

Safety and patient's satisfaction of preoperative carbohydrate drink until 2 hours before colorectal cancer surgery: a single-center, prospective randomized controlled trial

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Purpose: Traditionally, fasting from midnight has been a standard practice in elective surgery for reduce the risk of aspiration. However, Enhanced Recovery After Surgery (ERAS) programs recommend clear fluid intake until 2 hours before anesthesia. This study aimed to evaluate the safety and patient satisfaction of preoperative carbohydrate drink intake until 2 hours before colorectal cancer surgery.

Methods: Sixty patients who underwent colorectal cancer surgery between April 2021 and February 2023 at Keimyung University Dongsan Medical Center were enrolled. This study included 30 patients who fasted from midnight (nothing by mouth [NPO] group) and 30 patients who consumed a high concentration of complex carbohydrate fluids (New Care NO-NPO) until 2 hours before surgery (No-NPO group). Patient satisfaction was assessed using a visual analog scale. Perioperative and postoperative outcomes were compared.

Results: Basic characteristics of patients were similar for the 2 groups. The No-NPO group had a significantly higher patient satisfaction score than the NPO group (3.7 vs. 2.2, $P = 0.040$). Scores of operative difficulty, operation time, blood loss, postoperative recovery parameters, and postoperative complication rates were similar for the 2 groups. Pathological outcomes were also comparable. No mortality occurred in either group.

Conclusion: High-concentration carbohydrate fluid intake until 2 hours before induction of anesthesia could improve patient satisfaction without increasing postoperative complications, demonstrating its safety and feasibility in colorectal cancer surgery.

Trial registration: CRIS (cris.nih.go.kr) identifier: KCT0011323.

Keywords: Colorectal surgery; Preoperative care; Postoperative nausea and vomiting; Respiratory aspiration; Postoperative complications

INTRODUCTION

Traditionally, patients scheduled to undergo elective surgery have fasted from midnight. This practice was previously believed to

help empty the patient's stomach and prevent complications such as aspiration pneumonia [1–3]. However, recent studies have reported that preoperative carbohydrate intake does not increase the incidence of complications [4]. Several randomized controlled

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trials have also reported the safety of providing clear fluids and light meals to both children and adults before elective surgeries requiring general anesthesia [5–7].

Moreover, it is possible to reduce the catabolic response of surgical stress through preoperative nutrition support. Oral carbohydrate intake has been associated with decreased protein breakdown, better maintenance of lean body mass and muscle strength, and beneficial effects on cardiac health [8, 9]. It is noteworthy that oral carbohydrate intake has been demonstrated to be able to enhance postoperative peripheral insulin sensitivity, thereby reducing insulin requirements and the incidence of hyperglycemia in patients undergoing major abdominal surgery [9].

The impact of carbohydrate intake on surgical recovery and postoperative well-being remains a topic of debate. Some studies have indicated that preoperative carbohydrate intake is associated with faster return of normal gastrointestinal function and reduced thirst discomfort compared to the control group [10–12]. Moreover, numerous studies have demonstrated that preoperative carbohydrate intakes could reduce hospital stay for patients undergoing a major abdominal surgery [8, 13, 14].

Although benefits and safety of preoperative carbohydrate intake have been extensively established, it is still not widely used in Korea. To the best of our knowledge, few studies have investigated the relationship between preoperative carbohydrate intake and patient satisfaction. Therefore, this study aimed to investigate the safety and patient satisfaction associated with preoperative carbohydrate intake.

METHODS

Ethics statement

This study was approved by the Institutional Review Board of the Keimyung University Dongsan Medical Center (No. 2016-09-037). Written informed consent was obtained from all patients prior to any study-specific screening procedures. This trial was registered at the Clinical Research Information Service (CRIS; cris.nih.go.kr identifier: KCT0011323) and followed the CONSORT (Consolidated Standards of Reporting Trials) 2010 guidelines. All study procedures were conducted in compliance with the principles of the Declaration of Helsinki.

Patients

Between April 2021 and February 2023, we prospectively enrolled 60 patients aged 20 to 80 years who were scheduled to undergo the first surgery of the day. Subsequent surgery patients were excluded due to difficulty in accurately predicting the start time of surgery.

Exclusion criteria were as follows: emergency surgery, bowel obstruction or stenosis, surgery for recurrent colorectal cancer, and bowel resection combined with resection of other organs (Fig. 1). A computer-generated randomization sequence was used to assign participants to each study group in a 1:1 ratio. Allocation concealment was ensured by using sealed, opaque envelopes that were sequentially numbered and opened only after patient enrollment. The envelopes were prepared by a researcher not involved in patient recruitment or data collection. After randomization, 30 patients who traditionally began fasting from midnight (nothing by mouth [NPO] group) and 30 patients who consumed a high concentration of complex carbohydrate fluids (New Care NO-NPO, Daesan Wellife) until 2 hours before surgery (No-NPO group) were enrolled in the study. To minimize potential bias, the operating surgeons were blinded to the group allocation throughout the perioperative period. Surgeons performed the procedures without knowledge of whether the patient belonged to the NPO or No-NPO group. Importantly, the surgeons were informed of the patient's group assignment only after completing the surgery and recording the operative technical difficulty score. This approach ensured that the assessment of operative technical difficulty remained objective and uninfluenced by knowledge of the preoperative intervention.

Evaluation parameters

Demographic characteristics of patients, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status, and location of tumor, were obtained. To assess the inflammatory and nutritional status of patients, laboratory values were obtained, including hemoglobin (g/dL), white blood cell (WBC) count ($\times 10^3/\mu\text{L}$), C-reactive protein (CRP; mg/dL), serum albumin (g/dL), and serum glucose (mg/dL). These values were measured prior to surgery and on the first, third, and fifth days following surgery.

Perioperative details including patient satisfaction scores, operative technical difficulty, operation time, blood loss, time to first flatus, time to first sips of water, time to first liquid diet, time to first soft diet, length of stay, morbidity within 30 days after surgery, Clavien-Dindo classification, and mortality within 30 days after surgery were collected.

Patient satisfaction regarding preoperative fasting was assessed after surgery using the visual analog scale (VAS), which was chosen for its simplicity and precedent in similar studies evaluating fasting-related discomfort such as hunger, thirst, and overall satisfaction [15]. Patients were instructed to rate their satisfaction with the preoperative fasting experience on a scale from 1 (very dissatisfied) to 10 (very satisfied). Patient satisfaction was assessed once,

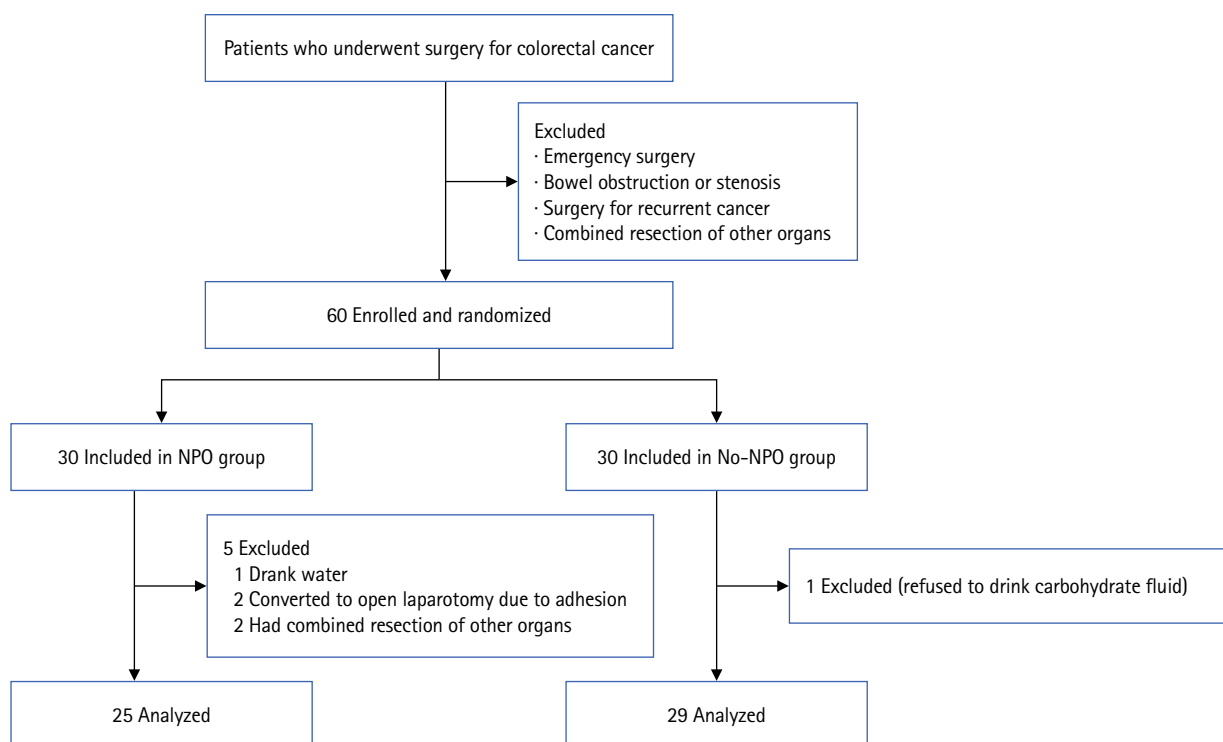


Fig. 1. Flowchart of patient selection. Sixty patients undergoing elective colorectal cancer surgery were randomized into those who fasted from midnight (nothing by mouth [NPO] group, $n = 30$) and those who consumed carbohydrate fluids (Nucare No-NPO, Daesang Wellife; No-NPO group, $n = 30$). After exclusions, 25 patients in the NPO group and 29 in the No-NPO group were included in the final analysis.

within 24 hours after surgery in the recovery ward, by a blinded research nurse using the VAS to evaluate fasting-related discomfort. Surgeons performed the surgery without knowledge of which group the patient was assigned to. Technical difficulty of the surgery was assessed by the primary operating surgeon immediately after the procedure using a subjective VAS ranging from 1 (very easy) to 10 (very difficult). This assessment reflected the surgeon's overall impression of intraoperative complexity, including factors such as exposure, dissection plane clarity, anatomic variations, and tissue handling. Additionally, objective assessments were conducted, including surgical duration, intraoperative blood loss, and occurrence of any specific events during surgery. Postoperative pathological outcomes included T category, N category, differentiation, number of retrieved lymph nodes, lymphovascular invasion, and perineural invasion.

Carbohydrate intake before surgery

Patients assigned to the No-NPO group were instructed to consume 2 cans of complex carbohydrate fluids, each containing 200 mL with 100 kcal, 104 mg of sodium, 96 mg of potassium, and 25.6 g of carbohydrates, at 2 hours before surgery. Patients in the No-NPO group were instructed to consume the carbohydrate drink at 6:00 AM, 2 hours before anesthesia. To ensure compli-

ance, patients received preoperative counseling and morning reminders from assigned nurse. Although early wake-up was required, no patients reported significant inconvenience, likely due to the hospital's structured preoperative routine.

Enhanced Recovery After Surgery (ERAS) protocol implementation

To contextualize the study within the ERAS framework, [Table 1](#) summarizes the ERAS components routinely implemented at our institution for colorectal cancer surgery, applied uniformly to both study groups except for the preoperative carbohydrate intervention.

Statistical analysis

The primary endpoint of this study was patient satisfaction. Secondary endpoints were perioperative outcomes and postoperative pathological outcomes. The sample size was calculated based on a noninferiority trial design. It was hypothesized that the rate of complications after laparoscopic colorectal surgery would be 20% based on a previous study [16]. We assumed a 20% complication rate and a 14% noninferiority margin to ensure adequate power (80%) to confirm safety, which was a key secondary objective. A trial with 60 patients contributing to the primary endpoint analy-

Table 1. ERAS components implemented at Keimyung University Dongsan Medical Center for colorectal cancer surgery

ERAS component	Description
Preoperative counseling	Patients receive education on the surgical procedure, recovery expectations, and ERAS protocol.
Preoperative carbohydrate intake	Two 200 mL cans of a complex carbohydrate drink consumed 2 hours before surgery.
Bowel preparation	Selective mechanical bowel preparation for left-sided colorectal resections on preoperative day 2; no routine preparation for right-sided resections.
Thromboprophylaxis	Intraoperative intermittent pneumatic compression applied to lower extremities during surgery.
Anesthesia type	General anesthesia.
Surgical approach	Minimally invasive surgery (laparoscopic or robotic) unless contraindicated (e.g., adhesions requiring conversion).
Antibiotic prophylaxis	Second-generation cephalosporin (cefotetan 1 g) administered intravenously 30 minutes before incision, every 8 hours after surgery, and discontinued within 24 hours.
Analgesia	Multimodal analgesia including intraoperative analgesia; postoperative IV NSAIDs, pain buster, patient-controlled analgesia until POD 2; oral analgesics from POD 2 onward.
Drain usage	No routine use of abdominal drains; removed by POD 4 if placed for clinical indications (e.g., high-risk anastomosis).
Catheter management	Urinary catheter inserted intraoperatively, removed on POD 1 unless complications arise.
Fluid management	Goal-directed fluid therapy to maintain euvolemia, guided by intraoperative monitoring.
Mobilization protocol	Early mobilization: sitting out of bed on operative day, ambulation encouraged on POD 1.
Postoperative nutrition	Sips of water on preoperative days 1–2 and postoperative 6 hours; liquid diet started on POD 1; soft diet initiated on POD 2 and continued through POD 5.
Discharge planning	Target discharge on POD 5, contingent on clinical stability and recovery milestones.

Except for preoperative carbohydrate intake, which was applied only to the No-NPO group, all components were standardized across both NPO and No-NPO groups to minimize confounding variables. The preoperative carbohydrate drink was the intervention under study for the No-NPO group. ERAS, Enhanced Recovery After Surgery; IV, intravenous; NSAID, nonsteroidal anti-inflammatory drug; POD, postoperative day; NPO, nothing by mouth.

sis would maintain this power, accounting for an expected 10% dropout rate. Results are presented as means and standard deviations (SDs) for continuous variables that satisfy the assumption of normality, and as medians and interquartile ranges (IQRs) for continuous variables that do not satisfy normality. Categorical outcomes are presented as frequencies and percentages (n, %). Normality was assessed for all continuous variables using the Shapiro-Wilk test across both groups. Based on the normality test results, continuous variables were analyzed using the Independent Samples t-test for variables that satisfied the normality assumption (e.g., length of stay and operative technical difficulty), and the Mann-Whitney U test for variables that did not. Categorical variables were analyzed using the Chi-square statistic or Fisher's exact test, where appropriate. A P-value of less than 0.05 was regarded as statistically significant. IBM SPSS ver. 25 (IBM Corp) was used for all statistical analyses.

A per-protocol analysis was conducted to evaluate outcomes among patients who adhered to the assigned protocol. Patients with significant deviations, such as those who consumed water outside the permitted timeframe or refused the carbohydrate drink, were excluded from the final analysis to ensure accurate assessment of the intervention's effect.

RESULTS

Patient and tumor characteristics

In accordance with the per-protocol analysis approach, patients who did not adhere to the assigned intervention were excluded from the final analysis. In the NPO group, 5 patients were excluded for the following reasons: 1 patient drank water 1 hour prior to the surgery, 2 required conversion to open laparotomies due to the presence of small intestine adhesions from previous surgeries, and 2 underwent resection of the urinary bladder and liver, respectively, due to cancer invasion. In the No-NPO group, 1 patient refused to drink carbohydrate fluids on the day of surgery. In the No-NPO group, 28 of 29 patients (96.6%) fully consumed both 200 mL cans of the carbohydrate drink (400 mL total, 200 kcal) at the designated time. One patient consumed only 1 can (200 mL, 100 kcal) due to personal preference. Finally, this study proceeded with 25 patients in the NPO group and 29 patients in the No-NPO group.

Table 2 describes baseline characteristics of patients in NPO and No-NPO groups. Age, sex, BMI, and ASA physical status were not statistically significant differences between the 2 groups. In both groups, the most prevalent location of colorectal cancer was the left side (72.0% vs. 72.4%, $P = 0.973$).

Table 2. Patient and tumor characteristics

Characteristic	NPO group (n = 25)	No-NPO group (n = 29)	P-value
Age (yr)	63.9 ± 12.1	65.0 ± 10.1	0.715
Sex			0.721
Male	15 (60.0)	16 (55.2)	
Female	10 (40.0)	13 (44.8)	
Body mass index (kg/m ²)	24.1 ± 4.0	23.7 ± 3.6	0.675
ASA physical status			0.529
I	6 (24.0)	11 (37.9)	
II	13 (52.0)	13 (44.8)	
III	6 (24.0)	5 (17.2)	
Location of tumor			0.973
Left sided	18 (72.0)	21 (72.4)	
Right sided	7 (28.0)	8 (27.6)	

Values are presented as mean ± standard deviation or number (%).
NPO, nothing by mouth; ASA, American Society of Anesthesiologists.

Perioperative outcomes

The No-NPO group exhibited a higher mean score of patient satisfaction than the NPO group (3.7 vs. 2.2, $P=0.040$). However, the mean score of operative technical difficulty was not significantly different between the 2 groups (3.1 vs. 2.7, $P=0.547$). Furthermore, median total operation time (203 minutes vs. 211 minutes, $P=0.828$) and intraoperative bleeding (30 mL vs. 30 mL, $P=0.986$) were similar between the 2 groups. The median time to first flatus was 2 days in both groups ($P=0.102$). Similarly, there were no significant differences in median time to sips of water (1 day vs. 1 day, $P=0.511$), time to liquid diet (2 days vs. 3 days, $P=0.865$), and time to soft diet (3 days vs. 4 days, $P=0.867$). The mean length of stay was also comparable between the NPO group and the No-NPO group. (6.8 days vs. 7.0 days, $P=0.678$).

Over a period of 30 days after surgery, the morbidity rate was 12.0% in the NPO group and 17.2% in the No-NPO group, showing no significant difference in incidence rate between the 2 groups ($P=0.589$). Surgical site infections occurred in 2 cases each, while ileus was observed in 1 case in the NPO group and 2 cases in the No-NPO group. All cases received conservative treatment and all patients were discharged. Additionally, there was 1 case of anastomosis site bleeding in the No-NPO group, which was managed conservatively before discharge. No case of postoperative pneumonia was observed. In both groups, there were no occurrences of mortality (Table 3).

Perioperative laboratory values

To compare perioperative inflammatory and nutritional status between the 2 groups, laboratory measurements of hemoglobin, WBC, CRP, serum albumin, and serum glucose were obtained

Table 3. Perioperative outcomes

Outcome	NPO group (n = 25)	No-NPO group (n = 29)	P-value
Patient's satisfaction score	2.2 ± 2.4	3.7 ± 2.7	0.040
Operative technical difficulty	3.1 ± 2.4	2.7 ± 1.1	0.547
Operation time (min)	203 (173–275)	211 (185–255)	0.828
Loss of blood (mL)	30 (15–100)	30 (5–50)	0.986
Time to first flatus (day)	2 (1–2)	2 (2–4)	0.102
Time to sips of water (day)	1 (1–4)	1 (1–4)	0.511
Time to liquid diet (day)	2 (1–5)	3 (1–5)	0.865
Time to soft diet (day)	3 (2–6)	4 (2–6)	0.867
Length of stay (day)	6.8 ± 2.2	7.0 ± 2.0	0.678
Morbidity within 30 days after surgery	3 (12.0)	5 (17.2)	0.589
Surgical site infection	2 (8.0)	2 (6.9)	
Ileus	1 (4.0)	2 (6.9)	
Anastomosis site bleeding	0 (0)	1 (3.4)	
Clavien-Dindo classification			0.850
II	1 (4.0)	2 (6.9)	
IIIA	2 (8.0)	3 (10.3)	
Mortality within 30 days after surgery	0 (0)	0 (0)	> 0.999

Values are presented as mean ± standard deviation, median (interquartile range), or number (%).

NPO, nothing by mouth.

preoperatively and on postoperative days 1, 3, and 5. There were no significant differences in these laboratory values between the 2 groups (Table 4, Fig. 2).

Postoperative pathologic outcomes

Table 5 presents postoperative oncological outcomes. There were no significant differences in T category, N category, or differentiation between the 2 groups. Additionally, no significant differences were observed in number of retrieved lymph nodes (21.4 vs. 21.9, $P=0.889$), lymphovascular invasion (28.0% vs. 34.5%, $P=0.612$), or perineural invasion (24.0% vs. 13.8%, $P=0.340$).

DISCUSSION

Patients scheduled to undergo initial surgery of the day were enrolled in this study. For patients who underwent subsequent surgeries, it was challenging to consume clear liquids 2 hours prior to the scheduled surgery, as they were unable to ascertain the precise commencement time of the surgery.

Following this, patients were randomly assigned to either the NPO or No-NPO group. The operators were blinded to the patient's group allocation at the time of surgery and at the time of when assessing surgical difficulty. This approach enabled the cre-

Table 4. Perioperative laboratory test results

Variable	NPO group (n = 25)	No-NPO group (n = 29)	P-value
Hemoglobin (g/dL)			
Preoperative	12.3 (11.1–13.3)	13.0 (12.0–13.9)	0.742
POD 1	10.9 (10.3–13.0)	12.2 (11.6–12.8)	0.256
POD 3	11.3 (10.3–12.4)	11.7 (11.0–12.5)	0.658
POD 5	11.7 (10.2–13.8)	11.8 (10.8–13.0)	0.883
White blood cell ($\times 10^3/\mu\text{L}$)			
Preoperative	6.7 (5.9–8.4)	6.6 (4.8–8.2)	0.801
POD 1	9.4 (6.9–11.6)	8.8 (7.6–12.9)	0.709
POD 3	8.4 (6.8–9.7)	7.3 (6.0–8.4)	0.456
POD 5	7.8 (6.7–8.2)	6.3 (5.7–8.1)	0.271
C-reactive protein (mg/dL)			
Preoperative	0.1 (0.1–0.4)	0.1 (0.1–0.2)	0.489
POD 1	5.9 (3.7–7.5)	5.9 (3.9–6.8)	0.282
POD 3	7.1 (5.1–11.1)	7.2 (4.9–10.5)	0.603
POD 5	3.7 (2.2–7.1)	3.7 (1.6–6.8)	0.876
Serum albumin (g/dL)			
Preoperative	4.2 (4.0–4.6)	4.4 (4.1–4.6)	0.855
POD 1	3.4 (3.2–3.7)	3.6 (3.5–3.7)	0.079
POD 3	3.6 (3.3–3.8)	3.6 (3.5–3.8)	0.993
POD 5	3.9 (3.4–4.1)	3.6 (3.3–3.9)	0.181
Serum glucose (mg/dL)			
Preoperative	116.0 (105.0–129.5)	105.0 (94.8–118.3)	0.290
POD 1	131.0 (106.5–154.0)	125.5 (110.3–136.5)	0.965
POD 3	117.0 (103.0–142.0)	121.5 (102.8–131.3)	0.395
POD 5	116.0 (90.5–133.5)	109.5 (98.5–128.0)	0.463

Values are presented as median (interquartile range).

NPO, nothing by mouth; POD, postoperative day.

ation of homogeneous groups, thereby reducing the potential for selection bias.

Several studies have investigated the safety of clear liquid consumption before surgery. Roberts and colleagues have suggested that when gastric contents exceed 25 mL with a pH of 2.5 or lower, there is a risk of fatal aspiration into the lungs. Liquids, including saline, typically pass through the stomach within 2 hours, with over 90% of gastric emptying occurring within 30 minutes [17]. In a study conducted by McGrady and Macdonald [18], patients consumed 100 mL of fluids 2 hours before surgery. Although the group that consumed fluids showed a decrease in gastric content volume and an increase in pH, these changes were not statistically significant. Therefore, clear liquid intake 2 hours before surgery is not considered to have a significant effect on gastric contents or pH to cause aspiration pneumonia. In fact, it does not significantly cause various complications such as aspiration pneumonia or regurgitation compared to a fasting state [19]. In this study, similar to previous studies, aspiration pneumonia did not occur in either group. There were no significant differences in other compli-

cations, including anastomosis site bleeding or postoperative ileus, between the 2 groups. Additionally, we had concerned that preoperative fluid intake might cause bowel distension, leading to decrease of safety. However, in practice, the level of bowel distension perceived by the surgeon was minimal and the estimated surgical difficulty was similar. This implies that drinking clear fluid before surgery does not affect surgical difficulty. The average perceived technical difficulty of operations did not differ significantly between the 2 groups (2.7 vs. 3.1, $P=0.547$), suggesting that preoperative fasting status did not impact the complexity of surgical procedures. Furthermore, the median total operation time (211 minutes vs. 203 minutes, $P=0.828$) and volume of intraoperative bleeding (30 mL vs. 30 mL, $P=0.986$) were comparable, providing further evidence in support of the noninferiority of the No-NPO protocol. Postoperative recovery markers such as the median time to first flatus (2 days vs. 2 days, $P=0.102$), initiation of water sips (1 day vs. 1 day, $P=0.511$), and progression to a liquid diet (3 days vs. 2 days, $P=0.865$) did not demonstrate significant differences, indicating comparable postoperative recovery profiles. The transi-

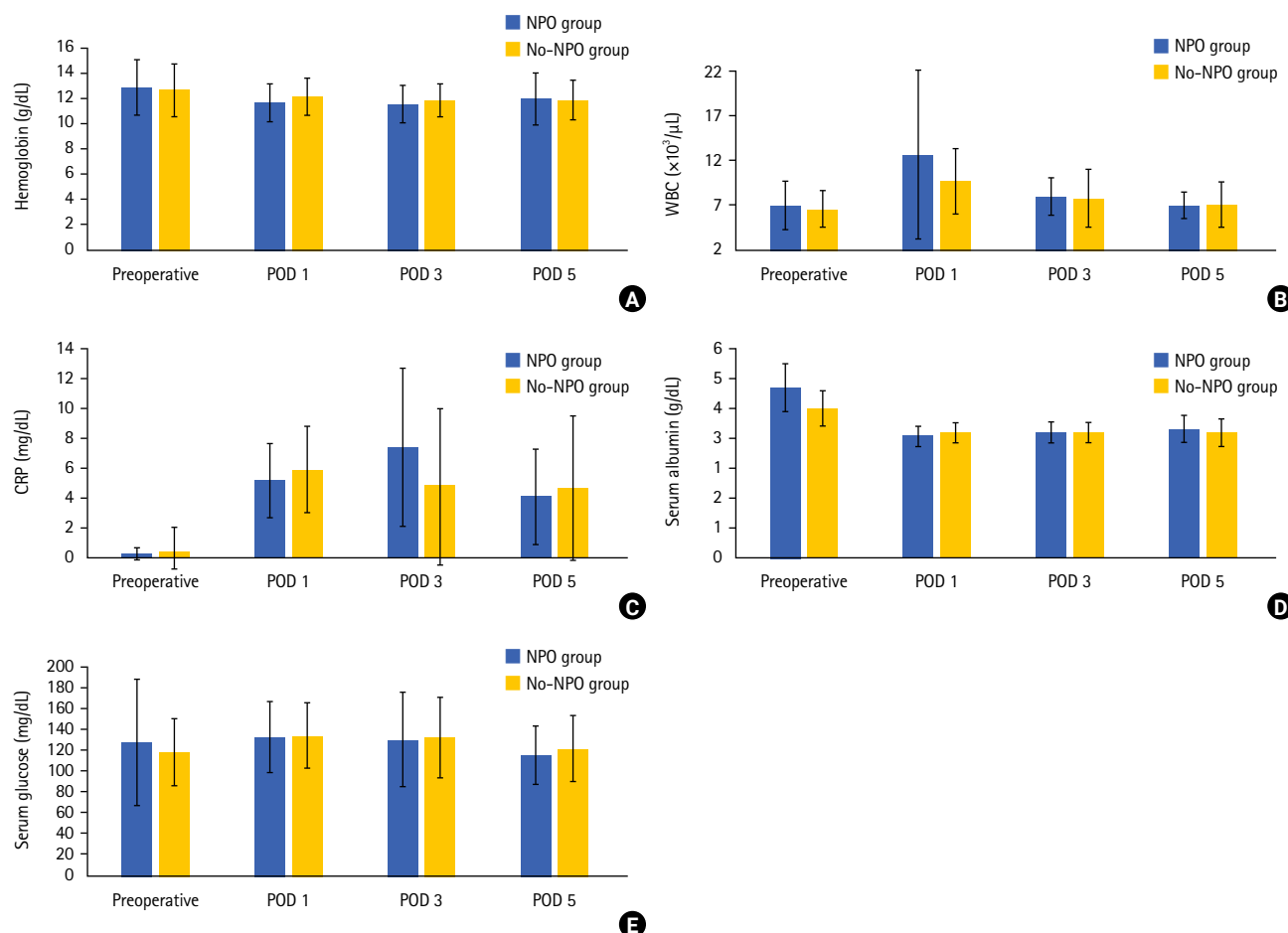


Fig. 2. Bar plots illustrating serial changes in laboratory parameters between those who fasted from midnight (nothing by mouth [NPO] group) and those who consumed carbohydrate fluids (Nucare No-NPO, Daesang Wellife; No-NPO group). Measurements were taken at 4 time points: preoperatively, and on postoperative day (POD) 1, 3, and 5. (A) Hemoglobin. (B) White blood cell (WBC) count. (C) C-reactive protein (CRP). (D) Serum albumin. (E) Serum glucose.

tion to a soft diet (4 days vs. 3 days, $P=0.867$) and the mean length of hospital stay (7.0 days vs. 6.8 days, $P=0.678$) did not demonstrate significant differences, indicating comparable postoperative recovery profiles.

Safety alone would not require patients to consume clear liquids before surgery. Previously, not much research has been done on preoperative hunger, thirst, or patient satisfaction. In this study, we found that consumption of clear liquid was not only safe, but also associated with higher satisfaction. By drinking clear liquid, patients were able to relieve preoperative discomfort such as hunger and thirst [20, 21]. The No-NPO group exhibited higher average patient satisfaction scores than the NPO group (3.7 vs. 2.2, $P=0.04$), indicating a preference for the nonfasting protocol. For these reasons, consumption of clear liquid up to 2 hours before surgery is suggested in the 2017 ASA guidelines, except in individuals at high risk for aspiration such as those with previous gastric surgery, gastroparesis, opioid use, gastrointesti-

nal obstruction or acute intra-abdominal processes, pregnancy, obesity, and emergency surgery [19, 22]. Although the No-NPO group reported greater satisfaction, we acknowledge that a mean score of 3.7 out of 10 remains relatively low. This may be attributed to several factors. First, patients may have interpreted the VAS conservatively, particularly in the context of preoperative anxiety. Second, satisfaction was assessed specifically in relation to fasting-related discomfort, which may not fully capture the overall surgical experience. Lastly, cultural tendencies in Korea may lead patients to avoid using the higher end of the VAS. These considerations highlight the need for further exploration of patient satisfaction metrics that more comprehensively reflect the perioperative experience.

Nutritionally, preoperative carbohydrate intake was considered as a treatment from the perspective of insulin resistance. Humans and other mammals respond to surgery and trauma with multiple neuroendocrine changes leading to catabolism. Surgical stress in-

Table 5. Postoperative pathologic outcomes

Outcome	NPO group (n = 25)	No-NPO group (n = 29)	P-value
T category			0.479
T0	0 (0)	2 (6.9)	
T1	8 (32.0)	11 (37.9)	
T2	7 (28.0)	4 (13.8)	
T3	9 (36.0)	12 (41.4)	
T4	1 (4.0)	0 (0)	
N category			0.809
N0	18 (72.0)	20 (69.0)	
N1	7 (28.0)	9 (31.0)	
Differentiation			0.872
Well differentiated	4 (16.0)	6 (20.7)	
Moderately differentiated	21 (84.0)	22 (75.9)	
Poorly differentiated	0 (0)	1 (3.4)	
No. of retrieved lymph nodes	21.4 ± 12.4	21.9 ± 15.3	0.889
Lymphovascular invasion	7 (28.0)	10 (34.5)	0.612
Perineural invasion	6 (24.0)	4 (13.8)	0.340

Values are presented as number (%) or mean ± standard deviation.
NPO, nothing by mouth.

volves activation of the sympathetic nervous system with secretion of catabolic hormones and local cytokine responses to tissue injury. These responses are associated with several deleterious effects, including organ dysfunction, hypercoagulation, immunosuppression, catabolism, and impaired wound healing. Peripheral insulin resistance in particular is associated with hyperglycemia, a possible cause of postoperative complications such as infection. It is also an independent predictor of hospital stay. Preoperative carbohydrate intake can stimulate the release of endogenous insulin, which can switch off the overnight fasting metabolic state. It is given to decrease the extent of peripheral insulin resistance while ameliorating surgical stress response [23]. Several studies have shown that preoperative oral carbohydrate intakes can reduce postoperative insulin resistance compared with overnight fasting in participants undergoing colorectal surgery or arthroplasty [24–26]. We tried to demonstrate the nutritional superiority of the carbohydrate group by looking at serum albumin and glucose levels. However, these levels showed no significant difference in this study. This might be due to the fact that this study was done in a very short time after surgery, or it might be because these biomarkers were not appropriate to look at this phenomenon.

This study is subject to several limitations. First, it was a single-center study. In addition, we limited the patient population to those scheduled for the initial surgery of the day. As a result, the number of cases was relatively small. Furthermore, although multiple ERAS components were implemented, this study isolated

preoperative carbohydrate loading, without assessing the synergistic effects of the full multimodal ERAS protocol. Future studies will aim to evaluate the combined impact of multiple ERAS elements on outcomes. Finally, sample size was calculated for assessing safety as a secondary objective, rather than for the primary outcome of patient satisfaction. Therefore, future studies should perform power calculations specifically for the primary endpoint to ensure adequate statistical validity.

The reason for introducing preoperative carbohydrate intake into the current ERAS guidelines is that it can shorten a patient's hospital stay without causing anastomotic leak. Similarly, this study demonstrated that an intake of high-concentration carbohydrate fluids until 2 hours prior to the induction of anesthesia could improve patient's satisfaction with comparable postoperative clinical and pathologic outcomes without increasing postoperative complication rates.

ARTICLE INFORMATION

Conflict of interest

Sung Uk Bae is an editorial board member of this journal, but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

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Author contributions

Conceptualization: SUB, SKB, WKJ; Data curation: SUB, SKB, WKJ; Formal analysis: YML, KEK, WKJ; Methodology: YML, KEK, WKJ; Project administration: WKJ; Validation: SUB, SKB; Visualization: SUB, SKB; Writing—original draft: YML, WKJ; Writing—review & editing: WML, KEK, WKJ. All authors read and approved the final manuscript.

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