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Effects of Preoperative Carbohydrate-rich Drinks on Immediate Postoperative Outcomes in Total Knee Arthroplasty: A Randomized Controlled Trial

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Research Article

Effects of Preoperative Carbohydrate-rich Drinks on Immediate Postoperative Outcomes in Total Knee Arthroplasty: A Randomized Controlled Trial

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ABSTRACT

Background: This study investigates the effects of preoperative carbohydrate-rich drinks on postoperative outcomes after primary total knee arthroplasty.

Methods: We prospectively randomized 153 consecutive patients undergoing primary total knee arthroplasty at one institution. Patients were assigned to one of three groups: group A (50 patients) received a carbohydrate-rich drink; group B (51 patients) received a placebo drink; and group C (52 patients) did not receive a drink (control). All healthcare personnel and patients were blinded to group allocation. Controlling for demographics, we analyzed the rate of postoperative nausea and vomiting, length of stay, opiate consumption, pain scores, serum glucose, adverse events, and intraoperative and postoperative fluid intake.

Results: Demographics and comorbidities were similar among the groups. There were no significant differences in surgical interventions or experience. Surgical fluid intake and total blood loss were similar among the three groups ($P = 0.47$, $P = 0.23$). Furthermore, acute postoperative outcomes (ie, pain, episodes of nausea, and length of stay) were similar across all three groups. There were no significant differences in adverse events between the three groups ($P = 0.13$). There was a significant difference in one-time postoperative bolus between the three groups ($P = 0.02$), but after multivariate analysis, it did not demonstrate significance. None of the intervention group were readmitted, whereas 5.9% and 11.5% were readmitted in the placebo and control groups, respectively ($P = 0.047$). The chance of 90-day readmission was reduced in group A compared with group C (odds ratio, 0.08; 95% confidence interval, 0.01 to 0.72; $P = 0.02$). There were no differences in other postoperative outcome measurements.

Conclusion: This randomized controlled trial demonstrated that preoperative carbohydrate loading does not improve immediate

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North or an immediate family member serves as a paid consult to VeraSense; has stock held in Peer Well; and serves as a board member/committee appointments of the Michigan Orthopaedic Society and American Association of Hip and Knee Surgeons. None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Kadado, Shaw, Ayoola, Akioyamen, and Charters.

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postoperative outcomes, such as nausea and vomiting; however, it demonstrated that consuming fluid preoperatively proved no increased risk of adverse outcomes and there was a trend toward decrease of one-time boluses postoperatively.

Clinical Trials Registry: NCT03380754

Total joint arthroplasty (TJA) is one of the most successful treatment options for managing joint osteoarthritis.[1-3] Surgical outcomes result in improved quality of life—physically, psychologically, and economically.[4] Within the American healthcare system, there has been a shift toward value-based reimbursement, with increased emphasis on the quality of services. This translates to increased pressure for practicing orthopaedic surgeons to deliver treatments with shorter associated lengths of stay, lower complication rates, and overall better outcomes.[5-7]

As surgical demand for TJA increases, an effort to increase cost efficiency and patient satisfaction with surgical outcome requires standardization of the care. Steps have been taken toward standardizing the care that patients receive with implementation of enhanced recovery after surgery (ERAS) protocols. ERAS pathways are programs that include multimodal evidence-based interventions as part of the perioperative care. The interventions within ERAS protocols are designed to improve stress response and enhance patient recovery.[8] The benefits of certain components of ERAS protocols have been well established.[9-11] When implemented for hip and knee arthroplasty, ERAS has demonstrated potential to decrease length of stay and total incidence of postoperative complication.[12] One aspect of ERAS in abdominal surgery literature is the recommendation of consumption of 300 mL of a clear carbohydrate-rich drink up to 2 hours before surgical intervention. However, the literature on the effect of this ERAS protocol and the consumption of a clear carbohydrate-rich drink preoperatively in TJA is lacking.

Within orthopaedic surgery, there have been no studies conducted that investigate the effect of preoperative carbohydrate loading on immediate postoperative outcomes. The purpose of this study aims to discover whether consumption of preoperative oral carbohydrate has an effect on TJA's immediate postoperative outcomes, primarily postoperative nausea and vomiting (PONV). We hypothesize that consumption would reduce the incidence of postoperative nausea without an increased risk of postoperative complications in patients undergoing elective total knee arthroplasty (TKA).

Methods

This study was a prospective, randomized, double-blind, placebo-controlled study approved by the local institutional review board. After approval, adult patients scheduled for elective, unilateral, primary TKA were recruited and consented for participation in the study. All surgeries were done by fellowship-trained orthopaedic surgeons at a single site in southeast Michigan. Patients were recruited from July 2017 to April 2019. Patients were excluded if they had a medical history of impaired gastrointestinal motility or were on promotility medication, had pregnancy, glycated hemoglobin level greater than 7.5%, fasting glucose level greater than 200mg/dL, acquired immunodeficiency, renal failure (creatinine >2 mg/dL), cirrhosis, or severe malnutrition (body mass index [BMI] <20 kg/m^2 and/or unintended weight loss of more than 5% in less than 6 months).

Enrolled patients were randomly assigned to one of three arms. Group A (intervention group) received a clear, non-carbonated lemon-flavored, iso-osmolar carbohydrate drink (Nutricia preOp; Nutricia; 12.5% carbohydrates, 50 kcal/100 mL, 260 mOsm/kg, and pH 5.0). Group B (placebo group) received a placebo drink of equal quantity, which was a clear, lemon-flavored water (Nestle Splash Lemon; Nestle Waters North America; 0 kcal/100 mL). Group C (control group) received no drinks. All beverages were bottled in clear polyethylene terephthalate plastic International Pharmaceutical Excipients Council (IPEC) tamper evident bottles. All enrolled patients were given a kit that included study information, instructions for participation, a data-collection questionnaire, multiple-alarm timer, and two beverage bottles labeled as drink 1 (800 mL) and drink 2 (400 mL). Patients in group C received a kit that lacked any beverage bottles. Randomization was done before enrollment in blocks of 20. The drinks were labeled by a research assistant, so neither patients nor the treatment team was able to identify the type of beverage or who was assigned to which arm of the study.

The evening before the surgery, patients in groups A and B consumed drink 1 of their respective bottles. After midnight, nothing was allowed by mouth, except for another morning dose of drink 2. Patients were instructed to take drink 2 three hours before the scheduled time of

Table 1. Demographics and Baseline Characteristics by Group

Characteristics	Treatment (N = 50)	Placebo (N = 51)	Control (N = 52)	*P* Value
Age (yrs), mean ± SD	67.1 ± 7.4	65.3 ± 10.2	67.7 ± 9.9	0.382
Sex, n (%)				
Male	15 (30.0)	13 (25.5)	17 (32.7)	0.721
Female	35 (70.0)	38 (74.5)	35 (67.3)	
BMI, mean ± SD	33.0 ± 5.4	31.9 ± 5.1	32.5	0.596
Race, n (%)				
Black	23 (46.0)	27 (52.9)	21 (40.4)	0.261
White	23 (46.0)	23 (45.1)	24 (46.2)	
Others	4 (8.0)	1 (2.0)	7 (13.5)	
ASA score, n (%)				
II	22 (44.0)	19 (37.3)	18 (34.6)	0.606
III	28 (56.0)	32 (62.8)	34 (65.4)	
Diabetes, n (%)				
No	39 (78.0)	38 (74.5)	39 (76.5)	0.918
Yes	11 (22.0)	13 (25.5)	12 (23.5)	
Nausea/vomit history, n (%)				
No	42 (85.7)	36 (75.0)	44 (86.3)	0.257
Yes	7 (14.3)	12 (25.0)	7 (13.7)	
Motion sickness history, n (%)				
No	42 (84.0)	38 (76.0)	41 (80.4)	0.633
Yes	8 (16.0)	12 (24.0)	10 (19.6)	
Smoking history, n (%)				
Current	2 (4.0)	1 (2.0)	1 (2.0)	0.865
Never	27 (54.0)	28 (54.9)	25 (48.1)	
Previous	21 (42.0)	22 (43.1)	26 (50.0)	
Opioid use, n (%)				
No	44 (88.0)	44 (86.3)	50 (96.2)	0.072
Yes	6 (12.0)	7 (13.7)	2 (3.9)	

ASA = America Society of Anesthesiologists, BMI = body mass index
Demographics compared by the three cohorts. There were no statistically significant differences between the three groups' characteristics.

surgery. The patients were instructed and confirmed to have completed all oral intake by 2 hours before surgery. Patients in group C had no drinks and were allowed nothing by mouth (NPO) after midnight. All other aspects of perioperative care were standardized.

All patients received an epidural of bupivacaine 0.5% 20 mL for anesthesia and 1 dose of 10 mg dexamethasone preoperatively. The standard postoperative protocol for nausea and vomiting included making ondansetron 4 mg available intravenously every 6 hours to all patients. This was given when the patient endorsed a symptom of nausea or after a confirmed episode of emesis, when nausea was not previously documented. No additional corticosteroid was given during the postoperative phase.

Basic preoperative demographics (ie, age, sex, BMI, race, and medical history) were collected via electronic chart review. Intraoperative data included type of anesthesia, incision to closing time, surgical net fluid rate, intraoperative net fluid given, and total blood loss. Episodes of nausea, vomiting, pain visual analog scale scores from 0 to 10, and glucose levels were recorded at 0 to 4 hours, 4 to 12 hours, and 12 to 24 hours by members of the care team and placed in the patient's electronic medical record. PONV was defined by vomiting

Table 2. Intraoperative Intervention and Characteristics Between the Groups

Characteristics	Treatment (N = 50)	Placebo (N = 51)	Control (N = 52)	*P* Value
Time from incision to close, mean ± SD	102.5 ± 16.4	100.8 ± 21.9	100.8 ± 17.4	0.508
Surgical net fluid rate (mL/min), mean ± SD	10.7 ± 3.7	11.2 ± 3.9	12.1 ± 5.0	0.473
Intraoperative net fluid (mL), mean ± SD	1,489.0 ± 436.4	1,545.1 ± 372.6	1,519.7 ± 485.9	0.612
Intraoperative blood loss (mL), mean ± SD	88.8 ± 59.7	108.0 ± 75.0	79.4 ± 46.4	0.225
Intraoperative fluid (mL), mean ± SD	1,227.4 ± 396.3	1,291.6 ± 377.2	1,218.1 ± 430.5	0.516
Length in the operating room (min), mean ± SD	138.8 ± 18.3	134.8 ± 21.6	129.7 ± 20.5	0.078

Intraoperative data compared by the three cohorts. $P > 0.05$ was considered statistically significant. There were no statistically significant differences between the three groups.

episodes with visible evidence of emesis recorded by the nursing staff, and reports of nausea were based on any use of antiemetic medication. Adverse events were defined as 90-day postoperative emergency department visit, readmission, return to the operating room, pulmonary embolism, hematoma, increased length of stay due to medical necessity, or anesthesia complication. Preoperative and postoperative physical functions were assessed using Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS JR) and Patient-Reported Outcomes Measurement Information System (PROMIS) mental and PROMIS physical scores. Postoperative data were collected between 2 to 14 weeks after surgery.

All data analyses were done using SAS 9.4 (SAS Institute), and statistical significance was set at $P < 0.05$. All continuous data were described using means, standard deviations, medians, minimums, maximums, 25th percentiles, and 75th percentiles and were compared between groups using the analysis of variance or Kruskal-Wallis test based on normality assumptions. All categorical variables were presented as frequencies and column percentages. Categorical variables were compared using the chi square test of independence or Fisher exact test if conditions were not met. Minimally clinically important difference was calculated for KOOS JR and PROMIS scores via one-half the standard deviation of the mean scores. Multivariable logistic or linear regression models were used with results presented as adjusted odds ratios and 95% confidence intervals or estimate and standard error, respectively.

The cohorts were divided into a sample size of 50 per group for a total of 150 individuals. The minimum rejection level used with the Hochberg method was 0.0167. The 2-sided test with 50 patients in each group had 80% power to detect a difference in the PONV rate from 40% in the control group to 12.1% in the carbohydrate group.

Results

There were 153 patients enrolled in the study. There were 50 patients in group A, 51 in group B, and 52 in group C. Demographic data and baseline characteristics were equal among the groups represented in Table 1. There were no statistically significant differences in age ($P = 0.38$), sex distribution ($P = 0.72$), race ($P = 0.26$), BMI ($P = 0.60$), or medical history of nausea or vomiting with surgery ($P = 0.31$) between the three groups.

There was no significant difference in surgical intervention or experience between the three groups (Table 2). The surgical length, incision to closing time, was similar between the three groups, ranging from 100.8 to 102.5 minutes ($P = 0.51$). There was no difference in the surgical fluid intake rate ($P = 0.47$) or estimated blood loss ($P = 0.23$).

In-hospital postoperative experience was also similar across all three groups. There was no difference in patient's length of stay, opioid consumption, nausea, vomiting, pain scores, glucose levels, or comfort levels (Table 3). Length of stay was on average 34.2 hours for the treatment group and 32 hours for the placebo and control groups, $P = 0.75$. In the univariable analysis (Table 3), postoperative 1-time bolus needs varied between the groups, with 4 of the individuals in the intervention group needing a postoperative bolus compared with 7 and 11 in the placebo and control groups, respectively ($P = 0.02$). However, after the multiple logistic regression model, postoperative bolus demonstrated no significance (Table 6). By the time 3 (12 to 24 hours postoperatively), confirmed episodes of emesis ranged from 0% to 14.3% ($P = 0.14$). There was no difference in the frequency of nausea or vomiting episodes at all time intervals. The average pain scores within 4 hours of surgery ranged from 4.3 to 4.2 between the 3 groups ($P = 0.53$). Glucose levels within 4 hours of surgery were also comparable (153.2 to

Table 3. Immediate Postoperative Outcomes

Perioperative Outcomes	Treatment (N = 50)	Placebo (N = 51)	Control (N = 52)	*P* Value
Length of stay (hr)	34.2 ± 8.3	36.5 ± 13.1	38.0 ± 22.9	0.703
Nausea (time 1)				0.506
No	70.8%	83.9%	79.0%	
Yes	29.2%	16.1%	21.1%	
Nausea (time 2)				0.290
No	78.3%	83.9%	65.0%	
Yes	21.7%	16.1%	35.0%	
Nausea (time 3)				0.228
No	91.3%	87.1%	71.4%	
Yes	8.7%	12.9%	28.6%	
Vomiting (time 1)				0.801
No	91.7%	90.0%	85.0%	
Yes	8.3%	10.0%	15.0%	
Vomiting (time 2)				0.363
No	87.0%	93.6%	81.0%	
Yes	13.0%	6.5%	19.1%	
Vomiting (time 3)				0.135
No	100.0%	93.6%	85.7%	
Yes	0%	6.5%	14.3%	
Postoperative pain (time 1), mean ± SD	4.3 ± 2.4	4.7 ± 2.5	4.2 ± 2.5	0.534
Postoperative pain (time 2), mean ± SD	3.6 ± 2.2	3.7 ± 2.4	3.2 ± 2.1	0.493
Postoperative pain (time 3), mean ± SD	3.2 ± 2.0	3.5 ± 2.1	3.1 ± 1.9	0.626
Glucose (time 1), mean ± SD	153.2 ± 26.8	165.9	164.4	0.697
Glucose (time 2), mean ± SD	165.3 ± 42.1	177.9 ± 43.8	176.2 ± 39.2	0.137
Glucose (time 3), mean ± SD	125.9 ±	132.2 ± 36.0	127.2 ± 20.7	0.388
Postoperative opiate,[a] mean ± SD	57.0 (0-232.5)	62.0 (0-270.5)	61.0 (0-423)	0.906
Postoperative bolus				**0.023**
No	46 (91.3%)	44 (84.1%)	41 (73.2%)	
Yes	4 (8.7%)	7 (15.9%)	11 (26.8%)	

[a]Total opioid consumed in morphine milligram equivalent.
Time 1 refers to data collected from 0 to 4 for hours postoperatively; time 2: 4 to 12 hours postoperatively; and time 3: 12 to 24 hours postoperatively.
No statistically significant difference was found during in-hospital postoperative events. Postoperative fluid requirements demonstrated that patients within the treatment group compared with those in the control group demonstrated a significantly higher incidence of postoperative one-time boluses ($P = 0.02$). There was no significant difference between the cohorts in intraoperative fluid intake.

165.9 mg/dL) in all 3 groups ($P = 0.70$). Mean opioid consumption for each group ranged from 57.0 to 61.0 morphine milliequivalents ($P = 0.91$) (Table 3).

Furthermore, there was no significant difference in 90-day postoperative events, except for readmission. The readmission rate for group A was 0%, group B was 5.9%, and group C was 11.5% ($P = 0.047$) (Table 4). In addition, all groups had similar postoperative KOOS JR and PROMIS physical and mental scores at follow-up (Table 5). There was no difference in the ratio of patients whose scores achieved minimally clinically important difference for KOOS JR, PROMIS mental, or PROMIS physical, $P = 0.84$, $P = 0.69$, and $P = 0.65$, respectively.

Controlling for the significant preoperative demographics, including sex, age, race, BMI, America Society of Anesthesiologists score, medical history of diabetes,

Table 4. 90- Day Adverse Events by Group

Adverse Events	Treatment (N = 50)	Placebo (N = 51)	Control (N = 52)	*P*-Value
ER visit (n, %)	4 (8.0)	4 (7.8)	5 (9.6)	
Hematoma (n, %)	1 (2.0)	0	0	
No 90 d event (n, %)	44 (88.0)	40 (78.4)	41 (78.9)	0.130
Other (n, %)	1 (2.0)	3 (5.9)	0	
PE (n, %)	0	1 (2.0)	0	
No 90 d event				
No (n, %)	44 (88.0)	40 (78.4)	41 (78.9)	0.373
Yes (n, %)	6 (12.0)	11 (21.6)	11 (21.2)	
ED visit				1.000
No (n, %)	46 (92.0)	47 (92.2)	47 (90.4)	
Yes (n, %)	4 (8.0)	4 (7.8)	5 (9.6)	
Readmission				**0.047**
No (n, %)	50 (100.0)	48 (94.1)	46 (88.5)	
Yes (n, %)	0	3 (5.9)	6 (11.5)	
Return to OR				0.174
No (n, %)	49 (98.0)	48 (94.1)	52 (100.0)	
Yes (n, %)	1 (2.0)	3 (5.9)	0	
PE				
No (n, %)	50 (100.0)	50 (98.0)	52 (100.0)	
Yes (n, %)	0	1 (2.0)	0	
Hematoma				0.327
No (n, %)	49 (98.0)	51 (100.0)	52 (100.0)	
Yes (n, %)	1 (2.0)	0	0	

ED = Emergency Department, OR = Operating room, PE = Pulmonary Embolism
$P < 0.05$ represents statistical significance.
Readmission rates were increased in control and placebo group compared with intervention group ($P = 0.047$). No statistically significant difference in all other 90-d postoperative events.

smoking status, and history of postoperative nausea and vomiting, Table 6 demonstrates no significant increase in the odds of having an adverse event between the three groups, except for readmission. The intervention group had a decreased risk of readmission compared with the control group (odds ratio, 0.08; 95% confidence interval, 0.01 to 0.72; $P = 0.02$). No difference was seen between the control and placebo groups ($P = 0.216$).

Discussion

This study assesses the effect that carbohydrate loading has on immediate postoperative outcomes, primarily preventing postoperative nausea, in patients who undergo TKA. The findings of this study demonstrate that although there may be no benefit to preoperative carbohydrate-rich drink regarding postoperative nausea and vomiting, pain scores, or glucose control, it is a safe option for patients with no notable effect on immediate postoperative outcomes.

Historically, there have been no studies conducted that strictly evaluate the relationship between preoperative carbohydrate drinks and PONV in patients receiving TKA. This study agrees with the systematic review conducted by Smith et al.[13] In the 27 studies identified, the 1,976 patients who received preoperative carbohydrate supplementation did not demonstrate statistically significant decreases in PONV compared with other patients. By contrast, there is literature stating that administering 5% dextrose preoperatively can markedly reduce PONV.[14] These conflicting findings suggest the need for additional studies around the subject.

Table 5. Preoperative and Postoperative Patient-reported Outcomes

Assessments	Treatment	Placebo	Control	*P* Value
Preoperative KOOS JR (N)	28	22	23	
Mean ± SD	49.8 ± 10.3	45.1 ± 13.7	50.8 ± 18.2	0.353
Preoperative PROMIS mental (N)	28	21	22	
Mean ± SD	52.4 ± 5.3	48.8 ± 8.2	48.2 ± 10.1	0.153
Preoperative PROMIS physical (N)	28	21	23	
Mean ± SD	41.5 ± 5.3	38.9 ± 6.7	39.0 ± 7.5	**0.047**
Postoperative KOOS JR (N)	23	24	24	
Mean ± SD	68.8 ± 14.2	68.5 ± 15.6	62.9 ± 19.8	0.358
Postoperative PROMIS mental (N)	22	24	23	
Mean ± SD	53.0 ± 6.3	53.0 ± 8.1	49.6 ± 7.5	0.232
Postoperative PROMIS physical (N)	23	23	24	
Mean ± SD	45.9 ± 6.6	46.5 ± 6.8	42.9 ± 7.2	0.232
KOOS JR MCID				
No	5 (31.5)	3 (25.0)	5 (38.5)	0.841
Yes	11 (68.8)	9 (75.0)	8 (61.5)	
PROMIS mental MCID				
No	12 (75.0)	7 (58.3)	7 (63.6)	0.690
Yes	4 (25.0)	5 (41.7)	4 (36.4)	
PROMIS physical MCID				
No	8 (50.0)	4 (33.3)	5 (38.5)	0.652
Yes	8 (50.0)	8 (66.7)	8 (61.5)	

KOOS JR = Knee Injury and Osteoarthritis Outcome Score for Joint Replacement, MCID = minimal clinically important difference, PROMIS = Patient-Reported Outcomes Measurement Information System

$P < 0.05$ is considered statistically significant.

Preoperative PROMIS Physical varied between the three groups, with the intervention group having the highest score and the placebo group having the lowest ($P = 0.047$). No other statistically significant differences were observed in physical or mental function tests.

Postoperative fluid management remains a controversial aspect of surgical care, with restrictive fluid regimens and goal-directed fluid therapy being the leading recommendations.[8] Patients receive postoperative fluid replacements to mitigate perioperative dehydration, which is often associated with nausea and vomiting.[15] Preoperative fasting contributes to perioperative hypovolemia.[16] The additional 1,200 mL of fluid given to the treatment and control groups in this study did not pose an increased adverse effect to the patients. There are few studies that evaluate the postoperative fluid status of patients after carbohydrate loading. Ljunggren and Hahn[17] found that preoperative water or nutritional drink did not affect a patient's hemodynamic status. This study demonstrated that patients receiving postoperative boluses were trending different between the treatment and control groups. This finding could indicate that those patients who are not having notable postoperative need for fluid could avoid boluses with preoperative fluid intake.

Ninety-day postoperative outcomes have become a popular topic in the arthroplasty literature in the past decade because of the federal Medicaid/Medicare reimbursement policies.[18,19] This study aimed to demonstrate that providing patients preoperative oral fluids was comparably as safe as an NPO status in today's arthroplasty ERAS protocol. Many arthroplasty patients have difficulty maintaining appropriate hydration at their age, which with an NPO status preoperatively can exacerbate dehydration.[20,21] This can lead to increased fluid intraoperatively or postoperatively, which then leads to additional complications for many comorbidities.[22] Therefore, this study has demonstrated that patients who presented preoperatively after oral fluid intake had similar immediate and 90-day postoperative outcomes and patient-reported outcomes. In fact, the treatment group demonstrated a

Table 6. **Multivariate Logistic Models Controlling for Sex, Age, Race, BMI, ASA Score, DM, Smoking, and Other Preoperative Conditions**

Outcome	Group	OR (95% CI)	*P* Value
Incidence of vomiting	A versus C	0.68 (0.17-2.65)	0.578
	B versus C	1.23 (0.35-4.26)	0.748
Antinausea medication	A versus C	0.63 (0.26-1.51)	0.296
	B versus C	0.55 (0.23-1.34)	0.188
90-d AE event	A versus C	0.49 (0.15-1.55)	0.223
	B versus C	1.14 (0.39-3.34)	0.808
ED visit	A versus C	0.93 (0.25-3.46)	0.911
	B versus C	1.02 (0.26-3.96)	0.980
Readmission	A versus C	0.08 (0.01-0.72)	**0.024**
	B versus C	0.40 (0.10-1.70)	0.216
Postoperative bolus	A versus C	0.72 (0.26-1.99)	0.532
	B versus C	1.07 (0.41-2.81)	0.895
Postoperative pain (time 1-3)[a]	A versus C	−0.05 (0.49)	0.911
	B versus C	0.31 (0.50)	0.536
KOOS JR MCID	A versus C	2.34 (0.27-19.89)	0.443
	B versus C	1.21 (0.11-13.04)	0.875
PROMIS mental MCID	A versus C	1.36 (0.13-13.95)	0.795
	B versus C	2.38 (0.15-38.83)	0.544
PROMIS physical MCID	A versus C	1.72 (0.26-11.13)	0.572
	B versus C	2.28 (0.25-20.73)	0.464

A = intervention group, B = placebo group, C = control group, AE = adverse event, ASA = America Society of Anesthesiologists, BMI = body mass index, CI = confidence interval, DM = diabetes mellitus, ED = emergency department, KOOS JR = Knee injury and Osteoarthritis Outcome Score for Joint Replacement, MCID = minimal clinically important difference, OR = odds ratio, PROMIS = Patient-Reported Outcomes Measurement Information System

[a]Multivariate linear regression model.

$P < 0.05$ is considered statistically significant.

There are increased odds of readmission in the control group compared with the intervention group (OR, 0.08; $P = 0.024$). No other statistically significant differences were observed in risks of postoperative complications when controlled for preoperative conditions. No statistically significant difference was found in odds of experiencing postoperative pain.

decreased readmission rate even after controlling for sex, age, race, BMI, America Society of Anesthesiologists score, medical history of diabetes, smoking status, and history of postoperative nausea and vomiting.

There are limitations to this study. Because of the high incidence of postoperative nausea and vomiting, a cohort of 153 patients offers acceptable power. However, this is not necessarily true with the secondary findings, and any significance should be treated more as a trend versus clinical significance. In addition, the accuracy of information collected via electronic chart review cannot be verified because of unstandardized input from individual healthcare providers. There were no standardized instructions given to nurses and other members of the care team regarding the importance of strict documentation during the postoperative period. So, it is possible that not all data were recorded or collected. Another limitation is the influence of epidural anesthesia on PONV. Perioperative anesthetics could have influenced the incidence of PONV because different approaches to anesthesia have their benefits and drawbacks.[17] In comparison to local infiltration anesthesia for pain control in TKA, epidural use in this setting has demonstrated higher incidence of PONV.[23] In choosing the appropriate anesthetic regimen, providers must reconcile the benefits and pitfalls of established protocols with patient-specific variables, such as allergies, urinary retention, and tolerance of delayed ambulation.[24] These considerations can make it difficult to minimize PONV risk. In our study, however, all patients received the same

anesthetics and had the same medical treatment option available to them.

Conclusion

This randomized controlled trial suggests that neither carbohydrate loading nor simple hydration poses an increase in postoperative complications compared with a standard fasting group, although there is not enough evidence to support the recommendation of preoperative carbohydrate loading for elective TKA for the reduction of postoperative nausea and vomiting and reduced discomfort postoperatively. Therefore, the study provides level 1 evidence that under this protocol, preoperative hydration and carbohydrate loading causes no harm to patients' postoperative recovery.

References

References printed in **bold type** are those published within the past 5 years.

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