Preoperative intake of carbohydrate-rich drinks is associated with postoperative pulmonary complications in patients after gastric cancer surgery

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Abstract:

Background: The aims of this study were: 1) to investigate the correlation between carbohydrate-rich drinks (CRDs) before gastric cancer surgery and postoperative nutrition laboratory findings; and 2) to determine whether CRDs affect the incidence of postoperative complications.

Materials and methods: A retrospective study was conducted on 142 patients who underwent radical stomach cancer surgery. The patients were divided into two groups (NPO group vs. CRD group) according to the intake of CRDs prior to surgery. We performed statistical analysis using Student’s t-test, the Chi-square test and a binary logistic regression model (SPSS Statistics software, version 24).

Results: Laboratory analysis of the nutrition status showed a significant increase in serum protein and albumin levels in the CRD group after postoperative day 1 (POD#1) (p<0.05).

The overall morbidity rate showed no difference between the two groups, but pulmonary complications showed significant differences of 1/72 and 9/70 (p=0.008). In the univariate analysis, there were significantly increased pulmonary complications in patients with higher Eastern Cooperative Oncology Group (ECOG) scores (p = 0.001), existing pulmonary disease (p = 0.003), anastomotic leakage (p = 0.03), and CRD intake (p=0.008). In the multivariate analysis, CRD intake was the only independent factor.

Conclusion
We found that administering a CRD is effective in improving albumin and protein levels in the short-term period after surgery but is an independent factor for pulmonary
complications after gastrectomy. We recommend that patients with no medications for pulmonary disease and with low ECOG scores can safely ingest CRDs and expect short-term nutritional effects.
Preoperative intake of carbohydrate-rich drinks is associated with postoperative pulmonary complications in patients after gastric cancer surgery

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Introduction

Recently, several enhanced recovery programs were introduced for standardizing medical care, not only to improve medical outcomes but also to reduce health care costs. A multimodal enhanced recovery after surgery program (ERAS) is used not only by doctors but also by nurses, patients, anesthesiologists, health care workers administering pain control, paramedical personnel of hospitals, and hospital administration. There are many studies in which the hospital stay was shortened by 30% by using the ERAS program. Initially, ERAS showed an effective use of health care resources, and examinations were performed at outpatient clinics to decrease the hospital stay. However, the traditional procedure or protocol was modified to avoid nasogastric tubes and peritoneal drainage, allow early oral feeding and ambulation, and supply of a carbohydrate-rich drink (CRD) two hours prior to surgery. Several studies have indicated that ERAS can reduce postoperative complications and hospital stays.

There are several reports of the advantage of CRDs as one of the strategies in the ERAS program. The patients usually experience long-term fasting both before and after the operation. Carbohydrate loading is achieved by consuming a clear drink approved by the American and European societies of anesthesiology. Preoperative loading of CRD reduced not only the anxiety and thirst of patients but also decreased the postoperative nausea, vomiting and hospital stay. However, another meta-analysis reported no evidence of effectiveness. The aims of this study were 1) to investigate the correlation between CRD before gastric cancer surgery and postoperative nutrition laboratory findings and 2) to determine whether CRD affects the incidence of postoperative complications in gastric cancer surgery patients.

Materials and Methods

A retrospective observational study was designed and carried out according to the principles of the Declaration of Helsinki, 1989. This study was approved by our institutional review board (GNUCH-20200224). We collected 142 patients who underwent radical gastric cancer surgery at Changwon Gyeongsang National University Hospital from February 2016 to May 2019.

The inclusion criteria of this study were as follows: histologically proven primary gastric adenocarcinoma in the gastric middle and lower body; no evidence of other distant metastasis; and R0 resection. The decision to undergo open gastrectomy or laparoscopy-assisted distal gastrectomy (LADG) was ultimately made by the patient after sufficient information was provided. We excluded patients with the following criteria: active double
cancer (synchronous and metachronous double cancer within 5 disease-free years), carcinoma in situ (lesions equal to intraepithelial or intramuscosal cancer), total gastrectomy and wedge resection methods, gastric cancer recurrence, or a history of gastrectomy.

Hospital course

1) Preoperative course

Patients ate lunch normally, and they drank 2 cans of CRD (NO-NPO, 200 ml, 100 kcal, Daesang Welllife, Chunan, Republic of Korea) for dinner. We educated them regarding postoperative deep breathing and inspirometry to prevent pneumonia by using education brochures and videos. The bowel preparation for surgery was performed via a laxative agent (two MYLAX POWD 17 g) (Pharvis Biotech Korea, Seoul, South Korea) with 500 ml of water and a 100 ml glycerin enema.

Patients were allocated into two groups according to the ingestion of CRDs before the surgery. The drinking of CRDs on the operation day was determined by the order of surgery. If the operation was scheduled to occur early (9:00 AM start), midnight Nothing Per Oral (NPO) was implemented the previous day (NPO group). If the operation was scheduled later, we supplied 2 cans of CRD (NO-NPO, 200 ml, 100 kcal, Daesang Welllife, Chunan, Republic of Korea) at 6 PM of the preoperation day to be used for breakfast on the operation day. Patients were permitted to drink clean water and CRDs by 7 AM on the day of the operation, and the nurse was required to check and collect the cans regardless of whether the patients had drunk the CRD (CRD group).

2) Day of operation

Patients with high blood pressure were given their medicine in the morning with a small amount of water. Antibiotics were used only before and after surgery. Fluid restriction was not performed during surgery. To prevent hypothermia, we used a warmer to maintain the patient’s temperature during and after the operation. After gastrectomy, we did not insert a Levin tube. The Foley catheter was inserted after anesthesia, and we usually removed the catheter 1-2 days after surgery, but it was removed after more than 3 days if benign prostate hyperplasia was present, if the patient was elderly, or if the patient complained of much pain.

3) Postoperative course

We applied an intermittent pneumatic pump up to postoperative day (POD#) 1 and removed it when the patient could ambulate.
Postoperative pain was managed via an IV postoperative pain control device. We recommended early mobilization on the first day after surgery. One surgical drain was inserted for distal gastrectomy and two for total gastrectomy, and all of the surgical drains were removed after 2 days of dieting.

The start of the postoperative diet was usually sips of water (SOW) on the first day after surgery. A CRD was taken on the second day after surgery, a soft fluid diet (SFD) on the third day and a soft blend diet (SBD) on the fourth day. Regardless of the type of surgery, the postoperative diet was carried out equally. If the patient was aged 70 years or older or had high ECOG scores, we delayed the start of the meal by 1-2 days, and we also delayed initiating meals when the patient complained of nausea, vomiting, or severe pain or showed signs of complications.

Surgical procedure Total, distal or proximal gastrectomy or total omentectomy and D1+ lymph node dissection were performed during laparoscopic surgery when the preoperative diagnosis using gastrofibroscopy and spiral CT scans revealed clinical TNM stage I or II. When the preoperative diagnosis was advanced gastric cancer with LN metastasis (clinical TNM Stage III), we preferred open surgery. Lymph node stations were identified according to the Japanese Classification of Gastric Carcinoma from 2011. Gastric resection and determination of the resection area of the lymph node stations were performed according to the Japanese Gastric Cancer Association (JGCA) guidelines from 2014. Partial omentectomy was performed in early gastric cancer patients. Reconstruction was performed based on the surgeon’s preference.

Complication data were retrieved from the prospectively collected complication database reported at the weekly morbidity conference. Complication grades were assessed with the Clavien-Dindo classification (CDC), and complications (morbidity) were defined as complications greater than grade II that required treatment action greater than an intervention to relieve the condition. Postoperative complications were classified, evaluated and recorded for hospitalized and discharged patients. The pulmonary complications were defined as the presence of pneumonia, empyema or pneumothorax on plain chest radiography or CT scans and worsening of previous pneumonia or tuberculosis.

In our center, we analyzed the underlying disease by the Charlson comorbidity index. We defined underlying pulmonological disease as being present in 1) patients requiring perioperative management on the basis of abnormal pulmonary function tests; such patients were classified into perioperative medication and non-perioperative medication groups (i.e., medication for pulmonological diseases such as chronic obstructive
pulmonary disease or asthma), and 2) patients currently prescribed antituberculosis medication.\(^4\)

*All statistical analyses* were performed using SPSS Statistics software, version 24 (IBM SPSS, Inc., Chicago, IL, USA). Continuous data were compared using Student’s t-test and are presented as the means ± standard deviations, and noncontinuous variables were assessed with the Chi square test. In all analyses, p values less than 0.05 were considered statistically significant. A binary logistic regression model was used for multivariate analyses.

Demographic features (age, sex, BMI, ASA classification, underlying disease), pathologic reports (TNM stage), operative findings and early surgical outcomes (total operation time, hospital stay, operation type, postoperative complications) were compared between the groups by Student’s t-test and the Chi-square test. For nutritional evaluation before and after surgery, blood glucose, cholesterol, protein, and albumin were examined before surgery and on POD#1, POD#3, and POD#5. Data were compared using Student’s t-test and are presented as the mean ± SD; * <0.05, ** <0.01.

**Results**

1. **Patient demographics**

The mean age of the patients was 64.8 ± 11.4 years (Supplement Table 1). The male-to-female ratio was 6.5:1 (123:19). The mean BMI of the patients was 23.2 ± 3.4. The most common operation was distal gastrectomy (73.9%), followed by total gastrectomy (19.7%) and proximal gastrectomy (4.9%). Stage I was the most frequent at 63.4% of the TNM stage, followed by III at 20.4% and II at 16.2%. In the CDC score, we had 17 cases of score I, 21 cases of score II, 20 cases of score IIIa, and 4 cases of score IIIb. The morbidity rate was 31.5% (score 2 or higher on the CDC score).

2. **Patient demographics between the NPO group and the CRD group**

Patients were allocated into two groups according to the ingestion of CRD before the surgery. We compared the two groups by dividing them into NPO groups and CRD groups. There was no significant difference in age, sex, BMI, TNM stage, operation time, postoperative hospital stay, operation type or underlying disease between the NPO and CRD groups (p>0.05) (Table 1). Overall morbidity rates (CDC>2) were not different between the two groups (NPO vs. CRD, 32/72 vs. 30/70), but pulmonary complications showed significant differences in
1/72 and 9/70 patients (p=0.008). (Table 2).

3. The CRD group showed better nutritional status than the NPO group

We compared the NPO group and CRD group with nutritional indicators preoperatively and postoperatively (POD#) at 1, 3 and 5 days. Serum protein levels were not different before surgery but were significantly higher in the CRD group at POD#1 (NPO/CRD, 5.3 ± 0.6/5.6 ± 0.5, p = 0.005), POD#3 (NPO/CRD, 5.6 ± 0.5/5.9 ± 0.5, p=0.003), and POD#5 (NPO/CRD, 5.7 ± 0.5/6.0 ± 0.5, p=0.006). The serum albumin level was also not significantly different before surgery, but the albumin level was significantly higher in the CRD group than in the NPO group at POD#1 (NPO/CRD, 3.1 ± 0.4/3.2 ± 0.3, p = 0.008), POD#3 (NPO/CRD, 3.1 ± 0.4/3.2 ± 0.3, p = 0.002), and POD#5 (NPO/CRD, 3.0 ± 0.3/3.2 ± 0.3, p = 0.001). The serum glucose level was significantly higher in the CRD group (136.4 ± 35.9) than in the NPO group (119.9 ± 25.9) at POD# 3 (p=0.007), and the serum cholesterol level was significantly higher at POD#5 (NPO/CRD, 138.6 ± 32.7/153.2 ± 37.6, p = 0.02) (Figure 1).

4. Postoperative complications

We compared the postoperative complications between the NPO and CRD groups, and there were no significant differences between the NPO and CRD groups in anastomotic leakage, intra-abdominal abscess, wound problems, pancreatic leakage, postoperative bleeding, intestinal obstruction, hepatic complications, heart complications, delayed gastric emptying, and pulmonary embolism (p>0.05) (Table 2). However, there were significantly more pulmonary complications in the CRD group (n=9/70) than in the NPO group (1/72) (p=0.008).

5. Univariate analysis of postoperative pulmonary complications

To determine the factors involved in postoperative pulmonary complications, univariate analysis was performed (Table 3). In the Chi square test analysis, the higher the ECOG (Eastern Cooperative Oncology Group performance status) score was (p = 0.001), the more underlying pulmonary disease (p = 0.003) and anastomotic leakage (p = 0.03) existed, and the intake of CRD (p=0.008) showed significantly increased pulmonary complications.

6. Multivariate analysis of postoperative pulmonary complications
Multivariate analysis was performed with ECOG, pulmonary disease, anastomotic leakage, and preoperative CRD intake, which appeared significant in the univariate analysis (p<0.05) (Table 4). In the multivariate analysis, only CRD intake was an independent factor in the occurrence of postoperative pulmonary complications (p<0.001). The relative risk of the CRD group was 6.25 times that of the NPO group (95% CI 3.03~12.5).

Discussion

The aim of this study was to investigate the correlation between drinking a CRD before gastric cancer surgery and postoperative nutrition laboratory findings and to determine the effect on postoperative complications. We compared the postoperative complications between the NPO and CRD groups, and there were significantly increased pulmonary complications in the CRD group. To determine the factors involved in postoperative pulmonary complications, univariate analysis was performed. We found that the higher that the ECOG score was, the more statistically significant that the existence of underlying pulmonary disease, anastomotic leakage, and intake of CRD were. In the multivariate analysis, only CRD intake was an independent factor in the occurrence of postoperative pulmonary complications.

The ERAS system is advanced from the colorectal surgery field, and it is also being tried in stomach cancer surgery 4,5,15. ERAS guidelines (2014) recommend gastrectomy patients have no bowel preparation, no nasogastric tube or abdominal surgical drainage, and no preoperative fasting and that they be administered early postoperative oral nutrition, epidural analgesia, reduced IV fluid, and early removal of urinary catheter 6. However, the Japanese guidelines recommend the removal of the nasogastric tube and the surgical drain on POD#1, the removal of IV fluids on POD#2~5, initial oral nutrition on POD#2~4 and removal of the Foley catheter on POD#1 16. Similarly, a nationwide survey in South Korea reported that Korean surgeons followed the ERAS protocol with respect to the avoidance of preoperative fasting (68.5%), early active ambulation (64.4%), absence of a Levin tube (71.6%) and early removal of the urinary catheter (68.5% removed on POD#1) but that they did not follow the guidelines in terms of the avoidance of preoperative bowel preparation (41.6%), abdominal drainage (10.1%), provision of preoperative CRD (10.1%), early postoperative oral nutrition (diet initiation on POD#1 [14.9%] and POD#2 [34.5%]), or epidural analgesia (15.9%) 17. These findings are influenced by several causes, including differences in culture, hospital environments and medical insurance.

Guidelines from the American Society of Anesthesiologist recommend ingesting clear fluids up to two hours
before the initiation of anesthesia; breast milk, up to 4 hours; and infant formula or nonhuman milk, up to 6 hours; fasting from solid food for more than 8 hours preoperatively is also recommended. However, CRD, fruit juices without pulp, carbonated beverages, clear tea, and black coffee are included in the clear fluid group and could be consumed 2 hours before anesthesia starts. One study that included observations by MRI compared CRD (OS-1) and ONS (Oral Nutrition) for patients with stomach cancer. For the CRD group, after one hour of taking a CRD (500 ml of the dose), the conservative gastric fluid volume averaged 55 ml, but for the ONS group, it showed a large difference of 409 ml. This result was in line with the ASA recommendation that the fluid be absorbed in less than two hours, just like the CRD and clear water.

The use of CRDs reduces hunger, thirst, anxiety, length of stay and postoperative insulin resistance; however, in postoperative nausea and vomiting, such intake is controversial. According to one meta-study, there were no differences in postoperative nausea or vomiting in 3 randomized controlled trials (RCTs), 1 RCT reported an increase in the CRD group, and 1 RCT reported a decrease in vomiting. Regarding nutrition, Tanaka et al. showed a significant increase in albumin on the seventh day after gastric cancer surgery in the CRD group, similar to the results in our study, and a significant increase in postoperative and body weight in the first month. However, they reported that postoperative complications were significantly reduced in ERAS groups, and there was no difference in the incidence of pneumonia in each group, for example. Regarding postoperative complications, one meta-analysis showed no difference in nine RCTs. However, the incidence of complications in most studies was low, and in some studies, there were cases of complications after discharge, and therefore, it was appropriate to consider the in-hospital complication to be low.

We found that preoperative CRD ingestion is an independent factor for postoperative pulmonary complications. The hypotheses explaining these results are as follows: First, underlying pulmonary disease and advanced ECOG score are independent factors, but the case numbers are too small to designate an independent factor. Underlying pulmonary disease (COPD, asthma, pneumonia, tuberculosis) and advanced ECOG are high risk factors for pulmonary complications. The second possibility is that the NPO time of the CRD group was shorter than that of the NPO group, which may be related to postoperative decreased bowel motility. Only patients who were operated on in the afternoon received CRDs, and patients who received surgery in the morning were excluded. Third, there was an aspiration duration of intubation in the CRD group, but there was no recognized accidental aspiration during anesthesia.

This study has limitations, such as its retrospective nature and small number of patients. We found limitations in the analysis of the results because we could not collect data on the exact NPO times or the start the day of
SOW, and we could not analyze the real NPO times between the two groups. Furthermore, we could not collect detailed data on nausea or only a small amount of aspiration due to the limitations of a retrospective study. Therefore, a prospective randomized study is needed. Even with these limitations, our study was the first analysis of pulmonary complications with underlying pulmonary disease (COPD, asthma, pneumonia, tuberculosis) and the association of high ECOG scores with a high risk of pulmonary complications in gastric cancer patients; a multivariate analysis between pulmonary complications and nutritional status was performed.

In conclusion, we found that ingesting a CRD is effective in improving albumin and protein levels during the short-term postoperative period and is an independent factor for postoperative complications after gastrectomy. We recommend that patients with no medications for pulmonary disease and with low ECOG scores can safely ingest CRDs and expect short-term nutritional effects.

Acknowledgements

Not applicable

Conflict of interest disclosure

The authors have no conflicts of interest or financial ties to disclose.

Ethical approval All of the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Exemption from informed consent requirements was permitted by Gyeongsang National University Hospital in Changwon and the Dongnam Institute of Radiological and Medical Sciences in Busan, Korea Institutional Review Board.

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Supplement table 1. Patient demographics

| Value                        |       |
|------------------------------|-------|
| **Age (mean ± SD)**          | 64.8 ± 11.4 |
| **Sex (%)**                  |       |
| Male                         | 123 (86.6) |
| Female                       | 19 (13.4)  |
| **BMI (mean ± SD)**          | 23.2 ± 3.4 |
| **Operation type (%)**       |       |
| DG                           | 107 (73.9%) |
| PG                           | 7 (4.9%) |
| TG                           | 28 (19.7%) |
| **TNM stage (%)**            |       |
| I                            | 90 (63.4%) |
| II                           | 23 (16.2%) |
| III                          | 29 (20.4%) |
| **ASA score (%)**            |       |
| 1                            | 52 (36.6%) |
| 2                            | 84 (59.2%) |
| 3                            | 4 (2.8%) |
| **Clavien-Dindo classification (%)** |       |
| I                            | 17 (12.0%) |
| II                           | 21 (14.8%) |
| IIIa                         | 20 (14.1%) |
| IIIb                         | 4 (2.8%) |
| **Morbidity rate (Clavien-Dindo classification >2) (%)** | 45/143 (31.5%) |

BMI, body mass index, DG, distal gastrectomy, PG, proximal gastrectomy, TG, total gastrectomy, TNM, tumor, node, metastasis, ASA, American Society of Anesthesiologists Classification, ASCPC, accordion severity classification of postoperative complications
Table 1. Patient demographics between the NPO and CRD groups

|                          | NPO group | CRD group | p value |
|--------------------------|-----------|-----------|---------|
| Age (mean ± SD)          | 66.3±11.5 | 63.3±11.1 | 0.11    |
| Sex                      |           |           |         |
| Male                     | 61        | 62        | 0.62    |
| Female                   | 11        | 8         |         |
| BMI (mean ± SD)          | 23.0±3.6  | 23.5±3.2  | 0.43    |
| TNM stage                |           |           |         |
| I                        | 40        | 50        | 0.11    |
| II                       | 13        | 10        |         |
| III                      | 19        | 10        |         |
| Operation time (min) (mean ± SD) | 256±71   | 260±96    | 0.79    |
| Postoperative hospital stay (mean ± SD) | 13.5±10.1 | 13.0±11.3 | 0.79    |
| Operation type           | DG        | 52        | 55      | 0.12    |
|                          | PG        | 2         | 5       |         |
|                          | TG        | 18        | 10      |         |
| ECOG performance status score | 0       | 68        | 67      | 1.0     |
|                         | ≥1        | 4         | 3       |         |
| Underlying pulmonary disease | No     | 64        | 67      | 0.20    |
|                          | Yes       | 8         | 3       |         |
| Morbidity (CDC>2)        | 32/72     | 30/70     | 0.86    |

NPO, Nil Per Os, Nothing Per Oral, CRD, carbohydrate-rich drink, BMI, body mass index, TNM, tumor, node, metastasis, DG, distal gastrectomy, PG, proximal gastrectomy, TG, total gastrectomy, ECOG, Eastern Cooperative Oncology Group, CDC, Clavien-Dindo classification. Data were compared using Student’s t-test and the Chi-square test.
| Complication                  | NPO group (N=72) | CRD group (N=70) | p value |
|------------------------------|------------------|------------------|---------|
| Postoperative leakage        | 12               | 7                | 5       | 0.76    |
| Intra-abdominal abscess      | 15               | 8                | 7       | 1.0     |
| Wound problem                | 3                | 1                | 2       | 0.61    |
| Pancreatic leakage           | 6                | 4                | 2       | 0.68    |
| Postop bleeding              | 5                | 5                | 0       | 0.058   |
| Intestinal obstruction       | 4                | 2                | 2       | 1.0     |
| **Pulmonary complication**   | **10**           | **1**            | **9**   | **0.008** |
| Hepatic complication         | 1                | 1                | 0       | 1.0     |
| Heart complication           | 1                | 1                | 0       | 1.0     |
| Delayed gastric emptying     | 4                | 0                | 4       | 0.056   |
| Pulmonary embolism           | 1                | 1                | 0       | 1.0     |

CDC, Clavien-Dindo classification. Data were compared using the Chi-square test.
3. Univariate analysis of postoperative pulmonary complication

|                          | N     | Value (%) | p value |
|--------------------------|-------|-----------|---------|
| **Age**                  |       |           |         |
| <70                      | 91    | 7 (7.7)   | 1.0     |
| ≥70                      | 51    | 3 (5.9)   |         |
| **Sex**                  |       |           |         |
| Male                     | 123   | 9 (7.3)   | 1.0     |
| Female                   | 19    | 1 (5.3)   |         |
| **ECOG score**           |       |           |         |
| 0                        | 135   | 8 (5.9)   | 0.001   |
| 1                        | 6     | 1 (16.7)  |         |
| 2                        | 0     | 0         |         |
| 3                        | 1     | 1 (100)   |         |
| **Smoking**              |       |           |         |
| Never                    | 100   | 7 (6.9)   | 0.94    |
| History                  | 18    | 1 (5.6)   |         |
| Positive                 | 24    | 2 (8.3)   |         |
| **Underlying pulmonary disease** |     |           |         |
| No                       | 131   | 6 (4.6)   | 0.003   |
| Yes                      | 11    | 4 (36.4)  |         |
| **TNM stage**            |       |           |         |
| I                        | 90    | 7 (7.8)   | 0.84    |
| II                       | 23    | 1 (4.3)   |         |
| III                      | 29    | 2 (6.9)   |         |
| **Operation type**       |       |           |         |
| Distal gastrectomy       | 107   | 6 (5.5)   | 0.36    |
| Total gastrectomy        | 28    | 4 (14.3)  |         |
| Proximal gastrectomy     | 7     | 0         |         |
| **ASA score**            |       |           |         |
| 1                        | 52    | 2 (3.8)   | 0.39    |
| 2                        | 84    | 8 (9.4)   |         |
| 3                        | 4     | 0         |         |
| **Anastomotic leakage**  |       |           |         |
| No                       | 130   | 7 (5.4)   | 0.03    |
| Yes                      | 12    | 3 (25)    |         |
| **Intraabdominal abscess** |     |           |         |
| No                       | 127   | 9 (7)     | 1.0     |
| Yes                      | 15    | 1 (6.7)   |         |
| **Pancreatic leak**      |       |           |         |
| No                       | 136   | 9 (6.6)   | 0.35    |
| Yes                      | 6     | 1 (16.7)  |         |
| **Wound infection**      |       |           |         |
| No                       | 139   | 10 (7.1)  | 1.0     |
| Yes                      | 3     | 0         |         |
| **Bleeding**             |       |           |         |
| No                       | 137   | 10 (7.2)  | 1.0     |
| Yes                      | 5     | 0         |         |
| **Intestinal obstruction** |     |           |         |
| No                       | 138   | 9 (6.5)   | 0.25    |
| Yes                      | 4     | 1 (25)    |         |
| **Preop CRD**            |       |           |         |
| No                       | 72    | 1 (1.4)   | 0.008   |
| Yes                      | 70    | 9 (12.9)  |         |

ECOG, Eastern Cooperative Oncology Group performance status, ASA, American Society of Anesthesiologists Classification, Preop CRD, preoperative carbohydrate rich intake; Data were compared using the Chi-square test.
4. Multivariate analysis of postoperative pulmonary complications

|                               | N   | Value (%) | p-value | RR   | 95% CI  |
|-------------------------------|-----|-----------|---------|------|---------|
| ECOG score                    |     |           |         |      |         |
| 0                             | 135 | 8 (5.9)   | 0.71    |      |         |
| 1                             | 6   | 1 (16.7)  |         |      |         |
| 2                             | 0   | 0         |         |      |         |
| 3                             | 1   | 1 (100)   |         |      |         |
| Underlying pulmonary disease  |     |           |         |      |         |
| No                            | 131 | 6 (4.6)   | 0.59    |      |         |
| Yes                           | 11  | 4 (36.4)  |         |      |         |
| Anastomotic leakage           |     |           |         |      |         |
| No                            | 130 | 7 (5.4)   | 0.26    |      |         |
| Yes                           | 12  | 3 (25)    |         |      |         |
| Preop CRD                     |     |           |         |      |         |
| No                            | 72  | 1 (1.4)   | <0.001  | 1    |         |
| Yes                           | 70  | 9 (12.9)  | 6.25    | 3.0-12.5 |}

ECOG, Eastern Cooperative Oncology Group performance status, Preop CRD, preoperative carbohydrate rich intake. **A binary logistic regression model was used for multivariate analyses.**
Figure legend

Figure 1. The comparison of nutritional laboratory findings between the NPO and CRD groups. Serum glucose level is significantly different on POD#3 (A); serum cholesterol level is significantly increased on POD #5 (B). However, serum protein and albumin level are significantly increased after surgery (C, D). Data were compared using Student’s t-test and are presented as the mean ± SD * <0.05, ** <0.01.
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