby reducing the length of hospital stays (Rizvanović et al. 2019; Nygren 2006). In this study, the perioperative blood glucose levels of patients after preoperative carbohydrate intake were not significantly different from those in fasting patients. This result may be because the trauma intensity of daytime oral surgery is low and the participants undergoing daytime oral surgery are typically young and in good physical condition.

Postoperative exhaust time is also an important indicator of ERAS (Wu et al. 2022b). In our study, the first postoperative exhaust time in patients with carbohydrate intake was significantly shorter compared to that of fasting patients. Previous studies also support our results, Lin et al. reported that the first anal exhaust time after laparoscopic radical prostatectomy in the ERAS group was significantly shorter compared with the control group (Lin et al. 2019). A study by Zuo et al. also showed that the exhaust recovery time in the ERAS group was significantly shorter than in the non-ERAS group in patients with lumbar disc herniation after discectomy (Zuo et al. 2021). However, there are few studies about the effect of preoperative oral carbohydrate intake on the postoperative exhaust time; thus, we will investigate the effect of oral carbohydrate (outfast) on the recovery of postoperative intestinal function in the future.

This study has several limitations. First, perioperative insulin resistance was not measured in our study. With insulin resistance measurement, we would have stronger evidence to verify the effect of preoperative carbohydrate intake. Second, even though no aspiration occurred in this study, the study design would be more rigorous if gastric ultrasound was performed to estimate the gastric content volume. However, previous studies have shown that the moderate intake of oral carbohydrates 2 h before anesthesia is safe for the preoperative management of fasting patients via ultrasonography (Zhang et al. 2020; Cho et al. 2021b). Third, the absence of a placebo group in our study may undermine the robustness of our findings. Finally, only participants aged 18–65 years having ASA physical status grades I and II were enrolled in this study. It is necessary to explore the effect of preoperative oral carbohydrate intake on elderly patients or patients with higher ASA grades in future studies.

Conclusions

Preoperative carbohydrate intake 2–3 h before anesthesia induction could improve the QoR-15 questionnaire scores 24 h after surgery and enhance the comfort of patients undergoing daytime oral surgery, making it a potential treatment aption for such patients.

Abbreviations

QoR	Quality of recovery
F	Fasting
O	Outfast
NRS	Numeric rating scale
ERAS	Enhanced recovery after surgery
ASA	American Society of Anesthesiologists
BMI	Body mass index
SpO_2	Peripheral capillary oxygen saturation
ECG	Electrocardiography
BIS	Bispectral index
$EtCO_2$	End-tidal carbon dioxide concentration
HR	Heart rate
M	Male
F	Female
MAP	Mean arterial pressure
SD	Standard deviation
IQR	Interquartile range
MCID	Minimal clinically important difference
T0	Before anesthesia
T1	5 Min after endotracheal intubation
T2	Surgery finish
T3	Tracheal extubation
Ta	Anesthesia induction
Tb	Surgery finish

PACU Postanesthesia care unit
Tc PACU discharge

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Authors' contribution
Y.L. and W.Z. conceived and designed the experiments. W.T., G.M., C.Y. and Y.S. performed experiments and analyzed data. W.T. and G.M. drafted the manuscript. Y.L. and W.Z. revised the manuscript. All authors reviewed the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Ethical approval (Ethical Committee No. PJ2022-01–19) was provided by the ethics committee of the First Affiliated Hospital of Anhui Medical University in January 2022. All patients provided informed consent and all procedures were conducted according to the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Anesthesiology, Ambulatory Surgery Center, The First Affiliated Hospital of Anhui Medical University, Hefei 230022, China.

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