

PAEDIATRICS

Ultrasound assessment of gastric volume in children after drinking carbohydrate-containing fluids

I.-K. Song, H.-J. Kim, J.-H. Lee, E.-H. Kim, J.-T. Kim and H.-S. Kim*

Department of Anesthesiology and Pain Medicine, Seoul National University Hospital, #101 Daehak-ro, Jongno-gu, 03080, Seoul, Republic of Korea

*Corresponding author. E-mail: dami0605@snu.ac.kr

Abstract

Background: Gastric ultrasound is a valid tool for non-invasive assessment of the nature and volume of gastric contents in adults and children. Perioperative fasting guidelines recommend oral carbohydrates up to 2 h before elective surgery. We evaluated gastric volume in children using ultrasound before and after drinking carbohydrate fluids before surgery.

Methods: Paediatric patients younger than 18 yr old undergoing elective surgery were enrolled. Initial ultrasound assessment of gastric volume was performed after fasting for 8 h. Two hours before surgery, patients were given carbohydrate drinks: 15 ml kg⁻¹ for patients younger than 3 yr old and 10 ml kg⁻¹ for those more than 3 yr old. Before induction of general anaesthesia, the gastric volume was reassessed. Parental satisfaction scores (0=totally satisfied, 10=totally dissatisfied) and complications were recorded.

Results: Of the 86 enrolled patients, 79 completed the study; three refused to ingest the requested volume, and surgery was delayed for more than 2 h in four patients. The mean (SD) of the initial and second ultrasound measurements were 2.09 (0.97) and 1.85 (0.94) cm², respectively ($P=0.01$; mean difference 0.24 cm², 95% confidence interval 0.06–0.43). The median (interquartile range) satisfaction score was 2.4 (0–6). Two instances of postoperative vomiting and one instance of postoperative nausea occurred.

Conclusions: Carbohydrate fluids ingested 2 h before surgery reduced the gastric volume and did not cause serious complications in paediatric patients. Parents were satisfied with the preoperative carbohydrate drink. Children may benefit from drinking carbohydrate fluids up to 2 h before elective surgery.

Clinical trial registration: cris.nih.go.kr (KCT0001546).

Key words: anaesthesia, paediatric; measurement techniques, ultrasound; metabolism, fasting; surgery, preoperative period

Editor's key points

- Gastric content volume can be estimated by ultrasound measurement of antral cross-sectional area.
- European guidelines promote the intake of carbohydrate-containing drinks during preoperative fasting.
- The authors measured antral area in children given a carbohydrate drink 2 h before surgery.
- Antral area was smaller before induction of anaesthesia than it was before the carbohydrate drink.

Gastric ultrasound (US) is a valid, reliable tool for non-invasive bedside assessment of the nature and volume of gastric contents in both adults and children.^{1–5} Several studies have suggested that the cross-sectional area of the gastric antrum can predict gastric fluid volume.^{2–4} There is a linear correlation between the antral cross-sectional area and gastric volume, with Pearson correlation coefficients ranging from 0.6 to 0.91.^{3 4 6–9}

Preoperative fasting guidelines are designed to reduce the risk of complications related to the perioperative regurgitation and aspiration of gastric contents, while enhancing the quality and efficiency of anaesthesia care. Current practice guidelines for

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preoperative fasting in children and infants recommend the following: at least 2 h of fasting for clear liquids, including water, pulp-free juice, or tea; 4 h for breast milk; 6 h for infant formula, non-human milk, and light meals; and 8 h for solids.^{10–11} However, children still undergo prolonged preoperative fasting for various reasons, including communication problems, organizational delay, or not being woken for a drink in the morning.^{12–14} Prolonged fasting does not further reduce gastric volume or increase safety, but rather leads to unnecessary discomfort for children and their caregivers.¹²

The perioperative fasting guidelines of the European Society of Anaesthesiology¹¹ focus on preoperative carbohydrates. They hold that it is safe for patients to drink carbohydrate-rich fluids up to 2 h before elective surgery and that drinking carbohydrate-rich fluids improves subjective well-being, reduces thirst and hunger, and reduces postoperative insulin resistance at an evidence level of 1⁺⁺. Nevertheless, these recommendations are for adults, and data on drinking carbohydrate fluids before surgery in children are limited.

Preoperative carbohydrates are a good option for paediatric patients because children are vulnerable to dehydration, and prolonged fasting may cause unexpected perioperative events, including hypoglycaemia and hypotension.^{15–16} The purpose of this study, therefore, was to assess gastric volume in fasted children using US before and after they drank carbohydrate fluids before surgery.

Methods

The study was approved by the Seoul National University Hospital Institutional Review Board (July 14, 2014/No.1404-123-575). After obtaining written informed consent from the parents or legal guardians, paediatric patients younger than 18 yr who were to undergo elective otolaryngological, orthopaedic, ophthalmological, plastic, or urological surgery under general anaesthesia and who had fasted for more than 8 h were enrolled prospectively. Only those who were admitted before the day of surgery were included in order to control the fasting status of the patient strictly. Patients with a history of oesophageal or gastric surgery or gastrointestinal disorders (including gastro-oesophageal reflux, hiatal hernia, or gastritis) were excluded. The study was registered at <http://cris.nih.go.kr> (KCT0001546).

On the day of surgery, every patient was visited by the same anaesthetist three times. After fasting for 8 h, an initial US assessment of gastric volume (fasting) was performed. Two hours before the surgery, the patients were given a carbohydrate drink (Nuicare NoNPO[®]; Daesang Wellife, Seoul, Republic of Korea) according to their age; 15 ml kg⁻¹ for patients younger than 3 yr old, and 10 ml kg⁻¹ for those more than 3 yr old. Immediately before general anaesthesia was induced, second US assessment of gastric volume (after drinking) was performed.

The US assessments of gastric volume were carried out by the aforementioned anaesthetist, who was instructed and supervised by an experienced radiologist, using the Logiq[®] e US (GE Healthcare, Wauwatosa, WI, USA) with a 4 MHz convex transducer. Patients were scanned in the supine position. The gastric antrum was imaged in a sagittal or parasagittal plane between the left lobe of the liver and pancreas, at the level of the aorta or inferior vena cava. The transducer was tilted and rotated perpendicular to the long axis of the antrum to obtain a true cross-sectional view of the antrum. The cross-sectional area of the antrum was measured using the traditional two-diameter method.² This involves measuring two orthogonal diameters of the antrum (Fig. 1) and calculating the antral area, assuming that the antrum

has a perfect elliptical shape, using the following standard formula for the surface area of an ellipse: $CSA = (AP \times CC \times \pi) / 4$, where AP and CC are the anteroposterior and craniocaudal diameters, respectively. Measurements were always made from the outer layer of the gastric wall, and all images were obtained between peristaltic contractions. Given that using three images per data point has been a standard practice in gastric sonography,^{3–4} we acquired three measurements and used average values.

After the patient entered the operating room, the parents were asked about their satisfaction with the preoperative carbohydrate drink. Responses were scored from 0 to 10, with 0 being totally satisfied and 10 being totally dissatisfied. All patients underwent a standardized general anaesthetic protocol that included induction with atropine 0.02 mg kg⁻¹ and propofol 2 mg kg⁻¹, neuromuscular block with rocuronium 0.6 mg kg⁻¹, and maintenance with desflurane or sevoflurane and an air-oxygen mixture. An i.v. route was established before bringing the patient to the operating room. The surgery proceeded according to pre-existing plans based on standard clinical practice. Complications, such as perioperative nausea, vomiting, and aspiration, were recorded. If the patient had a postoperative chest X-ray, official findings were recorded in search of evidence for aspiration.

Sample size was calculated based on our pilot study measuring the gastric volume of 10 paediatric patients after they had fasted for 8 h and again 2 h after they had ingested a carbohydrate drink. The mean gastric volumes after 8 h fasting and at 2 h after consuming the drink were 2.12 (0.95) and 1.87 (0.92) cm², respectively, for an effect size of 0.27. To achieve a power of at least 80% using Student's paired t-test at a significance level of 0.05 and a dropout rate of 10%, at least 87 patients were needed.

All data are expressed as the mean (SD) unless otherwise specified. Student's paired t-test or Wilcoxon signed rank test was used to compare normally distributed or non-normally distributed continuous variables. Pearson correlation analysis was used to evaluate correlations among age, height, weight, and the volume of the carbohydrate drink and the gastric volume. A P-value <0.05 was considered statistically significant. Statistical analysis

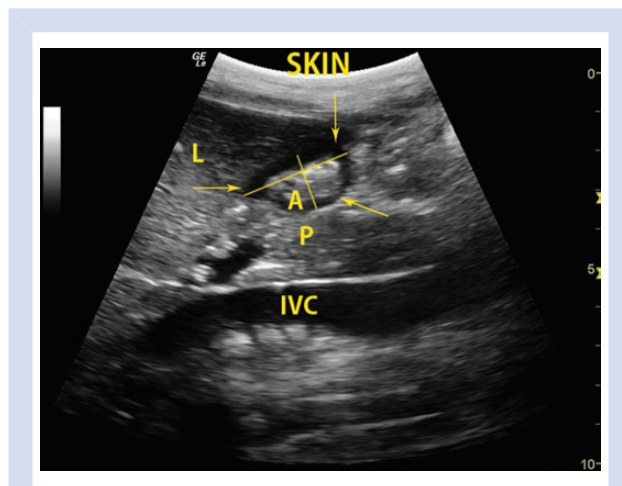


Fig 1 Ultrasound image of the gastric antrum in the epigastric area obtained in a sagittal or parasagittal plane. The arrows indicate the gastric antrum, which appears empty and small, with no distinguishable contents. Two perpendicular lines represent the anteroposterior and craniocaudal diameters measured from serosa to serosa, used for the calculation of area that assumes the antral cross-section is an ellipse. A, antrum; IVC, inferior vena cava; L, liver; P, pancreas.

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