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Original Article

Evaluation of the Effect of Preoperative Carbohydrate-Rich Fluid Administration on Gastric Volume With Ultrasound in Pediatric Patients

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Keywords

Gastric ultrasonography, gastric volume, pediatric anesthesia, postoperative nausea and vomiting, oral carbohydrate

Abstract

Background: *Preoperative fasting strategies in pediatric patients aim to avoid the negative situations that will be caused by long fasting periods and to prevent the complications that will be caused by inappropriate fasting periods.*

The gastric emptying time of clear liquids is mainly determined by the caloric content and volume. This study aimed to investigate whether the gastric emptying time of apple juice is shorter than that of water due to its caloric content by gastric ultrasonography.

Method: *A total of 70 pediatric patients who were planned for elective surgery by pediatric surgery, who met the inclusion criteria and whose ages ranged from 4 to 18 were included in the study. The patients were randomly divided into two groups. The water group (n=35) and the apple juice group (n=35) were given 5 ml* kg^{-1} *water and apple juice orally 2 hours before the surgical operation. Gastric volume measurements were performed on the patients by ultrasonography after a 6-hour fast (baseline value), 1 hour and 2 hours after drinking water or apple juice.*

Results: *Water and apple juice were not superior to each other in reducing residual gastric volume after 1 or 2 hours according to the basal volume value in measurements made in both supine and right lateral dekubitis positions. In RLD position measurements, we showed that giving 5ml* kg^{-1} *carbohydrate-rich fluid preoperatively reduced residual gastric volume at the 2nd hour.*

Conclusion: *Water and apple juice were not superior to each other in reducing the residual gastric volume after 1 or 2 hours in measurements according to the basal volume value.*

Introduction

In pediatric patients, active vomiting or passive regurgitation episodes after loss of airway protective reflexes during general anesthesia applications result in pulmonary aspiration. Therefore, clear liquid fasting period is tried to be reduced to the minimum period that will not threaten patient safety. ESA 2022 preoperative fasting guideline recommends pediatric patients to drink clear liquids up to the last 1 hour. Calorie and volume of the fluid consumed affect the emptying time. Although there are physiological data supporting preoperative carbohydrate drinks, studies investigating the type of drink and its clinical effect in children are limited. The gastric emptying rate for carbohydrate drinks depends on the volume, caloric content and osmolality of the fluid consumed. The gastric emptying rate varies for different types or forms of carbohydrates (maltodextrin, starch), even if they are isocaloric. For example, gastric emptying is faster for a fructose solution compared to isocaloric glucose and galactose solutions. A maltodextrin or sucrose solution empties more rapidly than a glucose solution. This is probably due to the intensity of inhibitory feedback caused by glucose entering the duodenum. In addition, fruit juices contain soluble fibers that modulate gastric emptying[1]. Studies comparing clear liquids given preoperatively are limited. In this study, we aimed to compare the effects of apple juice compared to water on reducing residual gastric volume in pediatric patients via gastric ultrasonography (GUS).

Materials and Methods

The study was approved by the Mersin University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee with the decision numbered 78017789/050.01.04/193135 dated 23/02/2022. It was planned to include 70 patients who met the inclusion criteria. The study design is a randomized controlled clinical trial.

Patients between the ages of 4-18, ASA I-II, and who had completed 6 hours of preoperative fasting, who were scheduled for elective lower abdominal surgery or urogenital surgery between 01.02.2022 and 01.02.2023 in the Pediatric Surgery Clinic, were included.

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Patients with oral intake disorder, gastroesophageal reflux disease, a disease affecting gastric emptying, patients receiving antiemetic treatment, and those who did not sign the informed consent form were excluded.

Anesthesia Management

All patients received general anesthesia. In patients with preoperative vascular access, Tiopental 5mg kg^{-1} iv (intravenous), Fentanyl 1mcg kg-1 iv and Rocuronium 0.6 mg kg-1 iv were administered for anesthesia induction. Mask ventilation was applied with a tidal volume of 6-8ml/kg given with an inspiratory pressure below 15 cm H2O. Anesthesia was maintained with Sevoflurane 1.3 MAC and 50% oxygen/nitrogen mixture. Paracetamol 10mg/kg was administered intravenously as an analgesia method half an hour before the end of the operation to patients with no contraindications. Local anesthetic infiltration was performed on appropriate patients before skin suturing. Neostigmine 0.05 mg kg-1 iv and atropine 0.015 mg kg-1 were administered to reverse neuromuscular blockade at the end of the surgery.

USG Evaluation Method

The anesthesiologist who will perform USG on the patients has experience in using USG in anesthesia practices (at the certification level), and in addition, he/she started the study by receiving 1-week theoretical and practical training on gastric USG in the Radiology clinic. USG was performed on all patients by the same anesthesiologist. Our study was designed with a blind technique so that the anesthesiologist who performed the USG measurement would not know which beverage the patient was drinking. The measurements were performed in the operating room pediatric preparation room with the parent's supervision. After 6 hours of fasting, 2 hours before surgery, the patients were randomly given 5ml kg-1 water or apple juice without particles (Dimes® 100% apple juice 48kcal energy, 11.5g carbohydrate) stored at +4 degrees. After 6 hours of fasting, volume 0 was measured as a basal assessment before drinking beverages, volume I was measured 1 hour after drinking apple juice or water, and volume II was measured 2 hours later (before anesthesia induction).

The gastric antrum and epigastric region were evaluated with ultrasonography (Esaote My Lab X7, which has a linear high-frequency (10–18 MHz) probe). The gastric antrum image was obtained in the sagittal or parasagittal plane as a superficial, hollow internal organ between the left lobe of the liver and the pancreas, in the upper part of the aorta or inferior vena cava. The epigastric region was scanned widely from the subcostal edge from left to right in the sagittal or parasagittal plane under the xiphoid and the transducer was scanned from left to right to image the stomach. The fluid in the USG imaging was interpreted as gastric secretions and clear fluids based on whether the image was anechoic or hypoechoic. Cross-sectional antral measurement was performed for quantitative evaluation. A motionless image was obtained when the antrum was immobile between peristaltic contractions. Antral cross-sectional area (CSA) was measured using the ultrasound cursor and including all layers of the stomach wall (serosa to serosa). Antral cross-sectional area in square centimeters was obtained by multiplying the anteroposterior and craniocaudal diameters by π and dividing by four. To calculate gastric volume in ml per kg, the calculated antral cross-sectional area was converted to square millimeters and adapted to the following formula developed by Adam O. Spencer, which included the patient's age in months[2].

CSA (cm^2) = anteroposterior diameter X craniocaudal diameter X π /4

Gastric volume ($ml.kg^{-1}$) = [-7.8 + 0.035 X CSA (mm^2) +0.127 X age (in months)] / kg

Bedside examination findings were recorded in writing on a form paper.

Statistical Method

The study of Song et al. titled 'Ultrasound assessment of gastric volume in children after drinking

carbohydrate-containing fluids' was examined by taking the effect size from the study titled "Evaluation of the Effect of Preoperative Carbohydrate-Rich Fluid Administration on Gastric Residual Volume in Pediatric Patients with the Help of Ultrasonography" and assuming that a medium level effect size (effect size=0.48x difference is accepted in the averages of the parameters, the sample size was calculated as 70 patients in total at 95% Power with an alpha significance level of 0.05.

The sample size was calculated with the G*Power Version 3.1.9.2 program. SPSS

28.0 for Windows program was used for statistical analysis. Mean, standard deviation, median lowest, highest, frequency and ratio values were used in the descriptive statistics of the data. The distribution of variables was measured with the Kolmogorov Simirnov test. In the analysis of quantitative independent data, 41 independent sample t test, Mann-Whitney u test was used. The Wilcoxon test was used in the analysis of

Table 1. *Comparison of Gastric Volume Measurements in the Supine Position Between Groups*

	Water Group		Apple Juice Group		p
	Ort.±ss	Medyan	Ort.±ss	Median	
SUPİNE					
Volume 0	0.54±0.2	0.51	0.4±0.13	0.38	0.001m
Volume I	0.54±0.21	0.56	0.42±0.15	0.4	0.008m
Volume II	0.52±0.21	0.49	0.39±0.14	0.38	0.013m
Change According to Volume 0					
Volume 0/Volume I change	0±0.17	0.01	0.02±0.11	0.03	0.414
Intra-group change p	0.844W		0.293W		
Volume 0/Volume II change	-0.03±0.18	-0.03	-0.01±0.11	-0.02	0.304
Intra-group change p	0.118W		0.837W		

mMann-whitney u test / wWilcoxon test

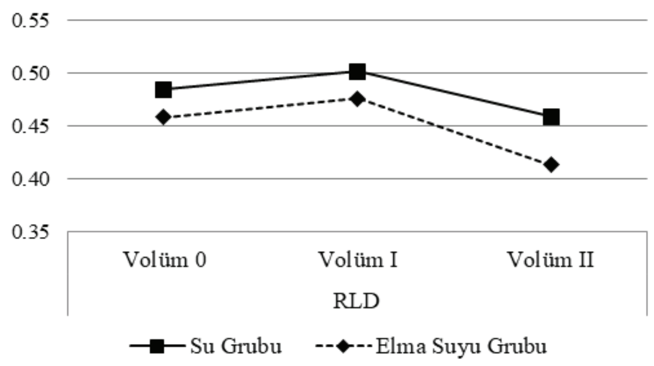

Figure 1. Comparison of Gastric Volume in RLD Position

dependent quantitative data. The chi-square test was used in the analysis of qualitative independent data, and the Fischer test was used when the chi-square test conditions were not met. Mc Nemar test was used in the analysis of dependent qualitative data. Mann-Whitney u test / Wilcoxon test was used for gastric volume evaluations. In all tests, statistical significance level was accepted as $p<0.05$.

Results

A total of 70 patients were included in the study, 35 in each group.

There was no significant difference ($p>0.05$) in age and gender distribution between the water and apple juice drinking groups.

There was no significant difference ($p>0.05$) in Volume 0/ Volume I and Volume 0/Volume II changes between the water and apple juice drinking groups in the supine position.

There was no significant difference ($p<0.05$) in volume 0, volume I, volume II RLD values between the water and apple juice drinking groups. There was no significant change ($p>0.05$) in volume I, volume II RLD values in the water drinking group compared to volume 0. There was no significant change ($p>0.05$) in volume I RLD values in the apple juice drinking group compared to volume 0. There was no significant difference ($p>0.05$) in volume 0/ volume I and volume 0/ volume II RLD values between the water and apple juice drinking groups.

There was a significant decrease ($p>0.05$) in volume II RLD values in the apple juice drinking group compared to volume 0.

Conclusion

In our study, we compared the effects of apple juice given to pediatric patients in the preoperative period compared to water on reducing the residual gastric volume using GUS. As a result, we found that water and apple juice were not superior to each other in reducing the residual gastric volume after 1 or 2 hours in measurements made in both positions according to the basal volume value. However, we showed that giving preoperative carbohydrate-rich fluids reduced the 2nd hour residual gastric volume in RLD position measurements. We also showed that reducing the preoperative clear fluid fasting period from 2 hours to 1 hour did not cause a significant change in gastric volume.

The time for emptying clear fluids from the stomach in children is largely determined by the calories, volume and time of administration of the fluids given. Although it is stated that factors such as temperature, pH value and osmolality of the fluids are also effective in gastric emptying, they do not create a clinically significant difference[3].

Basically, it has been shown that the gastric emptying time for clear liquids in children depends on the caloric content of the studied liquid. Most of the studies examining the effects of energy content on gastric emptying have used carbohydrate solutions. There are different opinions about the relationship between carbohydrate content and gastric emptying. It is thought that solutions with a carbohydrate content of less than 2.5% empty from the stomach at the same rate as an equal volume of water. If the carbohydrate content is above 6%, there is a significant decrease in gastric emptying. However, in some studies, no difference has been observed between liquids with a carbohydrate content of 10% and water in terms of gastric emptying rate[4]. The caloric content of the apple juice we used in the study was 48kcal/100ml and the carbohydrate content was 11.5g/100ml. In our study, no difference was observed in terms of gastric emptying rate, although the carbohydrate content was above 10%.

Gastric volume decreases in children who are given a carbohydrate drink 2 hours before the preoperative period. We believe that our study objectively demonstrates this claim using GUS. While there was no significant change in the 1st and 2nd hour gastric volume values for water, it was observed that the gastric volume showed a significant decrease compared to the basal value in the measurements made in the RLD position at the 2nd hour for apple juice. Similar to our study, Song et al. showed that carbohydrate-containing liquids taken 2 hours before surgery reduced the stomach volume before anesthesia induction[5].

If we examine the effect of volume on gastric emptying, the emptying half-life is similar to some extent for different volumes of liquids with the same caloric density. In our study, 5 ml kg-1 volume was used and no significant change was detected in gastric volume compared to the basal value in the measurements made 1 hour later. A decrease in gastric volume compared to the basal value was detected in those who drank apple juice in the RLD position at the 2nd hour. In a study conducted with healthy volunteer children, 3 ml kg-1 of carbohydrate-containing liquid was given to one group and 7 ml kg-1 to the other group after fasting overnight. 60 minutes after liquid intake, gastric volume was found to be significantly lower in the 3 ml kg-1 group and was observed to be close to the basal values[6]. In a study conducted by Taye et al., 3 ml kg-1 clear liquid was compared with 5 ml kg-1 clear liquid and they showed that 5 ml kg-1 volume resulted in similar residual gastric volume as 3 ml kg-1 volume[7]. As the results obtained in our study show, it was determined that giving 5ml kg-1 volume of carbohydrate-rich fluid did not cause a significant change in gastric volume within 1 hour. However, further studies are needed for the ideal volume value.

The caloric content of carbohydrate-containing liquids affects gastric emptying time. A study conducted with healthy volunteer children aged 8-14 found that gastric emptying times for apple juice ranged from 90 to 180 minutes. However, in this study, patients were given 296 ml of the drink. This means a very high volume of 10 ml kg-1 for some subjects [8]. In a study conducted by Okabe et al. on adult volunteers, the gastric emptying time for a 100 kcal glucose solution was found to be 50-80 minutes, while for water it was found to be 30-50 minutes [9]. Since the caloric content of the apple juice we used in the study was 48 kcal/100 ml and we used it in a volume of 5 ml/ kg, the fact that the children who drank approximately 200 ml or less of apple juice emptied their stomach contents after 50-80 minutes and that there was no significant difference in the 1st hour gastric volume measurement supports this.

Another factor affecting gastric emptying is the time of oral administration of fluids. Guidelines regarding the timing of administration of clear fluids encourage administration 1 hour before. (Level of evidence 1C) However, evidence regarding changes in gastric volume when preoperative clear fluid fasting is reduced to less than 2 hours is inconsistent. When the fasting period is less than 2 hours, gastric fluid volume increases exponentially, making it difficult for the stomach to empty adequately in the first hour, especially when large volumes are administered. In our study, fluids were administered to patients 2 hours before anesthesia following a 6-hour solid food fast. In our study, in the group that received both apple juice and water 54 , 1-hour and 2-hour gastric volume values did not show any significant change compared to baseline values. In a study conducted by Schmidtz et al., stomach contents were sampled from children undergoing elective surgery under general anesthesia using an oro-gastric tube in the supine, left and right lateral patient positions and it was concluded that 1 hour of clear liquid fasting did not significantly change gastric pH or residual volume compared to 2 hours of fasting[10]. In our study, the absence of a significant difference between the 1st and 2nd hour gastric volume measurements supports the 1-hour clear liquid fasting period.

In children, GUS is performed in the supine and right lateral decubitus positions. In our study, gastric volume according to weight was measured in both positions. No significant difference was observed between the mean gastric volume values in the supine and RLD positions. In a study by Schmitz et al., gastric volume measurements in the supine and RLD positions were compared and the correlation between total gastric volume and gastric volume according to weight was found to be the best in the RLD position. In the study, the gastric antral area was found to be significantly larger in the RLD position. It was thought that this could be explained either by the predominant expansion of the antrum of the stomach and intragastric volume shift or by the effect of gravity through intra-abdominal transposition of the stomach[11]. In our study, there was no difference between the supine and RLD position measurements in terms of gastric volume according to weight. Due to the low gastric volumes, there was no intragastric volume shift in the RLD position, therefore, we may have obtained similar results to the supine position measurements.

References

1. Moukarzel AA, Sabri MT. Gastric physiology and function: effects of fruit juices. J Am Coll Nutr. 1996;15(5 Suppl):18S-25S.
2. Spencer AO, Walker KJ, Anand KJS, et al. Reply to Schmitz et al. regarding "Ultrasound assessment of gastric volume in the fasted pediatric patient undergoing upper gastrointestinal endoscopy: development of a predictive model using endoscopically suctioned volumes". Paediatr Anaesth. 2016;26(6):672-673.
3. Leiper JB. Fate of ingested fluids: factors affecting gastric emptying and intestinal absorption of beverages in humans. Nutr Rev. 2015;73(Suppl 2):57-72.
4. Okabe T, Terashima H, Sakamoto A. Determinants of liquid gastric emptying: comparisons between milk and isocalorically adjusted clear fluids. Br J Anaesth. 2014;114(1):77-82.
5. Song IK, Kim HJ, Lee JH, et al. Ultrasound assessment of gastric volume in children after drinking carbohydrate-containing fluids. Br J Anaesth. 2016;116(4):513-517.
6. Schmitz A, Bevot A, Schmidt AR, et al. Effect of different quantities of a sugared clear fluid on gastric emptying and residual volume in children: a crossover study using magnetic resonance imaging. Br J Anaesth. 2012;108(4):644-647.
7. Taye S, Girdhar KK, Sethi A, et al. Gastric emptying time of two different quantities of clear fluids in children: a double-blinded randomized controlled study. Paediatr Anaesth. 2021;31(11):1187-1193.
8. Du T, Zhu Y, Zhang J, et al. Gastric emptying for liquids of different compositions in children. Br J Anaesth. 2017;119(5):948-955.
9. Okabe T, Terashima H, Sakamoto A. A comparison of gastric emptying of soluble solid meals and clear fluids matched for volume and energy content: a pilot crossover study. Anaesthesia. 2017;72(11):1344-1350.
10. Schmidt AR, Buehler PK, Schmitz A, et al. Gastric pH and residual volume after 1 and 2 h fasting time for clear fluids in children. Br J Anaesth. 2015;114(3):477-482.
11. Schmitz A, Schmidt AR, Buehler PK, et al. Ultrasonographic gastric antral area and gastric contents volume in children. Paediatr Anaesth. 2012;22(2):144-149.