

*Short Communications***The effects of carbohydrate-rich drink on perioperative discomfort, insulin response and arterial pressure in spinal anesthesia**

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Abstract

BACKGROUND: The aim of this study was to investigate the role of carbohydrate-rich drink (CHO) on perioperative discomfort, hemodynamic changes, and insulin response in patients undergoing surgery with spinal anesthesia.

METHODS: Forty-four adult patients were assigned to one of the two groups of 22, namely preparation with CHO (CHO group) or fasting from midnight (control group). Ten different discomfort variables, blood glucose and insulin concentrations, and hemodynamic changes were recorded during the perioperative period.

RESULTS: Preparation with CHO was effective in reducing hunger, thirst, malaise, unfitness, and, to some extent, anxiety ($p < 0.05$). Plasma glucose and insulin concentrations were increased in the CHO group ($p < 0.05$). Plasma glucose increased and insulin decreased in the control group ($p < 0.05$). In the control group, mean arterial pressure was lower compared to the CHO group ($p < 0.05$).

CONCLUSIONS: Preparation with CHO before spinal anesthesia is advantageous due to reducing perioperative discomfort, improving insulin response and stabilizing mean arterial pressure.

KEYWORDS: Spinal Anesthesia, Humans, Fasting, Surgery, Oral Carbohydrate, Perioperative Discomfort, Insulin Sensitivity.

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Overnight fasting is often long enough to deplete carbohydrate reserves and is also uncomfortable for the patient.¹ However, this routine has come into question recently, and several anesthetic institutions have changed their guidelines regarding preoperative fasting before elective surgery.²⁻⁸

We aimed to clarify whether preparation with a carbohydrate-rich drink (CHO) could reduce perioperative discomfort in patients undergoing surgery with spinal anesthesia. CHO before spinal anesthesia was also compared with overnight fasting in a randomized manner with respect to hemodynamic changes and insulin secretion.

Methods*Patients and study design*

Forty-four consecutive American Society of Anesthesiologists (ASA) classes I-II adult patients scheduled for elective inguinal hernia repair surgery under spinal anesthesia were included in this prospective randomized controlled clinical trial.

The patients were allocated into two groups of 22. The treatment group was prepared with CHO and the control group fasted from midnight. During the evening before surgery, patients in the CHO group ingested 800 mL of an iso-osmolar carbohydrate-rich drink [12.5% carbohydrates (glucose: 0.2 g, maltose: 0.7 g,

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polysaccharides: 10 g), 50 kcal/100 ml, 290 mOsm/kg, pH 5.0; Nutricia Preop®; Nutricia, Zoetermeer, The Netherlands]. The patients in the control group underwent spinal anesthesia after the routine fast from midnight. Nothing per os was allowed from midnight except another 400 mL of CHO in the morning at least 90 minutes before spinal anesthesia in the CHO group.

Assessment of self-reported discomfort

The patients scored their subjective sense of discomfort with 100-mm visual analogue scales (VAS) on five different occasions: 1) as a baseline (control) approximately 90-120 minutes after lunch the day before the operation; 2) before intake of the morning drink (BI); 3) 40 minutes after the morning drink (40 min AI); 4) 90 minutes after the morning drink (90 min AI); and 5) 60 minutes after the spinal anesthesia (60 min SA). The control group also completed the VAS scoring at the corresponding time points. Ten different variables were evaluated: malaise, thirst, hunger, unfitness, tiredness, nausea, pain, inability to concentrate, anxiety and depression.

Sampling and analysis

In order to measure blood glucose and insulin concentrations, blood samples were obtained before, and 40 and 90 minutes after the morning drink or at corresponding time points for the control group. Samples were also taken at 60 minutes after the spinal anesthesia.

Statistical analysis

The data except the perioperative discomfort variables are presented as means \pm standard deviation (SD). The perioperative discomfort variables are presented as median (min-max). Patients' characteristics were analyzed with student t-test and chi-square tests between groups. VAS measurements were analyzed with Mann-Whitney U-test between groups. Friedman's two-way analysis of variance (ANOVA) was used for within-group trend analysis of the VAS measurements. Changing patterns of glucose, insulin, mean arterial

blood pressure and heart rate were evaluated by repeated measurements of ANOVA in each group and Mann-Whitney U test between groups. A p value of < 0.05 was considered significant.

Results

Both groups were comparable with regard to age, sex, body mass index (BMI), ASA classification, duration of the anesthesia and surgery, total amount of fluid administered, and urine volume (Table 1).

The CHO group showed decreasing trends for discomfort variables of hunger ($p < 0.001$), thirst ($p < 0.001$), malaise ($p < 0.05$) and unfitness ($p < 0.01$) during the perioperative period (Table 2). The anxiety level was decreased significantly only at 40 and 90 minutes after the morning drink compared to baseline and before the intake of morning drink ($p < 0.05$). In the control group, hunger ($p < 0.001$) and thirst ($p < 0.01$) variables increased during the perioperative period (Table 2). The CHO group experienced less hunger ($p < 0.01$), thirst ($p < 0.05$), malaise ($p < 0.001$), and unfitness ($p < 0.05$) at 40 and 90 minutes after the morning drink and 60 minutes after the spinal anesthesia compared with the control group (Table 2). Furthermore, the CHO group was less anxious ($p < 0.05$) than the control group at 40 and 90 minutes after the morning drink. Plasma glucose and insulin concentrations were increased in the CHO group before spinal anesthesia compared to before intake of CHO (105 ± 4 mg/dl vs. 88 ± 3 mg/dl, and 15 ± 4 microunits/ml vs. 6 ± 2 microunits/ml, respectively) and the control group ($p < 0.05$) (Figures 1 and 2). Increased plasma glucose and decreased insulin were observed in the control group at 60 minutes after the spinal anesthesia compared to the baseline (128 ± 4 mg/dl vs. 90 ± 4 mg/dl, and 3 ± 1 microunits/ml vs. 8 ± 3 microunits/ml, respectively). However, the corresponding levels returned to BI levels in the CHO group, leading to significant differences between the groups ($p < 0.05$; Figures 1 and 2).

In the control group, MAP was lower before and 10 and 20 minutes after the spinal

Table 1. Patients' characteristics

	CHO Group	Control Group
Number (n)	22	22
Age (year)	45 ± 7	43 ± 8
Sex (M/F)	12/10	14/8
BMI (kg/m ²)	25 ± 2	24 ± 3
ASA (I/II)	9/13	10/12
Duration of surgery (min)	75 ± 12	72 ± 18
Duration of anesthesia (min)	105 ± 20	110 ± 25
Fluid volume (mL)*	1050 ± 250	1000 ± 350
Urine volume (mL)*	540 ± 150	520 ± 160

Data are presented as means ± SD.

CHO = carbohydrate-rich drink; BMI = body mass index; ASA = American Society of Anesthesiologists.

* Total amount of fluid and urine during the anesthesia and surgery.

Differences between the groups were nonsignificant.

Table 2. Visual Analogue Scale (VAS) data for perioperative discomfort variables

VAS variable (mm)	Group	Baseline	BI	40 min AI	90 min AI	60 min ASA
Malaise	CHO	21 (19-23)	20 (17-23)	10 (9-11)* [†]	10 (8-12)* [†]	8 (6-10)* [†]
	Control	20 (19-21)	21 (18-24)	22 (20-24)	21 (17-25)	23 (21-25)
Thirst	CHO	40 (35-45)	35 (32-38)	21 (19-23)* [†]	20 (16-24)* [†]	18 (13-23)* [†]
	Control	42 (39-45)	45 (41-48)	58 (52-64)*	60 (56-64)*	64 (59-69)*
Hunger	CHO	52 (50-54)	51 (48-54)	25 (21-29)* [†]	22 (19-25)* [†]	23 (18-28)* [†]
	Control	48 (43-53)	50 (46-54)	61 (58-64)*	69 (65-73)*	75 (73-77)*
Unfitness	CHO	32 (30-34)	31 (27-35)	16 (12-20)* [†]	17 (12-22)* [†]	16 (14-18)* [†]
	Control	30 (17-33)	34 (33-35)	32 (30-34)	32 (28-36)	30 (26-34)
Tiredness	CHO	38 (34-42)	40 (37-43)	41 (40-42)	40 (36-44)	39 (34-44)
	Control	33 (30-36)	33 (29-37)	37 (34-40)	38 (34-42)	37 (35-39)
Nausea	CHO	10 (8-12)	9 (6-12)	9 (5-13)	10 (7-13)	8 (4-12)
	Fasted	11 (9-13)	10 (9-11)	8 (5-11)	8 (4-12)	9 (5-13)
Pain	CHO	5 (3-7)	8 (6-10)	8 (6-10)	9 (8-10)	6 (3-9)
	Fasted	4 (1-8)	6 (5-7)	8 (7-9)	8 (6-10)	7 (4-10)
Inability to concentrate	CHO	21 (18-24)	20 (17-23)	21 (19-23)	25 (23-27)	23 (20-26)
	Control	22 (20-24)	24 (20-28)	22 (19-25)	23 (18-28)	24 (20-28)
Anxiety	CHO	43 (40-46)	40 (37-43)	21 (19-23)* [†]	20 (18-22)* [†]	43 (41-45)
	Control	45 (43-47)	47 (43-51)	50 (47-53)	48 (43-53)	46 (44-48)
Depression	CHO	6 (2-10)	6 (3-9)	7 (2-12)	6 (3-9)	5 (2-8)
	Control	7 (5-9)	6 (5-7)	5 (2-8)	5 (1-9)	6 (2-10)

Data are presented as median (min-max).

CHO = carbohydrate-rich drink; BI = before intake of the morning drink (or corresponding time in the control group); 40 min AI = 40 minutes after intake of the morning drink (or corresponding times in the control group); 90 min AI = 90 minutes after intake of the morning drink (or corresponding times in the control group); 60 min ASA = 60 minutes after the spinal anesthesia.

* $p < 0.05$; VAS scores of malaise, thirst, hunger, unfitness, and anxiety were lower compared to baseline (control) and BI in the CHO group. However VAS scores of thirst and hunger were higher compared to baseline (control) and BI in the control group.

[†] $p < 0.05$; VAS scores of malaise, thirst, hunger, unfitness, and anxiety of the CHO group were lower than those of the control group. Other differences between the groups were non-significant.

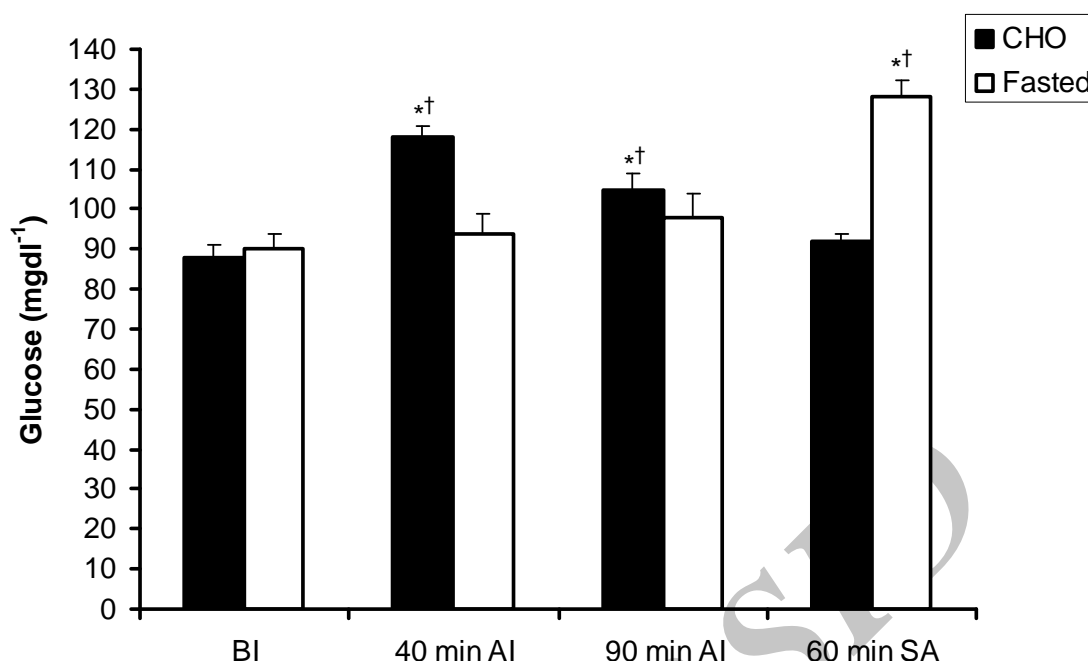


Figure 1. Perioperative plasma glucose concentration (mg/dl) in the two groups. Data are presented means \pm SD. BI = before intake of the morning drink (or corresponding time in the fasted group); AI = after intake of the morning drink (or corresponding time in the fasted group); 60 min SA = 60 min after the spinal anesthesia; * $p < 0.05$ compared to BI; † $p < 0.05$ compared to the other group.

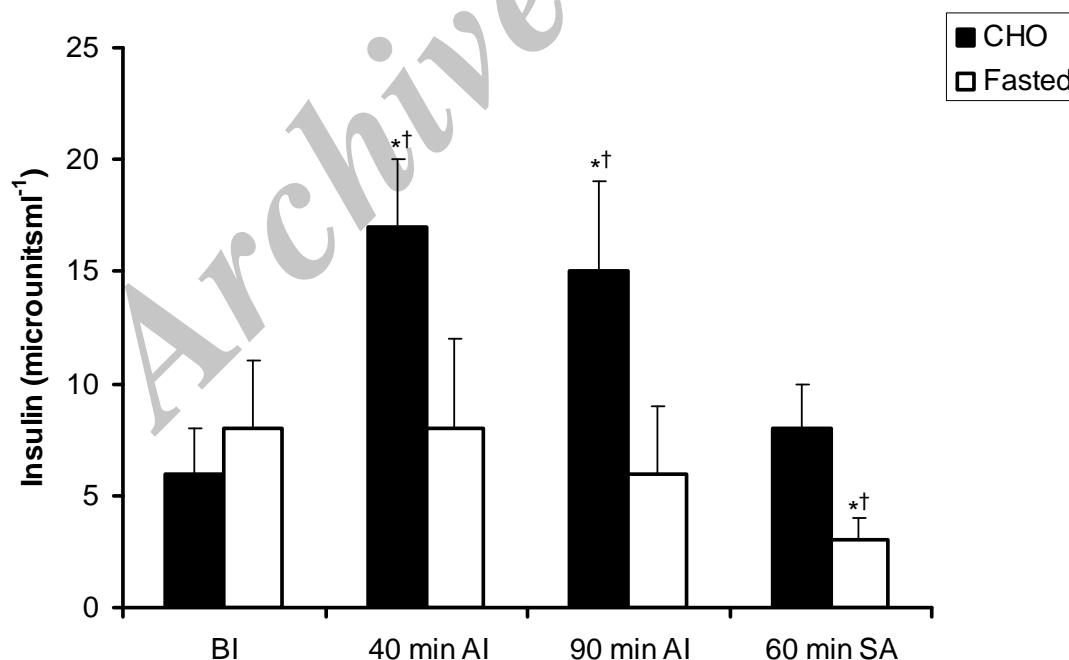


Figure 2. Perioperative plasma insulin concentration (microunits/ml) Data are means \pm SD. BI = before intake of the morning drink (or corresponding time in the Fasted group); AI = after intake of the morning drink (or corresponding time in the Fasted group); 60 min SA = 60 min after the spinal anesthesia; * $p < 0.05$ compared to BI; † $p < 0.05$ compared to the other group.

anesthesia compared to the CHO group and before intake of morning drink (or corresponding time in the control group) ($p < 0.05$) (Table 3).

Discussion

There were two most important findings in the present study. First, preoperative administration of CHO increased perioperative well-being compared with overnight fasting in patients undergoing elective inguinal hernia repair surgery with spinal anesthesia. Preparation with CHO was more effective than overnight fasting in reducing hunger, thirst, malaise, unfitness, and, to some extent, anxiety during the perioperative period. Second, administration of oral CHO before the spinal anesthesia improved insulin response and stabilized the mean arterial blood pressure during the spinal anesthesia.

For evaluation of perioperative discomfort, the VAS method was chosen and the variables in the VAS questionnaire were the same as those used in several previous studies.^{8,9}

Compared to the control group, patients in the CHO group were less hungry and thirsty and experienced less malaise and unfitness even 60 minutes after the spinal anesthesia. This is likely to be a remaining effect of the morning dose of carbohydrates on the post-spinal anesthesia period.

Anxiety was decreased preoperatively after intake of morning drink in the CHO group. Energy intake with carbohydrates may have

secondary effects on mood by making patients feel more at ease.¹⁰ It has been demonstrated previously that a carbohydrate-rich drink has a positive effect with regard to thirst, hunger, malaise, unfitness, and anxiety and should be initiated on the evening before surgery to observe the remaining effect of the previous evening dose of carbohydrates (100 g).^{8,9,11} Thus, our study seemed to be in the same line with the previous investigations. However, the similarity in anxiety level after the spinal anesthesia may be explained by the fact that patients were awake and had no sedation during the surgical procedure.

The positive effects of carbohydrates on the perioperative period were accompanied by increases in glucose and insulin concentrations in the CHO group. The response of insulin release to carbohydrate intake can be partitioned into the first phase (0-10 minutes; release phase) and the second phase (10-60 minutes; de novo biosynthesis phase). Obviously, the data presented in Figure 2 shows the second phase of insulin response. Insulin levels peaked at 40 minutes after intake of morning drink. A dose of 400 mL of this beverage given to patients ready to undergo a surgery increased serum insulin to levels seen after a standard mixed meal, thereby providing enough energy to switch the patient from the fasted to the fed state before the onset of the surgery.¹² Fasting from the previous evening inhibited insulin secretion and the glycolysis system was enhanced in the morning of the

Table 3. Hemodynamic changes in patients

Variable	Group	BI	BSA	10 min ASA	20 min ASA	30 min ASA	60 min ASA
Heart rate (bpm)	CHO	78 ± 9	74 ± 11	65 ± 10	64 ± 13	73 ± 8	77 ± 10
	Control	75 ± 12	72 ± 11	67 ± 8	66 ± 10	74 ± 13	79 ± 12
Mean arterial blood pressure (mmHg)	CHO	115 ± 13	110 ± 10	98 ± 15	100 ± 12	108 ± 10	112 ± 14
	Control	110 ± 9	82 ± 10*	75 ± 11*	80 ± 15*	105 ± 11	108 ± 16

Data are presented as mean ± SD.

CHO = carbohydrate-rich drink; BI= before intake of the morning drink (or corresponding time in the control group); BSA = before spinal anesthesia; ASA = after spinal anesthesia.

* $p < 0.05$ compared to the CHO group and BI. Mean arterial pressures of the control group at BSA, 10 min ASA, and 20 min ASA were lower than those of the CHO group.

operation day, resulting in an increase in the plasma glucose level. In the CHO group, intake of carbohydrate-rich drink prevented the increase in the plasma glucose level by endogenous release of insulin. This, in turn, resulted in a less stressful response to the surgical trauma and improved insulin sensitivity postoperatively.

In patients undergoing abdominal surgery, spinal anesthesia has been shown to produce efficient afferent blockade which resulted in pronounced reduction of the metabolic-endocrine response and improved insulin sensitivity.^{13,14}

In the control group, the observed increase in glucose concentrations together with a reduction in insulin concentrations did not exactly indicate the loss of normal insulin sensitivity. It may suggest reduced release or increased turnover rate of insulin due to perioperative hypo-caloric nutrition or reduction in whole body glucose disposal, or both.¹⁵

In the CHO group, intake of morning drink before the spinal anesthesia improved MAP just before and after the spinal anesthesia. Although the present study was not designed to elucidate the factors responsible for the stable MAP levels in the CHO group, we can only speculate on the underlying endocrine mechanisms like improved glucose and insulin responses and the patients' feeling more at ease during this period due to energy intake with carbohydrates.

In conclusion, preparation with oral carbohydrate before spinal anesthesia had advantages over overnight fasting during the perioperative period by increasing patient well-being, improving insulin response and stabilizing mean arterial pressure in patients undergoing elective inguinal hernia repair surgery.

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Conflict of Interests

Authors have no conflict of interests.

Authors' Contributions

HYa carried out the design and coordinated the study, participated in most of the experiments and prepared the manuscript. SG provided assistance in the design of the study. HYi carried out all the experiments. HG provided assistance for all experiments. CT carried out the biochemical analysis of the study. All authors have read and approved the content of the manuscript.

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