Section: Anaesthesia

Original Research Article

BENEFITS OF SUPPLEMENTING PREOPERATIVE CARBOHYDRATE DRINK IN ELECTIVE LAPAROSCOPIC CHOLECYSTECTOMY SURGERY

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Received : *07/05/2026*
Received in revised form : *29/06/2026*
Accepted : *12/07/2026*

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DOI: 10.70034/ijmedph.2026.3.539

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 3449-3457

ABSTRACT

Background: Preoperative fasting has been cited as a source of metabolic stress, creating insulin resistance, and causing discomfort to patients. To help reduce the effects of fasting, Enhanced Recovery After Surgery (ERAS) guidelines recommend preoperative carbohydrate loading. This study looked into using a carbohydrate supplement (SurgiCarb) for preoperative use in patients undergoing elective laparoscopic cholecystectomy.

Materials and Methods: The study was a prospective randomized controlled trial that included 80 ASA I–II patients who were non-diabetic, and undergoing elective laparoscopic cholecystectomy under GA. The study participants were randomized to receive a 355 mL bottle of SurgiCarb (n=40) or a 355 mL bottle of plain water (n=40) two hours before surgery. Assessments included blood glucose levels to assess for differences between control and experimental groups both during the perioperative period. Secondary assessments included preoperative and postoperative subjective symptoms (hunger, anxiety, fatigue, thirst), haemodynamic data (heart rate, systolic and diastolic blood pressures, mean arterial pressure, oxygen saturation), as well as incidence and severity of postoperative nausea and vomiting (PONV).

Results: The SurgiCarb group had a statistically significant change in random blood sugar values from pre-intervention (mean difference –16.75) that suggested effective carbohydrate absorption without detrimental levels of hyperglycemia. Postoperative random blood sugar values in the SurgiCarb group (110.10±11.908 mg/dL) were significantly lower than the plain water group (127.38±3.988 mg/dL, p<0.001). There was a significant change in hunger (p=0.010) and thirst (p=0.001) from preoperative to postoperative between the two study groups. Fatigue reduction was significantly greater in the SurgiCarb group (p<0.001 between groups). PONV occurred in 12.5% of the SurgiCarb group versus 30.0% of the plain water group (p=0.050), with significantly lower severity grades in the SurgiCarb group (95% no PONV vs. 25% in plain water, p=0.001). Haemodynamic parameters showed greater stability in the SurgiCarb group, with significant differences in heart rate at T0 and T4 (p=0.008 and p=0.002 respectively) and consistently higher mean arterial pressure (p<0.001).

Conclusion: Preoperative carbohydrate loading with SurgiCarb significantly improves patient comfort, reduces PONV, enhances haemodynamic stability, and maintains safe glycaemic control without adverse effects. Routine use of preoperative carbohydrate drinks should be considered standard care in elective laparoscopic cholecystectomy.

Keywords: Preoperative carbohydrate loading, ERAS, laparoscopic cholecystectomy, PONV, insulin resistance, perioperative care.

INTRODUCTION

Surgical procedures and anaesthesia administration are associated with a complex stress response. The adverse metabolic and haemodynamic effects of this stress response can lead to perioperative problems. Decreasing this stress response is the key factor in improving outcome.[1] Enhancements in the protocols of Enhanced Recovery after Surgery (ERAS) have also suggested a change within pre-operative fasting procedures such as drinking a carbohydrate-based beverage approximately two hours before the onset of surgery. It has been determined that pre-operative carbohydrate loading will improve the metabolic stress response (i.e. insensitivity to insulin), reduce the amount of time that a person has been fasted (i.e. catabolism), and provide direct benefits from providing food and/or drink (i.e. alleviation of hunger and thirst) without an increase in either gastric residual volume (i.e. the amount of food remaining in the stomach) or the risk of pulmonary aspiration.[2]

Laparoscopic Cholecystectomy is acknowledged as the "gold standard" for managing gall bladder disease because it provides less post-surgical pain and allows for a quicker recovery compared to traditional open surgery. However, conventional pre-operative fasting methods, which are ultimately used to minimize the likelihood that a patient will develop pulmonary aspiration, creates additional metabolic stress due to the depletion of glycogen stored in the liver and the creation of insulin insensitivity within the patient as well. Such metabolic disturbances have been linked to delayed recovery and increased patient discomfort.[3]

Preoperative fasting is defined as a prescribed period before a procedure when patients are not allowed oral intake of liquids or solids. Latest guidelines suggest a preoperative fasting time of 6 hours for a light meal and 2 hours for clear liquids.[4]

Preoperative anxiety is a very common phenomenon that adversely affects a patient's physical and psychological outcome. Postoperative nausea and vomiting (PONV) is the most common reported complication after anaesthesia, with incidence of 38–60% reported within 24 hours after laparoscopic cholecystectomy.[5]

Stress response to surgery involves catabolism and gluconeogenesis resulting in postoperative hyperglycaemia, which is a risk factor for postoperative complications. Preoperative fasting further aggravates this response. Preoperative carbohydrate drink intake has been shown by meta-analysis to shorten hospital stay, reduce postoperative endocrine catabolic responses, improve insulin resistance, and prevent postoperative hyperglycaemia.[6] Carbohydrate drink neither delays gastric emptying nor affects gastric acidity and is therefore considered safe in elective surgical patients without risk factors for pulmonary aspiration.[6]

There are very few studies on this topic in the northeastern part of India. Therefore, the present study was conducted to observe the benefits of supplementing an oral preoperative carbohydrate drink—SurgiCarb—in elective laparoscopic cholecystectomy surgery in a tertiary centre in Northeast India.

MATERIALS AND METHODS

2.1 Study Design and Setting

This was a prospective, randomised, controlled, double-blind study conducted in the Department of Anaesthesiology at Shija Hospitals and Research Institute and Shija Academy of Health Sciences Imphal West, Manipur, from June 2023 to May 2024. The study was approved by the Institutional Ethics Committee (Ref No. SHRI/c/n/DNB/95/2023) and registered with the National Board of Examinations. Written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines.

2.2 Sample Size Calculation

Sample size was calculated using the standard formula for comparing two means:

$n = 2\sigma^2(Z\alpha/2 + Z\beta)^2 / \Delta^2$

Assuming standard deviation σ=10, clinically meaningful difference Δ=5, significance level α=0.05 (two-tailed, $Z\alpha/2$=1.96), and power 80% ($Z\beta$=0.84), the calculated sample size was 63 per group. Due to practical constraints, 40 patients per group were enrolled, which reduced power but remained adequate for detecting large effect sizes.

2.3 Inclusion and Exclusion Criteria

Inclusion Criteria:

- Age 18–60 years
- ASA grade I and II
- Undergoing elective laparoscopic cholecystectomy
- BMI 20–30 kg/m²

Exclusion Criteria:

- Diabetic patients
- Patients on preoperative antianxiety drugs
- Age <18 years or >60 years
- Pregnant or nursing women
- Patient refusal to participate
- Any history of drug reactions
- Cardiac patients
- Patients on drugs affecting gastric emptying

2.4 Randomisation and Blinding

Patients were randomly allocated using an online computer-generated randomiser to one of two groups (40 patients each):

- **Group A (SurgiCarb group):** Received 355 mL of SurgiCarb (complex carbohydrate pre-surgery drink) 2 hours prior to surgery
- **Group B (Plain water group):** Received 355 mL of plain water 2 hours prior to surgery

Patients were blinded to group allocation. The anaesthesiologist recording outcomes was also blinded. The concerned nurse administered the drink according to protocol.

2.5 Preanaesthetic Evaluation

Preanaesthetic evaluation was performed one day prior to surgery, including:

- General condition and comorbid illnesses
- Physical examination including height, weight, BMI
- Airway examination
- Cardiovascular and respiratory system examination
- Medication and surgical history
- ASA grading

Investigations included complete hemogram, blood sugar (RBS/FBS/PPBS), blood urea, serum creatinine, serum electrolytes, 12-lead ECG, and screening chest X-ray.

For both groups, fasting instructions included 6 hours of solid food fasting. The test group received SurgiCarb (355 mL) 2 hours before surgery, and the plain water group received the same volume of plain water.

2.6 Outcome Measures

Primary outcome: Comparison of preoperative and postoperative random blood sugar levels between SurgiCarb and plain water groups.

Secondary outcomes:

a) Preoperative and postoperative subjective components (thirst, hunger, fatigue, anxiety) using Verbal Descriptive Score (0=no discomfort, 1=mild, 2=moderate, 3=severe)

b) Intraoperative and postoperative vitals (HR, SBP, DBP, MAP, SpO_2)

c) Postoperative nausea and vomiting (PONV) assessed by APFEL risk score and PONV grading scale (0=no nausea, 1=nausea present no vomiting, 2=nausea and vomiting present, 3=>2 or more vomiting episodes in 30 minutes)

2.7 Anaesthetic Technique

On arrival in the operating room, patients were connected to a multichannel monitor measuring HR, SBP, DBP, MAP, $EtCO_2$, SpO_2 , and ECG. A 20G intravenous cannula was secured, and Ringer's lactate infusion was started. Patients were premedicated with ondansetron 4 mg IV and midazolam 1 mg IV. Induction and tracheal intubation were performed with propofol 2 mg/kg, succinylcholine 2 mg/kg, and butorphanol 1 mg. Maintenance used oxygen, sevoflurane, and air.

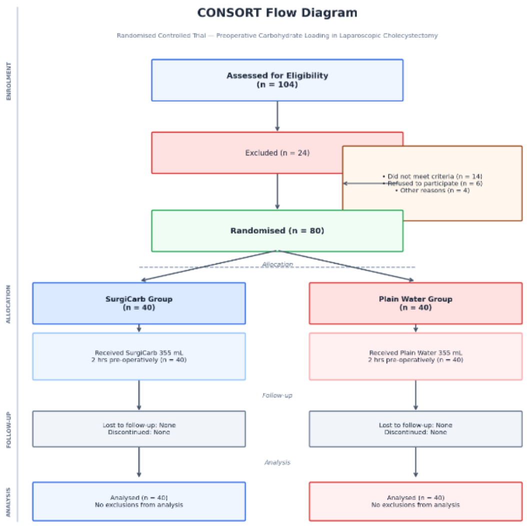
Vital parameters were recorded at:

- Before induction (T0)
- After intubation at 0, 5, 10, 15, 20, 25, 30 minutes (T1–T7)
- Before extubation (T8)
- After extubation at 15, 30, 45, and 60 minutes (T9–T12)

Reversal was with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg IV. Postoperative blood sugar was recorded in PACU 30 minutes after extubation.

2.8 Statistical Analysis

Data were entered in Microsoft Excel 2019 and analysed using SPSS software. Descriptive statistics summarised demographic and clinical parameters. Independent sample t-test and paired sample t-test compared continuous variables. Chi-square tests compared categorical outcomes. Wilcoxon signed-rank tests compared within-group ordinal scale changes. Repeated measures ANOVA evaluated haemodynamic parameters over time. A p-value <0.05 was considered statistically significant.



RESULTS

A total of 80 patients (40 per group) completed the study. The SurgiCarb group had equal sex distribution (50% female, 50% male), while the plain water group had a slight male predominance (60% male, 40% female). ASA status distribution was comparable: SurgiCarb had 50% ASA I and 50% ASA II; plain water had 47.5% ASA I and 52.5% ASA II. Mean age was similar between groups (SurgiCarb: 40.30±12.13 years; plain water: 40.00±11.48 years). There were no statistically significant differences in baseline characteristics between groups.

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	SurgiCarb (n=40)	Plain Water (n=40)	Total (n=80)
Sex			
Female	20 (50.0%)	16 (40.0%)	36 (45.0%)
Male	20 (50.0%)	24 (60.0%)	44 (55.0%)
ASA Status			
I	20 (50.0%)	19 (47.5%)	39 (48.8%)

II	20 (50.0%)	21 (52.5%)	41 (51.2%)
Age (years)	40.30 ± 12.13	40.00 ± 11.48	40.15 ± 11.74

Preoperative RBS was lower in the SurgiCarb group (105.90±9.74 mg/dL) than in the plain water group (110.62±10.94 mg/dL). Postoperative RBS was significantly higher in the plain water group (127.38±3.98 mg/dL) compared to the SurgiCarb group (110.10±11.90 mg/dL). The SurgiCarb group showed a statistically significant increase in RBS post-intervention (mean difference -16.75, p<0.001), while the plain water group showed a non-significant change (mean difference -4.20, p=0.088). The between-group comparison of RBS change was highly significant (p<0.001), indicating greater metabolic impact of carbohydrate loading.

Table 2: Perioperative Random Blood Sugar Levels

Group	**Pre RBS (mg/dL)**	**Post RBS (mg/dL)**	**Mean Difference**	**t-value**	**p-value**
SurgiCarb	105.90 ± 9.74	110.10 ± 11.90	-4.20	-1.75	0.088
Plain Water	110.62 ± 10.94	127.38 ± 3.98	-16.75	-9.33	<0.001*

*Between-group comparison of RBS change: p<0.001

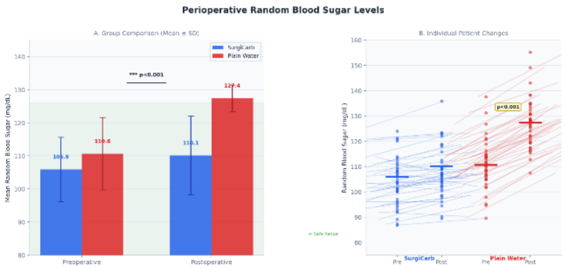


Table 3 presents the within-group and between-group comparisons of preoperative and postoperative subjective symptoms. In the plain water group, hunger scores showed no significant change from preoperative to postoperative (0.73±0.68 vs. 0.70±0.72; p=0.949), whereas the SurgiCarb group demonstrated a significant reduction in hunger (0.98±0.92 vs. 0.58±0.68; p=0.010). Anxiety decreased significantly in both groups (plain water: 0.73±0.82 vs. 0.25±0.49, p=0.003; SurgiCarb: 0.73±0.96 vs. 0.40±0.55, p=0.047). Fatigue worsened in the plain water group (0.65±0.74 vs. 0.80±0.72; p=0.350) but improved in the SurgiCarb group (0.90±0.84 vs. 0.68±0.73; p=0.119); however, neither within-group change reached statistical significance. The between-group comparison of fatigue change scores was highly significant (p<0.001), indicating that carbohydrate loading produced a greater reduction in fatigue compared to plain water. Thirst decreased significantly in the SurgiCarb group (0.88±0.79 vs. 0.40±0.63; p=0.001) but showed a borderline increase in the plain water group (0.37±0.74 vs. 0.72±0.88; p=0.053). Between-group comparisons for hunger (p=0.130), anxiety (p=0.093), and thirst (p=0.297) were not statistically significant.

Table 3: Subjective Symptoms – Within-Group and Between-Group Comparisons

Symptom	**Group**	**Preop (Mean±SD)**	**Postop (Mean±SD)**	**Within-group p-value***	**Change (Post-Pre) (Mean±SD)**	**Between-group p-value****
Hunger	Plain Water	0.73 ± 0.68	0.70 ± 0.72	0.949	-0.02 ± 1.02	0.130
	SurgiCarb	0.98 ± 0.92	0.58 ± 0.68	0.010*	-0.40 ± 0.90	
Anxiety	Plain Water	0.73 ± 0.82	0.25 ± 0.49	0.003*	+0.15 ± 1.02	0.093
	SurgiCarb	0.73 ± 0.96	0.40 ± 0.55	0.047*	-0.22 ± 0.89	
Fatigue	Plain Water	0.65 ± 0.74	0.80 ± 0.72	0.350	+0.35 ± 1.05	<0.001*
	SurgiCarb	0.90 ± 0.84	0.68 ± 0.73	0.119	-0.47 ± 0.75	
Thirst	Plain Water	0.37 ± 0.74	0.72 ± 0.88	0.053	+0.47 ± 0.90	0.297
	SurgiCarb	0.88 ± 0.79	0.40 ± 0.63	0.001*	-0.32 ± 0.99	

*Wilcoxon signed-rank test (Preop vs. Postop within each group)
**Mann-Whitney U test (between-group comparison of change scores)

Table 4 displays the distribution of APFEL risk scores for postoperative nausea and vomiting between the two study groups. In the plain water group, 26 patients (65.0%) were classified as low risk, 11 (27.5%) as moderate risk, and 3 (7.5%) as high risk. In the SurgiCarb group, 23 patients (57.5%) were low risk, 12 (30.0%) moderate risk, and 5 (12.5%) high risk. The chi-square test revealed no statistically significant difference in baseline PONV risk distribution between the two groups ($\chi^2 = 0.727$, $p = 0.629$), confirming that both groups were comparable with respect to their underlying risk of developing postoperative nausea and vomiting prior to any intervention.

Table 4: APFEL Risk Score Distribution

Risk Category	Plain Water (n=40)	SurgiCarb (n=40)	Total (n=80)
Low Risk	26 (65.0%)	23 (57.5%)	49 (61.3%)
Moderate Risk	11 (27.5%)	12 (30.0%)	23 (28.7%)
High Risk	3 (7.5%)	5 (12.5%)	8 (10.0%)

Chi-square = 0.727, p = 0.629 (no significant difference in baseline risk distribution)

Table 5 summarizes the incidence and severity of postoperative nausea and vomiting in both groups. The overall incidence of PONV was 30.0% (12 patients) in the plain water group compared to 12.5% (5 patients) in the SurgiCarb group, a difference that approached statistical significance (p=0.050). More strikingly, the severity distribution differed significantly between groups (p=0.001). In the SurgiCarb group, 38 patients (95.0%) experienced no PONV (Grade 0), compared to only 10 patients (25.0%) in the plain water group. Conversely, in the plain water group, 13 patients (32.5%) had nausea only (Grade 1), 15 (37.5%) had nausea with vomiting (Grade 2), and 2 (5.0%) experienced more than two vomiting episodes in 30 minutes (Grade 3). In the SurgiCarb group, only one patient (2.5%) had nausea alone and one patient (2.5%) had nausea with vomiting; no patient experienced severe vomiting. Although the requirement for PONV rescue management was lower in the SurgiCarb group (12.5% vs. 25.0%), this difference did not reach statistical significance (p=0.152).

Table 5: PONV Incidence and Severity

Parameter	Plain Water (n=40)	SurgiCarb (n=40)	p-value
PONV Present	12 (30.0%)	5 (12.5%)	0.050
PONV Severity Grade			0.001*
No PONV (Grade 0)	10 (25.0%)	38 (95.0%)	
Nausea only (Grade 1)	13 (32.5%)	1 (2.5%)	
Nausea & vomiting (Grade 2)	15 (37.5%)	1 (2.5%)	
>2 vomiting episodes (Grade 3)	2 (5.0%)	0 (0%)	
PONV Management Required	10 (25.0%)	5 (12.5%)	0.152

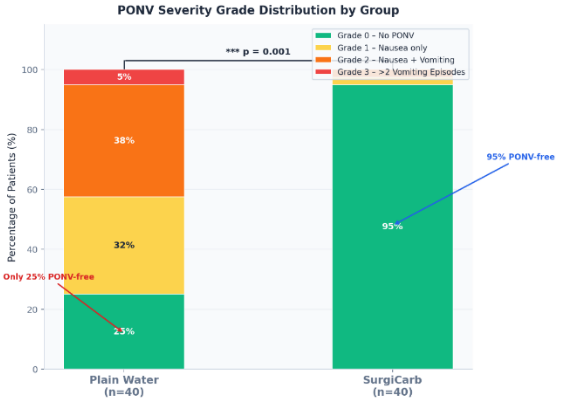
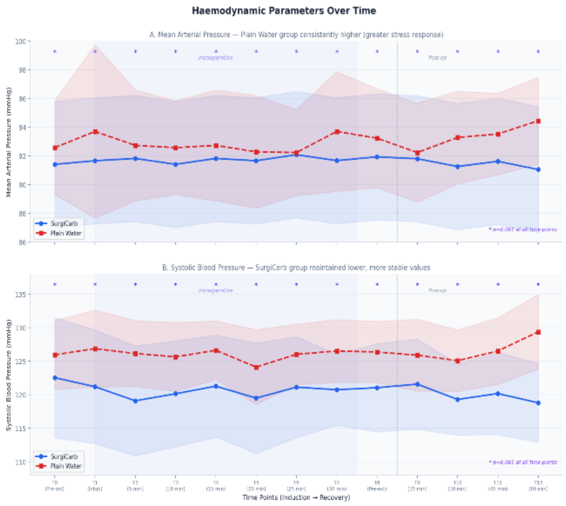


Table 6 presents the perioperative haemodynamic parameters, including heart rate, systolic blood pressure, mean arterial pressure, diastolic blood pressure, and oxygen saturation, measured at 13 time points from before induction to 60 minutes after extubation. The plain water group demonstrated significantly higher systolic blood pressure at every time point compared to the SurgiCarb group (p<0.001 for all comparisons), indicating a heightened sympathetic stress response in the absence of carbohydrate loading. Similarly, mean arterial pressure was consistently and significantly higher in the plain water group at all time points (p<0.001 for all). Heart rate showed significant differences only at T0 (before induction: 85.38±11.72 bpm in plain water vs. 79.38±7.44 bpm in SurgiCarb; p=0.008) and T4 (15 minutes post-intubation: 76.08±4.63 bpm in plain water vs. 79.35±4.70 bpm in SurgiCarb; p=0.002), with no other significant differences at remaining time points. Diastolic blood pressure was comparable between groups at all measured time points (p=0.213). Oxygen saturation remained stable and excellent in both groups, with no significant differences at any time point (p=0.183 for all comparisons). Of note, the T12 heart rate value in the SurgiCarb group (93.23±101.77 bpm) demonstrated an implausibly large standard deviation, suggesting a potential data entry error or outlier, and this finding should be interpreted with caution.

Table 6: Perioperative Haemodynamic Parameters Over Time (Mean ± SD)

Time Point	Group	HR (bpm)	SBP (mmHg)	MAP (mmHg)	DBP (mmHg)	SpO_2 (%)
T0 (Before induction)	SurgiCarb	79.38 ± 7.44	122.55 ± 8.99	91.42 ± 4.39	76.60 ± 5.47	99.52 ± 0.64
	Plain Water	85.38 ± 11.72	125.95 ± 5.15	92.58 ± 3.27	76.52 ± 4.71	99.68 ± 0.47
	p-value	**0.008***	**<0.001***	**<0.001***	0.213	0.183
T1 (After intubation)	SurgiCarb	78.80 ± 5.87	121.20 ± 8.46	91.67 ± 4.02	76.40 ± 5.12	99.65 ± 0.48
	Plain Water	77.75 ± 5.85	126.88 ± 5.76	93.71 ± 6.03	77.35 ± 4.52	99.63 ± 0.59
	p-value	0.425	**<0.001***	**<0.001***	0.213	0.183
T2 (5 min post-intubation)	SurgiCarb	78.05 ± 4.81	119.10 ± 8.20	91.83 ± 5.03	77.63 ± 4.86	—

	Plain Water	76.80 ± 4.35	126.15 ± 4.91	92.74 ± 3.86	77.30 ± 4.10	—
	p-value	0.227	**<0.001***	**<0.001***	0.213	—
T3 (10 min)	SurgiCarb	78.05 ± 5.23	120.15 ± 7.92	91.42 ± 4.39	—	97.33 ± 14.17
	Plain Water	77.07 ± 5.14	125.65 ± 5.15	92.58 ± 3.27	—	99.65 ± 0.53
	p-value	0.403	**<0.001***	**<0.001***	—	0.183
T4 (15 min)	SurgiCarb	79.35 ± 4.70	121.28 ± 7.59	91.83 ± 5.03	—	—
	Plain Water	76.08 ± 4.63	126.63 ± 4.39	92.74 ± 3.86	—	—
	p-value	**0.002***	**<0.001***	**<0.001***	—	—
T5 (20 min)	SurgiCarb	77.45 ± 4.79	119.50 ± 8.25	91.67 ± 4.02	—	—
	Plain Water	76.80 ± 4.35	124.13 ± 5.56	92.29 ± 3.92	—	—
	p-value	0.527	**<0.001***	**<0.001***	—	—
T6 (25 min)	SurgiCarb	78.18 ± 4.57	121.13 ± 7.52	92.09 ± 4.32	—	—
	Plain Water	76.32 ± 3.87	126.03 ± 4.51	92.24 ± 3.01	—	—
	p-value	0.054	**<0.001***	**<0.001***	—	—
T7 (30 min)	SurgiCarb	77.53 ± 5.03	120.75 ± 5.30	91.68 ± 3.98	—	—
	Plain Water	76.33 ± 3.68	126.53 ± 4.68	93.71 ± 4.17	—	—
	p-value	0.227	**<0.001***	**<0.001***	—	—
T8 (Pre-extubation)	SurgiCarb	76.77 ± 4.97	121.05 ± 6.57	91.94 ± 4.73	—	—
	Plain Water	77.78 ± 5.06	126.38 ± 4.57	93.24 ± 3.44	—	—
	p-value	0.375	**<0.001***	**<0.001***	—	—
T9 (15 min post-extubation)	SurgiCarb	76.63 ± 5.23	121.58 ± 6.73	91.81 ± 5.02	—	—
	Plain Water	76.55 ± 4.75	125.90 ± 5.37	92.24 ± 3.45	—	—
	p-value	0.947	**<0.001***	**<0.001***	—	—
T10 (30 min)	SurgiCarb	76.93 ± 5.41	119.30 ± 5.31	91.27 ± 4.35	—	—
	Plain Water	76.53 ± 3.82	125.08 ± 4.59	93.29 ± 3.22	—	—
	p-value	0.704	**<0.001***	**<0.001***	—	—
T11 (45 min)	SurgiCarb	76.75 ± 5.73	120.18 ± 6.12	91.63 ± 3.84	—	—
	Plain Water	77.00 ± 3.96	126.53 ± 4.97	93.53 ± 2.84	—	—
	p-value	0.821	**<0.001***	**<0.001***	—	—
T12 (60 min)	SurgiCarb	93.23 ± 101.77*	118.80 ± 5.87	91.06 ± 4.91	77.15 ± 4.86	99.60 ± 0.55
	Plain Water	77.35 ± 3.61	129.38 ± 5.58	94.45 ± 3.02	77.05 ± 4.21	99.68 ± 0.53
	p-value	0.327	**<0.001***	**<0.001***	0.213	0.183



DISCUSSION

In this prospective randomized controlled study (RCT), the authors assessed the effectiveness of SurgiCarb, a preoperative carbohydrate-containing beverage, compared to plain water on the evaluation of glycaemic control, subjective comfort of patients, postoperative nausea/vomiting (PONV), and haemodynamic stability for patients undergoing laparoscopic cholecystectomy procedures that were electively done.

The group that received carbohydrate loading using SurgiCarb exhibited predictable elevations in random blood sugar (mean difference -16.75; p<0.001) after ingesting carbohydrates. The fact that these elevations occurred without any patients developing perioperative hyperglycaemia (postoperative random blood sugar for this group was 110.10±11.90 mg/dL) indicates successful glucose absorption following carbohydrate loading. Conversely, there was an increase in postoperative random blood sugar for the group that received plain water (127.38±3.98 mg/dL; p<0.001), indicating a hyperglycaemic response as a result of surgical trauma and physically stressful event (as in prior study findings illustrating that preoperative carbohydrate loading prevents and assists in glycaemic control through glucose homeostasis and reducing postoperative insulin resistance).[7,8] A metabolic benefit demonstrated in our study was previously noted by Ljungqvist et al,[7] and Rajan et al,[8] regarding the impact of glucose infusing versus preoperative fasting on reducing postoperative insulin resistance and preoperative oral carbohydrate loading reducing intraoperative hyperglycaemia.

At the time of postoperative evaluation, patients receiving SurgiCarb preoperatively rated their level of preoperative hunger at a significantly lower level than they did for preoperative hunger levels before consuming the drink (p=0.010) while the plain water group showed no significant change in preoperative hunger levels from their preoperative hunger assessment (p=0.949). These results are also consistent with other study findings (i.e. Hausel et al,[5]) which found that a carbohydrate-rich drink led to decreased preoperative discomfort in patients undergoing elective surgery. Additionally, patients receiving SurgiCarb reported decrease in thirst levels from the time of preoperative hunger evaluation to the postoperative evaluation (p=0.001) whereas the plain water group experienced an increase in thirst levels from preoperative to postoperative evaluations(p=0.053). The study's results provide evidence that ingestion of carbohydrate fluid (CF) may achieve better hydration status than water. Researchers speculate that the absorption of fluids in CF may be more efficient than with water due to the presence of sodium transport agents which are associated with glucose.[9,10]

Anxiety was significantly reduced by both CF and water (p=0.003; p=0.047 for SurgiCarb respectively), but there was significantly more reduction in anxiety levels from baseline in the plain water group vs CF (p=0.003 vs p=0.047 respectively). This finding is contrary to what was expected, and may be due to the type of preoperative anxiety experienced, or the difference in baseline expectations prior to each treatment.[11,12]

Fatigue was also significantly greater in the SurgiCarb group when compared to plain water (p<0.001 for between groups), which is consistent with Enyedi et al,[9] and Bilku et al.[13] They showed that fatigue was reduced in patients after surgical procedures who were preoperatively loaded with carbohydrates. This difference in fatigue may indicate that SurgiCarb metabolised glucose into energy for muscular and cerebral activity that would have been reduced had the patient been fasted (i.e., hypotonic fatigue).[14,15]

Postoperative nausea and vomiting (PONV) occurred at a rate of 12.5 percent and 30.0 percent, respectively, for the SurgiCarb group and water group (p=0.050). Additionally, 95.0 percent of patients in the SurgiCarb group experienced no PONV (Grade 0) compared to only 25.0 percent of patients in the plain water group. The incidence of nausea only was significantly more frequent in the plain water group (n=32.5; 95% CI) than in the SurgiCarb group (p=0.001); 37.5 of patients had nausea with vomiting; and 5.0 percent had vomiting with no previous nausea or vomiting.

These findings from the current study are consistent with the majority of studies showing that preoperative carbohydrate loading decreases PONV.[5,8,16,17] The underlying mechanism for the decrease of PONV may include improved blood flow to the gastric mucosa, decreased release of serotonin, and stabilisation of blood glucose levels.[18,19] There were no statistically significant differences in the APFEL risk scores between the two groups (p=0.629), however there was a significant reduction in the incidence of PONV in the SurgiCarb group providing further evidence that preoperative carbohydrate loading gives an independent benefit and protection from the traditional PONV risk factors.[20]

The SurgiCarb group maintained stable and effective haemodynamic parameters throughout the perioperative phase. Heart rate was significantly different at T0 (p=0.008) and T4 (p=0.002), with a significantly lower and more stable heart rate measured in the SurgiCarb group. There was a consistent difference between groups in Systolic Blood Pressure with values lower than the SurgiCarb group at all time points (p<0.001), suggesting that the SurgiCarb group had a decreased sympathetic response to stress. The Mean Arterial Pressure was significantly different with the SurgiCarb group demonstrating higher Mean Arterial Pressure values (mean difference 1.528 mmHg, p<0.001), suggesting that the SurgiCarb group maintained better vascular tone than the control group.[21] These findings are consistent with other reports that have shown carbohydrate loading of patients decreases the incidence of intraoperative hypotensive events and provides for increased haemodynamic stability.[21] The increased stability of the haemodynamic profile in this study is likely due to greater preservation of intravascular volume, lower levels of catecholamine release and improved metabolic preparation.[22,23] Both groups maintained oxygen saturation levels above 99% during the procedures confirming that preoperative carbohydrate loading is safe and free from pulmonary complications.[24,25]

There were no reports of any adverse events in either group supporting that the provision of 355 ml of preoperative carbohydrate beverage, two hours prior to surgery, in non-diabetic ASA I–II patients is a safe and effective practice. This systematic review and meta-analysis include several key recommendations based on prior studies, including that carbohydrate loading prior to surgery does not affect gastric residual volume, nor does it affect risk of aspiration.[13,26,27] With the addition of ERAS protocols for preoperative carbohydrate loading as a standard intervention to improve postoperative outcomes and decrease length of stay,[2,29] this study also supports these recommendations for LC because of the high occurrence of discomfort and PONV related to LC.[3,5,20]

The limitations identified in the current study include: first, there was a smaller sample size (80 patients; 40 per group) than required (63 per group) limiting the power for detecting small effect sizes; second, the outcomes of the study addressed immediate perioperative outcomes only and did not evaluate long-term recovery, length of stay in hospital, or any nutritional variables; third, the outcome variables (e.g., hunger, anxiety, fatigue, thirst) were measured on verbal descriptive scales and therefore their subjectivity may have limited consistency of interpretation between individuals; fourth, because the study was a single centre design, the generalisability of the results is limited; a larger multicentre study across various health care settings will provide greater external validity; fifth, this study excluded participants with diabetes; further studies are warranted to determine the safety and efficacy of carbohydrate loading in the diabetic population,[24,30,31] finally, one variable (T12 heart rate at T12 post-op) was highly variable in the plain water group (SD 101.77) and any conclusions drawn from these data must be regarded with caution due to the potential for outlier results.

CONCLUSION

The conclusions of this controlled, randomised trial demonstrate carbohydrate loading via SurgiCarb improves perioperative outcomes in elective LC. In particular the major findings include:

1. **Glycaemic control:** The anticipated increase in glycaemic control was achieved without any adverse effects related to hyperglycaemic blood sugar levels postoperatively when compared with the plain water group.
2. Patient comfort: Hunger (p=0.010) and thirst (p=0.001) preoperatively were significantly less in the SurgiCarb group and fatigue was considerably less in the SurgiCarb group than the plain water group (p<0.001).
3. **Decreased incidence and severity of PONV:** The incidence of PONV in the SurgiCarb group was significantly less than that in the plain water group. The severity of PONV symptoms was also significantly lower (95% vs 25%, p=0.001) in patients with PONV in the SurgiCarb group.
4. **Improved haemodynamics:** The heart rate was more stable and both systolic blood pressure (p<0.001) and mean arterial blood pressure (p<0.001) were consistently lower in the SurgiCarb group.
5. **Excellent safety data:** No adverse events were experienced by either group.

These findings support ERAS guidelines for shorter fasting and preoperative carbohydrate loading. Therefore, we recommend the routine use of preoperative carbohydrate drinks for elective laparoscopic cholecystectomy in order to improve recovery, decrease postoperative complications, and improve the overall patient experience. Future multicentre, large-scale studies should be performed to confirm and expand on these findings in diabetic patients as well as patients at higher risk for developing perioperative complications.

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