

Preoperative oral carbohydrate loading: Effects on intraoperative blood glucose levels, post-operative nausea and vomiting, and intensive care unit stay

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Abstract

Background and Aims: Preoperative fasting imparts safety to patients from aspiration of gastric contents, but undue fasting may predispose to hypoglycemia and dehydration. Preoperative carbohydrate drink reduces postoperative nausea and vomiting (PONV). Primary objective of the present study was to assess effect of carbohydrate drink given 2h before surgery on intraoperative blood glucose levels as compared to those who did not receive it. Secondary objectives included assessment of incidence and severity of PONV and duration of Intensive Care Unit (ICU) stay.

Material and Methods: It was a prospective randomized study done in 52 non-diabetic patients undergoing thyroidectomy. Group A received 39gm of carbohydrate in 250 mL of apple juice (tetrapack) and Group B patients were given equivalent volume of plain water 2 h prior to surgery. Random blood glucose (RBS) levels were checked before fluid administration, preinduction, 1 h postinduction, and at the end of surgery. PONV was assessed using PONV Impact Scale Score (ISS) and rescue drugs, if needed, were noted. Paired *t*-test, sample *t*-test, Mann-Whitney *U* test, and Fisher's exact test were used as applicable.

Results: The fasting, preinduction, and postoperative RBS values were comparable in both groups. Group B had significantly higher RBS at 1h intraoperatively. Group A patients had less vomiting, dry retching, or nausea and required less rescue therapy compared to Group B.

Conclusion: Compared to patients who received carbohydrate drink 2 h before surgery, those who did not receive it had significantly higher blood glucose values intraoperatively with a higher incidence and severity of PONV and comparable ICU stay.

Keywords: Carbohydrate, fasting, hyperglycemia, hypoglycemia, PONV

Introduction

Although recent guidelines have stated that it is appropriate to reduce the interval of clear fluid ingestion to 2h prior to surgery,^[1] as a routine, most of the patients are kept fasting after midnight for both solids as well as clear fluids. By decreasing the duration of fasting period, there has also been a decrease in the risk of dehydration and hypoglycemia and thereby a decrease in the perioperative morbidity.^[2] Shortening of

preoperative fasting with a nonparticulate carbohydrate-rich beverage up to 2h preoperatively has shown to reduce insulin resistance and surgical stress and, additionally, improved the patient's well-being.^[3]

The primary objective of the present study was to assess the effect of carbohydrate drink given to non-diabetic patients 2h before surgery on the intraoperative blood glucose levels as compared to those patients who did not receive it. Secondary objectives

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included assessment of the incidence and severity of postoperative nausea and vomiting (PONV) and to compare the duration of intensive care unit stay in patients who were given carbohydrate drink preoperatively in contrast to those who did not receive it.

Material and Methods

The present study was a prospective randomized study conducted after obtaining approval from Institutional Ethical Committee (IRB- AIMS-2018-061) and consent of patients. The study has been registered with Clinical Trial Registry India (CTRI/2019/02/017601). Patients aged 18–60 years undergoing thyroidectomy and belonging to American Society of Anesthesiologists (ASA) physical status 1–2 were included. Those receiving intravenous (IV) fluids, having diabetes mellitus, pregnancy, obesity, severe hepatic or renal failure, hiatus hernia, reflux esophagitis, anticipated difficult airway, history of motion sickness, patients on opioids or steroids, and who received dexamethasone intraoperatively, were excluded from the study.

As there was no study comparing the effect of carbohydrate drink on intraoperative blood sugar levels, we had conducted a pilot study with 20 patients. In the pilot study, the difference in random blood sugar (RBS) value from fasting to preinduction in carbohydrate group versus fasting group was $+16.5 \pm 30.9$ versus -14.6 ± 10.6 . Based on this observation with 95% confidence interval and 90% power, the sample size was calculated as 26 per group to obtain statistically significant results.

All patients were given metoclopramide 10mg, pantoprazole 20mg, and alprazolam 0.5mg orally on the night prior to surgery and were kept fasting for 6 h for solid food. On the day of surgery, 2 h prior to surgery, patients in Group A were given 250 mL of apple juice (tetra pack) containing 39 grams of carbohydrate, after taking a fasting blood sugar (FBS) value, and Group B patients were given an equivalent volume of plain water. If FBS was <70 mg, 25mL of 25% dextrose was given intravenously and those patients were excluded from the study.

All patients received general anesthesia according to a standardized protocol. In the operation theatre, RBS was checked before starting IV fluid Ringer lactate (RL). If RBS was less than 80 mg/dL, 25% dextrose 25 mL bolus was given and those patients were excluded. RBS was checked using Free Style Optimum Neo H glucometer and Abbott blood glucose test strip. Four values of RBS were recorded: fasting RBS before the carbohydrate drink was given, just before the induction of anesthesia, 1 h following induction, and the last value in the immediate postoperative period.

The patients received fentanyl 2mcg/kg, glycopyrrolate 0.2mg, and midazolam 2mg intravenously. Induction was with propofol 2mg/kg, followed by vecuronium 0.1 mg/kg, and patients were intubated with cuffed endotracheal tube of size 8.5/7.5 for males and females, respectively. Hemodynamic variables such as heart rate (HR) and mean arterial pressures were noted at preinduction and at 5, 15, 30, 45, 60, 90, and 120 min. Anesthesia was maintained with 1% isoflurane in oxygen nitrous oxide (1:2) mixture. Fentanyl 1mcg/kg was repeated after 1 h, and vecuronium 1/5th the initial dose was also repeated every 30 min. Paracetamol 1gm was given half an hour after the beginning of surgery.

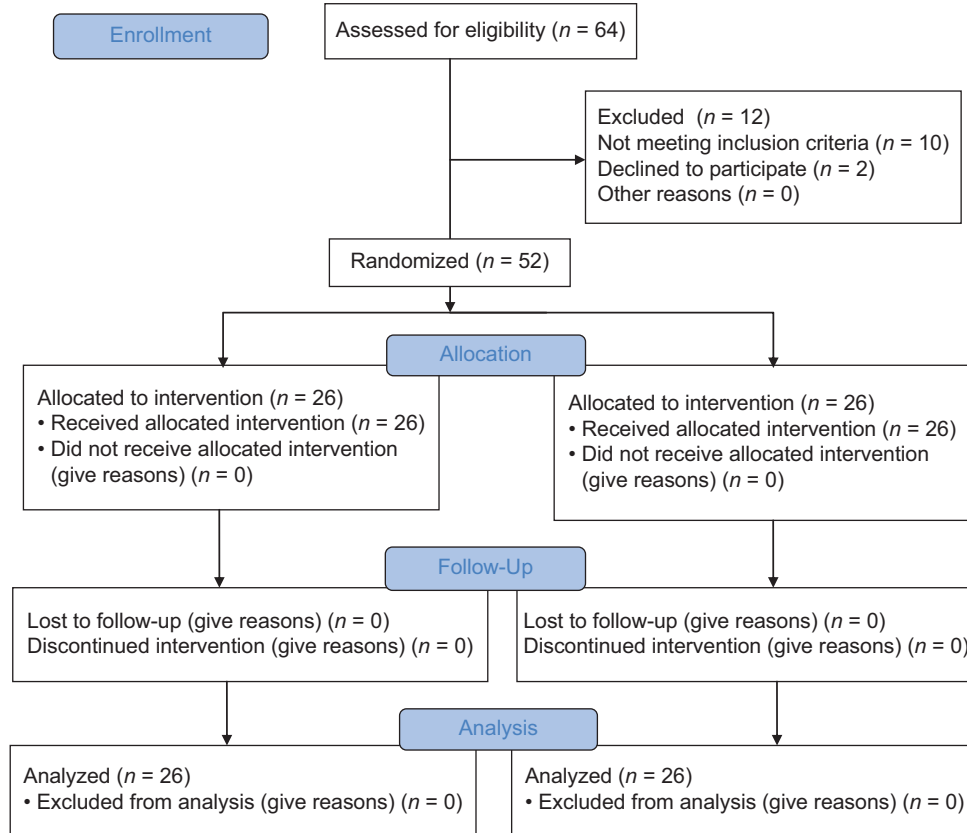
Any increase in HR and mean arterial blood pressure (MAP) $>20\%$ from baseline value was managed with increasing isoflurane to 1.5% and propofol at 20–30 mg bolus were repeated. If not controlled, fentanyl boluses at 10–20mcg were also given. Half an hour before the end of surgery, ondansetron 0.1 mg/kg was given intravenously. Neuromuscular blockade was reversed with neostigmine 0.05mg/kg and glycopyrrolate 0.01 mg/kg and the patients were extubated on table. PONV was assessed in the postoperative period using PONV Impact Scale Score,^[4] and a score of ≥ 5 defined clinically important PONV.

PONV was managed with antiemetics such as ondansetron 0.1 mg/kg, followed by metoclopramide 10 mg, dexamethasone 8mg, and haloperidol 1–2 mg/kg IV in that order. Risk factors for PONV were determined using the Apfel score. ICU stay was noted from postoperative period to the time they had been shifted out to the ward.

Paired *t*-test was used to compare the average RBS at base line to different time points. Independent sample *t*-test was used to compare RBS, heart rate, blood pressure, IV fluids, fentanyl, ICU stay, and demographic parameters. Mann–Whitney *U* test was used to compare the change in RBS at different time points from the baseline. Fisher's exact test was used to compare the need for rescue, risk score, and gender. Statistical analyses were done using SPSS version 20.0 for Windows (IBM Corporation, Armonk, NY, USA).

Results

The data of 52 patients were analyzed statistically [Table 1]. Age, height, weight, and distribution of gender were comparable in both groups. However, Group B had a higher number of ASA physical status 2 patients [Table 2]. Intragroup analysis in Group A showed that RBS at preinduction was significantly lower from baseline value. But, at subsequent time points, there was no significant difference. Intragroup analysis in Group B has shown that RBS at preinduction was significantly lower

Table 1: CONSORT flow diagram

from baseline value. But, at subsequent time points, there was no significant difference. When difference of RBS from baseline was compared in Group A and Group B at different time points, there was no significant statistical difference between the groups. FBS and preinduction RBS levels were comparable in both groups. RBS at 1 h intraoperatively was significantly lower in Group A compared to that in Group B [$P = 0.017$, Table 3 and Figure 1].

Comparison of mean HR in both groups did not show any statistically significant difference at any time point. MAP was significantly higher in Group A at 45, 60, and 90 min [Table 4]. Group A and Group B received comparable volumes of IV fluid (1336.5 ± 580 versus 1157.7 ± 327.9 mL, $P = 0.177$). Intraoperative consumption of fentanyl (156.9 ± 40.6 versus 140 ± 37.5 mcg) and mean ICU stay (6.7 ± 4 versus 6.3 ± 1.7 h) were also similar in both groups.

While PONV ISS score was compared, it was shown that significantly higher number of patients (80.8%) in Group A had no vomiting, dry retching, or nausea, compared to 7.7% in Group B. Grade 1, 2, and 3 symptoms were significantly higher in Group B [$P = 0.001$, Table 5]. Need for ondansetron rescue therapy was significantly lesser in Group A compared

Table 2: Comparison of demographics and ASA physical status

Variables	Group A	Group B	P
	Mean \pm SD	Mean \pm SD	
Age	47.5 \pm 13.9	15.6 \pm 13.0	0.414
Weight	65.5 \pm 11.2	64.0 \pm 12.2	0.649
Height	159.6 \pm 9.0	155.7 \pm 8.7	0.122
Gender	n (%)	n (%)	
Male	7 (26.9)	4 (15.4)	0.499
Female	19 (73.1)	22 (84.6)	
ASA PS 1	15 (57.7)	7 (26.9)	0.025
ASA PS 2	11 (42.3)	19 (73.1)	

to Group B (19.23% versus 92.30%, $P = 0.001$). No patient in Group A required metoclopramide. But 26.9% in Group B received metoclopramide, which was statistically significant. Comparison of risk factors based on Apfel score was comparable in both groups. 23.1% in Group A and 15.4% in Group B had risk factors for PONV based on Apfel score, and the difference was statistically not significant.

Discussion

Emerging evidence suggests that we may be overstarving patients in the preoperative period for the fear of aspiration

and so, except for patients who are at high risk of aspiration, all other patients should have a more liberal preoperative fasting protocol. Preoperative fasting and surgical stress response mounts a physiological response, which include stress hormone

Table 3: Comparison of RBS at various time points

Variables	Group A	Group B	P
	Mean±SD	Mean±SD	
Fasting RBS	101.0±17.4	110.1±23.9	0.122
Preinduction RBS	91.2±16.1	101.2±31.9	0.158
RBS 1h intraop	95.6±12.9	111.3±29.3	0.017
Postop RBS	110.3±25.8	117.6±24.4	0.300
Intragroup comparison of changes in RBS from baseline in Group A			
	Mean	SD	P
Fasting RBS	101.0	17.4	NA
Preinduction RBS	91.2	16.1	0.033
RBS 1h intraop	95.6	12.9	0.129
Postop RBS	110.3	25.8	0.153
Intragroup comparison of changes in RBS from baseline in Group B			
	Mean	SD	P
Fasting RBS	110.1	23.9	NA
Preinduction RBS	101.2	31.9	0.013
RBS 1h intraop	111.3	29.3	0.757
Postop RBS	117.6	24.4	0.131

Table 4: Comparison of hemodynamic parameters

Time	Group A		Group B		P
	Mean HR	SD	Mean HR	SD	
Baseline	82.3	12.0	88.1	16.8	0.161
5 min	78.7	14.1	83.3	13.4	0.237
15 min	76.0	13.0	77.7	13.5	0.654
30 min	71.9	12.4	74.7	11.8	0.400
45 min	71.8	12.3	77.2	13.9	0.145
60 min	70.2	10.9	75.0	13.9	0.172
90 min	70.7	12.0	76.6	12.8	0.109
120 min	69.0	13.8	76.7	11.6	0.071
Mean arterial pressure					
Baseline	95.7	15.3	90.8	13.5	0.231
5 min	83.9	14.8	80.9	18.6	0.528
15 min	84.0	12.5	82.4	15.7	0.683
30 min	87.8	14.5	84.0	11.9	0.312
45 min	91.5	10.6	83.0	9.7	0.004
60 min	93.5	11.1	83.5	12.3	0.004
90 min	92.4	9.0	85.1	7.3	0.006
120 min	93.8	7.8	88.1	7.8	0.070

Table 5: Comparison of incidence and severity of PONV

Group	PONV		P		
	No n (%)	Yes n (%)			
A	21 (80.80)	5 (19.2)	<0.001		
B	2 (7.75)	24 (92.3)			
	PONV ISS Grade 0 n (%)	PONV ISS Grade 1 n (%)	PONV ISS Grade 2 n (%)	PONV ISS Grade 3 n (%)	
A	21 (80.8)	5 (19.2)	-	-	
B	2 (7.7)	8 (30.8)	13 (50.0)	3 (11.5)	

and cytokine-induced hyperglycemic and catabolic metabolic profile. This occurs as a result of decreased transport of glucose transporter type 4 (GLUT-4) glucose transporters to the cell membrane, causing insulin resistance and low muscle glycogen synthetase activity. This leads to utilization of prior glycogen storage, in a counterregulatory hormonal environment that enhances muscle protein degradation due to gluconeogenesis.

Carbohydrate loading is one of the recommended methods of control of metabolic response by the administration of an isotonic, carbohydrate containing clear fluid prior to surgery, so that the patients can enter surgery in a fed state rather than a fasted state.^[5] The advantages of carbohydrate loading is a decline in the insulin resistance, which in turn reduces hospital stay, postoperative complications,^[5,6] lowers muscle catabolism,^[7,8] and improves intraoperative hemodynamic stability.

Anesthesia impairs the finely regulated balance between hepatic glucose production and glucose utilization in peripheral tissues in fasting patients.^[9] An increase in blood glucose levels is caused by cortisol, which increases hepatic glucose production, stimulates protein catabolism, and causes gluconeogenesis. Catecholamine surge increases glucagon secretion and inhibits insulin release by pancreatic beta cells. Stress hormones also cause lipolysis and an increase in free fatty acid concentrations, which inhibit insulin-mediated glucose uptake.^[9]

PONV is the most common reported complication after anesthesia with an incidence of 20%–40%^[11] despite antiemetic

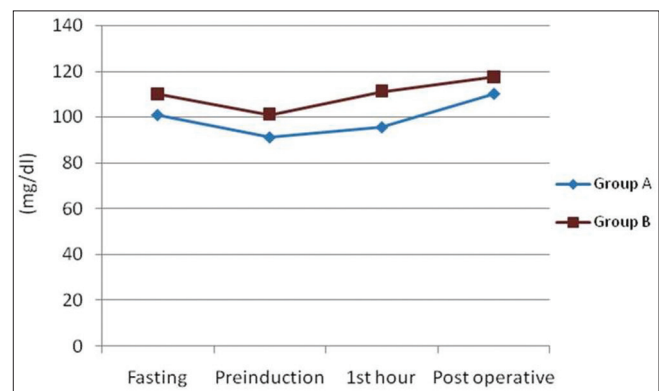


Figure 1: Changes in RBS

measures. Prolonged stay in postanesthesia care unit and unanticipated hospital admission in view of unresolved PONV can cause an increase in overall health care costs.^[10–12] Multiple factors play a pivotal role in PONV such as factors related to the patient, surgery and anesthesia which result in release of 5-hydroxytryptamine in a cascade of neuronal events involving both the central nervous and gastrointestinal tract. PONV was found to be less in patients who had received preop carbohydrate drink.^[13]

We observed a decline in RBS after carbohydrate loading, before surgery was started, which could be due to insulin release. There was a statistical difference in intraoperative value of RBS in the carbohydrate-loaded group when compared to noncarbohydrate-loaded group. This may be explained based on the fact that stress hormones play an important role in increasing blood glucose levels. Patients loaded with carbohydrate showed a decline in intraoperative blood glucose values because of decreased insulin resistance and as an effect of counterregulatory action of hormones released in them.^[14] It has been documented that postoperative hyperglycemia commences a few hours after surgery in the fasted group.^[15]

Previous research had shown that preoperative carbohydrate loading had reduced both PONV and antiemetic consumption.^[1,16,17] This could have been due to improvement of glucose metabolism,^[18] increased gastric emptying because of low osmolarity of ingested fluids,^[1] and normalization of digestive tract function and alleviation of psychological stress response.

Post-thyroidectomy patients in our institute are shifted out to ward from the ICU after 4 h when they have no nausea or vomiting for at least 30 min with a modified Aldrete score of > 10. However, due to lack of availability of ward beds and delays in shifting out of patients on time from ICU, we were not able to accurately assess the ICU stay in our study.

Most of the previous studies had compared length of hospital stay in patients undergoing colorectal surgeries and had shown reduction in length of hospital stay after preoperative carbohydrate loading.^[19,20] In our study, the study subjects were thyroidectomy patients and we had assessed duration of ICU stay as a reflection of short-term advantage of preoperative carbohydrate loading on PONV, which is a major factor preventing early shift out from postoperative ICUs after short surgeries. The average duration of surgery was 1.5–2 h in our study.

We had observed a trend of rising intraoperative blood sugar values in the absence of preoperative carbohydrate loading, although the values were within normal range clinically in our study population of nondiabetics. However, this difference

could possibly be exaggerated in diabetic patients resulting in clinically overt hyperglycemia affecting clinical outcome parameters in terms of postoperative length of hospital stay, wound healing, and postop infections. We did not assess duration hospital stay or incidence of postoperative infection as these patients were routinely discharged from hospital on the second postoperative day and diabetic patients were not included in our study. Therefore, we were unable to assess incidence of postoperative infection, which could have been taken as a factor leading to a prolonged hospital stay. Moreover, we did not anticipate a higher infection rate since all our patients were nondiabetics.

The strong point of our study was that no prior literature had studied on the intraoperative blood sugar levels when a preoperative carbohydrate drink was given. Limitations of the study were that we could not assess the patient satisfaction as we could not find an appropriate patient satisfaction scoring system and the study was an open label study. The study can be extended to different surgical populations like gastrointestinal surgeries where patients will require bowel preparation rendering them even more hypoglycemic and dehydrated. The study can be done in diabetic patients to find out whether it prevents hypoglycemia or results in hyperglycemia.

Conclusion

It is concluded that compared to patients who received carbohydrate drink 2 h before surgery, those who did not receive it had significantly higher blood glucose values intraoperatively. Administration of preoperative carbohydrate drink produced a significant reduction in incidence and severity of PONV.

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Conflicts of interest

There are no conflicts of interest.

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