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The Effect of Oral Carbohydrates on Blood Sugar and Hemodynamic Parameters in Children Undergoing Inguinal Hernia Surgery

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ABSTRACT

Background and Objective: Fasting before surgery can cause metabolic stress and insulin resistance. The aim of this study is to investigate the effect of oral carbohydrates before surgery on blood sugar levels and hemodynamic indicators in children under three years of age who are candidates for inguinal hernia surgery.

Methods: In this double-blind clinical trial, 207 children under three years of age who were candidates for inguinal hernia surgery were randomly divided into three groups. Patients in the carbohydrate group received 5 cc/kg of 20% dextrose solution orally, in the water group, 5 cc/kg of drinking water 2 hours before surgery, and in the control group, standard fasting was applied before surgery. Mean arterial pressure, heart rate and blood sugar at different times (5, 10, 15 and 20 minutes) as well as the incidence of vomiting were compared between the three groups.

Findings: Heart rate changes were significantly different between the three groups (p=0.002). The mean changes in heart rate at 10, 15 and 20 minutes were -6.76±0.89, -10.9±1.25 and -12.47±1.3 in the oral carbohydrate group, -4.03±0.65, -7.4±0.75 and -8.76±0.8 in water group and -2.7±0.36, -5.9±0.72 and -6.9±0.73 in the control group, respectively. In the oral carbohydrate group, the mean blood sugar changes during surgery (+4.15±4.8 and p=0.39) and during recovery (-0.35±0.94 and p=0.94) were not significant. The mean changes in blood sugar during surgery (+35.01±1.8) and during recovery (+46.57±1.4) in the water group, as well as blood sugar increase during surgery (42.12±1.5) and recovery (+39±1.3) in the control group compared to before induction of anesthesia were statistically significant (p<0.001).

Conclusion: The results of the study showed that preoperative oral carbohydrate intake provides more stable hemodynamics in children undergoing inguinal hernia surgery. Despite the high blood sugar in the oral carbohydrate group before induction of anesthesia, its changes during surgery and recovery are small compared to the water and control groups.

Keywords: *Preoperative Fasting, Oral Carbohydrates, Serum Blood Sugar, Hemodynamic Parameters.*

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Introduction

Inguinal hernia surgeries are one of the most common surgeries in children under 15 years of age (1). The cumulative incidence of inguinal hernia repair is reported to be 7% in boys and 1% in girls (2). Patients undergoing surgery are usually asked to fast a few hours before surgery, and in some cases fasting starts 24 hours before surgery (3). In children, fasting before surgery is also observed for various reasons, including reducing the risk of aspiration of stomach contents and reducing the acidity and volume of materials in the stomach (4). According to the existing guidelines, the duration of fasting in children is 6 hours for solid foods, 4 hours for breast milk, and 2 hours for liquids before surgery to avoid aspiration and fasting for a long time (5). Fasting before surgery causes metabolic stress and insulin resistance, which is characterized by hyperglycemia and reduced response of tissues (mainly skeletal muscles and liver) to the biological activities of insulin, and the development of insulin resistance can lead to more complications, higher mortality and longer hospitalization (6-8). On the other hand, the body uses glycogenolysis to provide energy during fasting before surgery. With the depletion of glycogen reserves, gluconeogenesis and fatty acid oxidation along with ketogenesis become the main sources of energy supply. The surgery itself increases the metabolism and decreases the glycogen reserves in the liver and muscles, which then release fatty acids and amino acids from the fat tissue and muscles and in general increase insulin resistance (8).

In recent years, the need to fast for a long time before surgery has been discussed and questioned. According to ERAS (Enhanced Recovery Programs) guidelines, clear liquids are acceptable up to 2 hours before surgery. This type of management does not increase the risk of aspiration during anesthesia (9). Several guidelines recommend that carbohydrate beverages be allowed in nondiabetic patients undergoing elective surgery up to 2 hours before induction of anesthesia (10). It has been shown that shortening the fasting time with a carbohydrate-containing drink up to 2 hours before surgery can reduce insulin resistance and surgical stress and, in addition, promote faster patient recovery (11). However, studies show that these guidelines are not routinely implemented in pediatric surgeries, and most studies emphasize prolonged fasting before pediatric surgery. Prolonged fasting time in children can lead to clinical and metabolic consequences. In children under long-term fasting, the rate of hunger and thirst, irritability, anxiety, discomfort, boredom, dehydration (which can hinder venous access), headache and delay in recovery are higher (12, 13).

In most studies, the effects of preoperative carbohydrate in adult surgeries such as laparoscopic cholecystectomy, laparotomy, and thyroidectomy have been investigated (10, 11, 14, 15). In one study, it was shown that the use of carbohydrate-containing drinks before surgery was safe and could be consumed up to 2 hours before surgery. Such beverages have also been found to reduce insulin resistance and improve postoperative discomfort, particularly in patients undergoing laparoscopic cholecystectomy (3). However, few studies have examined the effect of oral carbohydrates in pediatric surgeries (12, 16). In a study, it was shown that reducing preoperative fasting time with a carbohydrate-containing drink improved postoperative metabolic and inflammatory responses in children undergoing inguinal hernia surgery (12). Based on our search, no study was found regarding the effect of carbohydrates on hemodynamics and serum blood sugar levels in children undergoing elective inguinal surgeries. Therefore, the present study was designed and implemented with the aim of investigating the effect of oral carbohydrates on blood sugar and hemodynamic parameters in children under three years of age who are candidates for inguinal hernia surgery.

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Methods

After being approved by the Ethics Committee of Urmia University of Medical Sciences with the code IR.UMSU.REC.1400.058 and registered in the Iranian Clinical Trials Registration Center with the code IRCT20170516033992N7 and obtaining written consent from the parents of the children, this double-blind clinical trial was conducted on 207 children undergoing inguinal hernia surgery who referred to Shahid Motahari Hospital in Urmia for surgery. Convenience sampling was used to choose the samples. Children under three years of age, class I and II ASA and elective surgeries were included in the study, and children with underlying heart and lung diseases, liver diseases, metabolic diseases, diabetes, glucose 6-phosphate enzyme deficiency, and patients who had any complications during anesthesia and surgery were excluded from the study. Using block randomization, patients were divided into three groups (69 people in each group) based on the numbers given by the random allocation software. The study was conducted in a double-blind manner; In this way, the patient and their parents, as well as the final evaluator of the results, were unaware of the allocation of the patients in any of the studied groups.

Medicines were given to the patients by the ward nurse and coded for the names of the groups. In group one (carbohydrate group), 5 cc/kg of 20% dextrose solution was given orally (made by Samen Pharmaceutical Company). In the second group (drinking water group), children were given 5 cc/kg drinking water 2 hours before the operation by the nurse. In group three (control group), standard fasting procedure was observed before surgery. After transferring the patients to the operating room, standard monitoring including pulse oximetry, electrocardiography, non-invasive blood pressure measurement and heart rate control was performed for all patients. Then induction of anesthesia was done by inhalation of 3-8% sevoflurane gas, and after that, Catheter 24 was inserted for the patients and 25 cc/kg of Ringer's serum was administered near the operation. During this time, serum containing carbohydrates was prescribed to the patients. Then the patients underwent general anesthesia with 3 mg/kg propofol, 0.05 mg/kg midazolam and 2 μg/kg fentanyl. After induction, airway management was performed with a laryngeal mask according to weight, and anesthesia was continued with 1-1.5% isoflurane, 50% nitrous oxide, and 50% oxygen. Before induction of anesthesia, during surgery and during recovery, the blood sugar of the patients was measured by a glucometer. Mean arterial pressure and heart rate were measured every 5 minutes for 20 minutes. The incidence of vomiting was evaluated during induction of anesthesia and after waking up from anesthesia until discharge from recovery.

Quantitative variables were reported as mean±standard deviation and qualitative variables were reported as number (percentage). ANOVA test was used to compare the mean age and weight of the child among the three groups, and chi-square test was used to compare the frequency of qualitative variables. Repeated measurement test was used to compare the mean heart rate, MAP and blood sugar at different measurement times. Data analysis was done using SPSS 17 software and $p<0.05$ was considered significant.

Results

In this study, 66 people in the carbohydrate group, 67 people in the water group and 69 people in the control group were included in the analysis. Of all the participants in the study, 157 children (77.7%) were boys and 45 children (23.3%) were girls. There was no significant difference in the mean age, weight and frequency of gender among the three groups (Table 1).

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Table 1. Comparison of demographic characteristics in children under three years of age who are candidates for inguinal surgeries between the three groups

Variable	Carbohydrate group (n=66) Mean±SD or Number(%)	Drinking water group (n=67) Mean±SD or Number(%)	Control group (n=69) Mean±SD or Number (%)	p-value
Age (months)	13.39±9.2	12.55±7.5	13.29±8.7	0.93*
Weight (kg)	9.34±2.6	9.21±2.33	9.3±2.38	0.95*
Gender				
Girl	14(21.2)	16(23.9)	15(21.7)	0.93**
Boy	52(78.8)	51(76.1)	54(78.3)	

***One-way analysis of variance (ANOVA), **Chi-square test**

The comparison of the mean heart rate at different times between the three groups showed that the decrease in heart rate at all three time points compared to minute 5 in the oral carbohydrate group was more than the other two groups, and this difference between the three groups was statistically significant (p=0.002). The mean changes in heart rate at 10, 15 and 20 minutes were -6.76±0.89, -10.9±1.25 and -12.47±1.3 in the oral carbohydrate group, -4.03±0.65, -7.4±0.75 and -8.76±0.8 in water group and -2.7±0.36, -5.9±0.72 and -6.9±0.73 in the control group, respectively. Comparing the groups two by two, the results showed that the mean heart rate changes in the oral carbohydrate group had a significant difference (p<0.001) compared to both the water and the control groups, while the mean changes between the two groups of water and control were not significant. Intra-group comparison also showed that the reduction of heart rate at all time points compared to minute 5 in all three groups was statistically significant (p<0.001).

In general, there was no significant difference in mean MAP changes between the three groups. But in the two-by-two comparison of the groups, the mean changes in MAP in the oral carbohydrate group were significant compared to the other two groups (p<0.001), while the mean changes in the water and control groups were not significant (p=0.83).

In the oral carbohydrate group, intra-group comparison of MAP changes in each of the time points compared to minute 5 showed that the decrease in MAP values in minutes 15 and 20 compared to minute 5 was statistically significant (p<0.001) and in minute 10 was not significant (p=0.18). The mean changes in minutes 10, 15, 20 compared to minute 5 were -0.83±0.62, -1.82±0.36 and -2.45±0.36, respectively. In the drinking water group, the decrease in MAP values at all time points compared to minute 5 was statistically significant; the mean changes in 10, 15, and 20 minutes were -1.1±0.28, -2.57±0.24 and -3.1±0.28, respectively (p<0.001). In the control group, the decrease in heart rate values at all time points compared to minute 5 was statistically significant; the mean changes in minutes 10, 15, 20 were -1.5±0.25, -2.94±0.28 and -3.45±0.31, respectively (p<0.001) (Table 2).

The comparison of blood sugar at different time points between the three groups showed that the increase in blood sugar during surgery and recovery compared to the time of induction in both the water and control groups was higher compared to the oral carbohydrate group. There was a significant difference in the mean blood sugar changes between the three groups (p<0.001). Comparing the groups two by two, the results showed that the mean blood sugar changes in the oral carbohydrate group had a significant difference compared to both the water group and the control group (p<0.001). However, its mean changes were not significant between drinking water and control groups. In the intra-group comparison, the changes in blood sugar during surgery and recovery compared to before induction of anesthesia showed that in the oral carbohydrate group, the increase in blood sugar during surgery and its decrease during recovery compared to its value before induction of anesthesia were not statistically significant; the mean changes during surgery compared to before induction of anesthesia were (+4.15±4.8 and p=0.39) and during recovery were (-0.35±0.94 and p=0.94). The mean blood sugar in recovery has almost reached its value before induction of anesthesia. In the drinking water group, the increase in blood sugar levels during surgery and recovery compared to before induction of anesthesia was statistically significant; the mean changes during surgery compared to before induction of anesthesia were (+35.01±1.8) and during recovery were (+46.57±1.4) (p<0.001). In the control group, the increase in blood sugar levels during surgery and recovery compared to before induction of anesthesia was statistically significant; the mean changes during surgery compared to before induction of anesthesia were (+42.12±1.5) and during recovery were (+39±1.3) (p<0.001) (Table 2). Comparing the frequency of vomiting during anesthesia induction and 5, 15, and 30 minutes after anesthesia induction between the three groups showed that none of the patients in all three groups had vomiting at all time points (Table 3).

Table 2. Comparison of mean changes in heart rate, mean arterial pressure in children under three years of age who are candidates for inguinal surgeries between three groups

Variable	Oral carbohydrate group Mean±SD	Changes from baseline Mean±SE	Drinking water group Mean±SD	Changes from baseline Mean±SE	Control group Mean±SD	Changes from baseline Mean±SE	p-value1*	p-value2*	p-value3*
Heart beat									
Min 5	117.36±18.6	-	134.29±17.2	-	132.22±17.9	-	-	-	-
Min 10	110.6±16.5	-6.67±0.89	130.26±16.2	-4.03±0.65	129.5±17.05	-2.7±0.36	<0.001	<0.001	<0.001
Min 15	106.45±15.7	-10.9±1.25	126.89±15.8	-7.4±0.75	126.29±16.3	-5.9±0.72	<0.001	<0.001	<0.001
Min 20	104.89±15.6	-12.47±1.3	125.5407±15.3	-8.76±0.8	125.33±15.6	-6.9±0.73	<0.001	<0.001	<0.001
				P-trend=0.002					
MAP									
Min 5	54.3±4.3	-	57.83±4.5	-	58.27±5.4	-	-	-	-
Min 10	53.57±6.7	-0.83±0.62	56.73±4.4	-1.1±0.28	56.75±4.8	-1.5±0.25	0.18	<0.001	<0.001
Min 15	52.5±4.3	-1.82±0.36	55.26±3.5	-2.57±0.24	55.33±3.9	-2.94±0.28	<0.001	<0.001	<0.001
Min 20	51.8±3.9	-2.45±0.36	54.73±3.4	-3.1±0.28	54.82±3.7	-3.45±0.31	<0.001	<0.001	<0.001
				P-trend=0.27					

***Repeated measurement**
p-value1: intra-group comparison of each time point compared to minute 5 (reference) in the oral carbohydrate group
p-value2: intra-group comparison of each time point compared to minute 5 (reference) in the drinking water group
p-value3: intra-group comparison of each time point compared to minute 5 (reference) in the control group

Table 3. Comparison of mean changes in blood sugar in children under three years of age who are candidates for inguinal surgeries between three groups

Variable	Oral carbohydrate group Mean±SD	Changes from baseline Mean±SE	Drinking water group Mean±SD	Changes from baseline Mean±SE	Control group Mean±SD	Changes from baseline Mean±SE	p-value1*	p-value2*	p-value3*
Blood sugar									
Before anesthesia	126.03±10.5	-	75.28±11.3	-	76.62±10.1	-	1	1	1
During surgery	130.18±14.7	+4.15±4.8	110.29±16.3	+35.01±1.8	118.74±12.1	+42.12±1.5	0.39	<0.001	<0.001
Recovery	125.68±14.4	-0.35±0.94	121.85±9.7	+46.57±1.4	115.62±9.02	+39±1.3	0.94	<0.001	<0.001
				P-trend<0.001					

***Repeated measurement**
p-value1: intra-group comparison of the values during surgery and recovery compared to the time of induction (reference) in the oral carbohydrate group
p-value2: intra-group comparison of values during surgery and recovery compared to the time of induction (reference) in drinking water group
p-value3: intra-group comparison of the values during surgery and recovery compared to the time of induction (reference) in the control group

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Discussion

The results of the present study showed that in the group receiving oral carbohydrates compared to the two groups of drinking water and the control group, heart rate reduction at different time points of the measurement was more than its baseline value, and this difference between the three groups was statistically significant. Also, its intra-group changes were significant in all three groups. However, there was no significant difference in the mean changes of MAP between the three groups, there was a significant difference in the reduction of its values at different time points compared to the baseline in all three groups. In other words, carbohydrate intake before surgery provides more stable hemodynamics.

In a number of studies, the effect of preoperative carbohydrate intake on hemodynamic parameters in adults in other surgeries such as laparoscopic cholecystectomy and gastrointestinal surgeries has been investigated (10, 14, 17). In line with the results of the present study, in the study of Lee et al., it was shown that the control group (the group that had fasting before surgery) had a higher heart rate during surgery compared to the group that received carbohydrates and drinking water, while the MAP changes were not significant between the three groups (17). The study of Li et al. showed that the incidence of hypotension during surgery in the carbohydrate receiving group was significantly lower than the control group (10). In a study conducted by Kukliński et al. with the aim of investigating the effect of oral carbohydrate on hemodynamic parameters in healthy volunteers, it was shown that carbohydrate intake had no significant effect on hemodynamic parameters in healthy individuals (18). In a study, it was shown that reducing preoperative fasting time with a carbohydrate-rich drink improved postoperative metabolic and inflammatory responses in children undergoing inguinal hernia surgery (12). In the study of Karami et al., it was shown that the intake of oral carbohydrates 2 hours before anesthesia leads to a decrease in restlessness and improvement in awakening from anesthesia in children undergoing hernia surgeries (16).

In this study, although the blood sugar level before induction of anesthesia (baseline) in the group receiving oral carbohydrates was higher than the other two groups, during surgery and recovery, its changes were small compared to the baseline value and these changes were not statistically significant; the patients in the drinking water and control groups had lower blood sugar levels before induction of anesthesia, and they had a sudden and higher increase during surgery and recovery compared to the baseline and compared to the oral carbohydrate group. In line with the results of the present study, it was shown in a study that the blood sugar level in the 90th minute after surgery in patients of the control group was significantly higher than the group receiving carbohydrates (19). In the study of Rajan et al., it was shown that blood sugar changes in the group that received carbohydrates were small during surgery, and the control group had significantly higher blood sugar one hour after the beginning of surgery (11). In the study by Breuer et al. about the effect of oral carbohydrates in patients who were candidates for elective heart surgeries, blood sugar levels did not differ between the two carbohydrate and control groups (20). Therefore, oral carbohydrate can effectively improve the symptoms of hypoglycemia caused by prolonged fasting, and there is no risk of a sudden increase in blood sugar due to excessive consumption of sugary substances (21). Preoperative oral carbohydrate intake improves insulin sensitivity and shortens the time of bowel function return without increasing gastric volume or acidity compared to preoperative fasting (22). This study was conducted as an intervention with a control group with a large sample size, and considering that few studies have been conducted on the effect of oral carbohydrates before surgery in children undergoing inguinal surgeries, it seems necessary to conduct more studies in this area.

The results of this study showed that the consumption of oral carbohydrates before surgery in children undergoing inguinal surgeries can lead to lower heart rate and mean arterial pressure and, as a result, more stable hemodynamics in patients. Although the blood sugar level during induction of anesthesia in the group receiving oral carbohydrates was higher than the other two groups, but during surgery and recovery, its changes were small compared to the baseline value. Nevertheless, the patients in the drinking water and control groups, despite having a lower blood sugar level at the time of induction of anesthesia, had a sudden and higher increase compared to the oral carbohydrate group, which can cause metabolic conditions and delay in recovery.

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