Original Article

Safety and benefit of pre-operative oral carbohydrate in infants: a multi-center study in China

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Background and Objectives: Pre-operative oral carbohydrate administration (POCA) is an important aspect of enhanced recovery after surgery and has many advantages. The objective of this study was to explore the safety and effect of pre-operative oral carbohydrate administration in infants. **Methods and Study Design:** This was a prospective, multi-center, randomized study that randomly assigned 1200 infants into four groups. In the control group (group A), the infants were strictly restricted to 6-h preoperative fasting before anesthesia. In the enhanced recovery after surgery (ERAS) groups (groups B, C, and D), the infants were orally administered a 10% carbohydrate solution (10% glucose water; 5, 10, and 15 mL/kg, respectively) 2 h before anesthesia. Blood glucose, gastric residual volumes, crying ratios, and the length of hospital stay were observed. **Results:** The blood glucose was significantly higher in groups B, C, and D than group A at the time of anesthesia. The gastric residual volume revealed virtually no residue in groups A, B, and C, but 15 infants in group D had a gastric residual volume. The crying ratio was significantly higher in group A. The length of hospital stay was not significantly different between the groups. **Conclusions:** POCA is well-tolerated in infants at a dose of 10 mL/kg.

Key Words: enhanced recovery after surgery, preoperative oral carbohydrate, infants, blood glucose, gastric residual

INTRODUCTION

Kehlet and Wilmore[1] were the first to describe rapid rehabilitation after surgery. Since the turn of the century, the concept of enhanced recovery after surgery (ERAS) or rapid post-operative rehabilitation has been standardized.[2] ERAS is a combination of pre-, peri-, and post-operative measures in an attempt to accelerate post-operative recovery, and reduce the surgical stress response, post-operative morbidity, length of hospital stay, and complications.[3-10] ERAS mainly includes pre-operative oral carbohydrate administration (POCA), limited peri-operative fasting, early enteral intake, early mobilization, and limited use of surgical drains and tubes.[11-15]

POCA is an important aspect of the ERAS program, which appears to have many advantages.[16,17] The conventional approach entails long periods of fasting, thus liquid or solid intake is prohibited 6–8 h before a planned procedure. This long fasting time has recently been questioned in favor of breaking the fast by POCA, which is more comfortable for the patients.[18]

POCA has gradually been applied to adult surgery. Recently, many articles have been published on POCA in adult surgical populations, such as elective abdominal surgery,[19] cardiac surgery,[20] thyroidectomy,[21] and orthopedic surgery.[22,23] Despite its many benefits, POCA has not been universally adopted in pediatric surgery. Moreover, POCA data from pediatric populations is limited. The use of POCA in pediatric surgery is still in the initial stages and is in need of additional research.

The objective of this study was to explore the safety and benefit of POCA in the pediatric population, and the effect of POCA on pre- and peri-operative blood glucose in infants.

METHODS

Patients

This was a prospective, multi-center, randomized study. We studied consecutive patients who underwent surgery in the Department of Pediatric Surgery at Children's

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Manuscript received 29 December 2017. Initial review completed 28 February 2018. Revision accepted 07 April 2018.
doi: 10.6133/apjcn.052018.08

Hospital of Nanjing Medical University, Anhui Provincial Children's Hospital, Xuzhou Children's Hospital, Children's Hospital of Soochow University, Changzhou Children's Hospital, and Wuxi Children's Hospital between 1 March 2014 and 31 January 2017. The inclusion criteria were an infant who could eat normally before the operation, such as a patient with Hirschsprung's disease, sacrococcygeal teratoma, biliary atresia, or undergoing second stage operation for congenital anus atresia. The exclusion criteria were patients with emergency ileus, enterobrosis, or neonatal necrotizing enterocolitis.

The study was approved by the Ethics Committee of Children's Hospital affiliated with Nanjing Medical University (201601005-1.1, 201701025), multi-center research registration number (NCT02776176). Informed consent was obtained from the parents of all children, and the study was conducted in accordance with the Declaration of Helsinki.

Peri-operative care

The 1200 infants were randomly assigned to four groups. In the control group (group A), the patients were strict implementation of preoperative fasting at 6 hours before anaesthesia. In the ERAS groups (groups B–D), the patients were orally administered a 10% carbohydrate solution 2 h before anesthesia; in groups B, C, and D the patients received 10% glucose water at 5, 10, and 15 mL/kg, respectively.

Observation indices

The gastric juice residual was determined by preoperative gastrointestinal decompression. Blood glucose (2 h before anesthesia, at the time of anesthesia, 2 h post-operatively, and 12 h post-operatively) was determined using a glucose meter (Bayer Healthcare LLC, Mishawaka, IN, USA). Crying ratios (when the duration of crying was >15 min, or the paroxysmal crying time was >1 h) and lengths of hospital stays were also measured.

Statistical analysis

Statistical analysis was performed with SPSS software (version 20.0; SPSS, Inc., Chicago, IL, USA). A Pearson chi-square test was used to compare the crying ratio between the groups. Analysis of variance was used to compare multi-group variables.

RESULTS

Clinical characteristics

The characteristics of the patients in groups A, B, C, and D are shown in Table 1. There were no significant differences with respect to gender, age, or type of disease in groups A, B, C, and D.

Blood glucose

Blood glucose were not significantly different between the groups 2 h before anesthesia, 2 h post-operatively, and 12 h post-operatively (p>0.05), but were significantly higher in groups B, C, and D than group A at the time of

Table 1. Clinical characteristics

Characteristics	Group A (n=300)	Group B (n=300)	Group C (n=300)	Group D (n=300)	p value
Gender					0.369
Male	138	146	134	154	
Female	162	154	166	146	
Age					0.474
≤28 days	96	100	84	88	
28 days–1 year	204	200	216	212	
Disease					0.338
Hirschsprung's disease	148	162	157	152	
Sacrococcygeal teratoma	30	16	28	20	
Biliary atresia	34	30	35	44	
Congenital anal atresia	88	92	80	84	

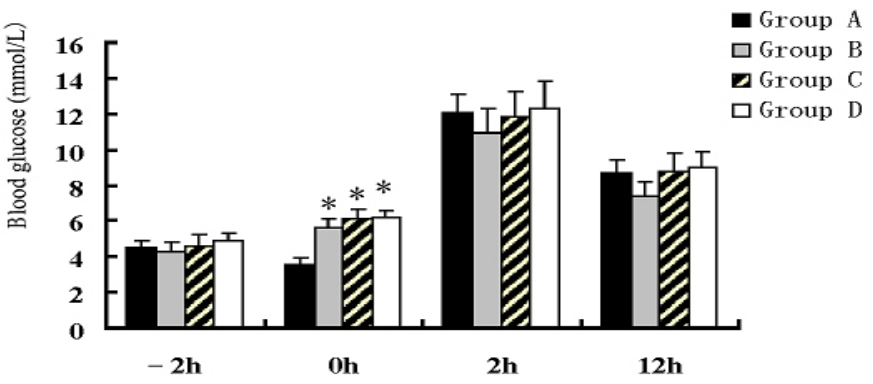

Figure 1. Blood glucose was shown 2 h before anesthesia, at the time of anesthesia, 2 h post-operatively, and 12 h post-operatively. Blood glucose was significantly higher in groups B, C, and D than group A at the time of anesthesia. ($^*p$<0.05 groups B, C, and D vs group A groups).

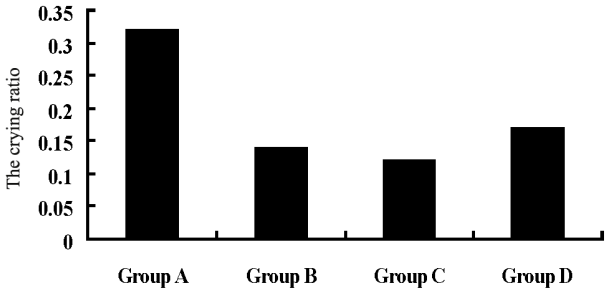

Figure 2. The crying ratio was significantly higher in group A than groups B, C, and D.

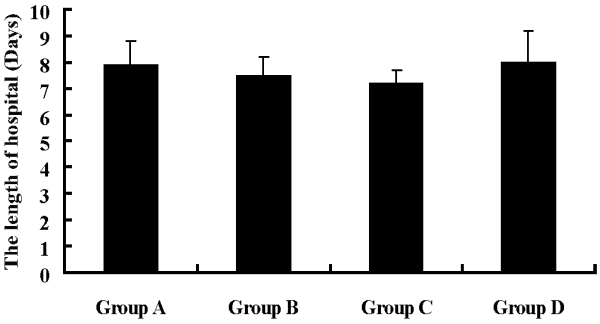

Figure 3. The length of hospital stay was not significantly different between the groups.

anesthesia (p<0.05) (Figure 1).

Gastric residual

Nearly no residue was measured in groups A, B, and C, but there were 15 patients in group D given the 10% oral carbohydrate solution with gastric residual volume.

Crying ratio peri-operatively

The crying ratio was significantly higher in group A than groups B, C, and D (p<0.05) (Figure 2).

Hospital stay

The length of hospital stay was not significantly different between the groups (Figure 3).

DISCUSSION

Following traditional surgery, patients often experience long periods of fasting, mobilization is limited, and the hospital stay is long, all of which are now gradually changing based on the concept of ERAS. Traditional thinking is that long periods of fasting reduce the risk of aspiration during surgery; however, this may let the patient feel thirst and hunger and increases anxiety and resistance to some clinically-relevant stressors which are involved in surgical stress.[24] Thus, are long periods of fasting before surgery really needed?

The typical gastric emptying time is 1.5 h, so POCA 2 h before surgery might be safe and without risk of pulmonary aspiration.[25] POCA is defined as an isotonic liquid rich in carbohydrates administered orally in the evening before surgery and 2 h before anesthesia.[26] A number of studies have demonstrated the risk of regurgitation or aspiration was no increase in POCA, so POCA is safe in adults and children.[16,27,28] In the current study involving infants, there was almost no gastric residual in the POCA-5 mL and -10 mL groups, and 5% of infants had 10% gastric residual in the POCA-15 mL group. At doses of 5 and 10 mL/kg, oral POCA did not increase gastric residuals; as a result, in this study vomiting/aspiration was not observed. Therefore, we think that 10 mL/kg is a safe dose in infants.

In adults, POCA may reduce pre-operative discomfort, such as hunger and thirst. POCA may also reduce postoperative catabolism and insulin resistance, which leads to an alleviation of metabolic stress responses, an reduced postoperative vomiting, pain, and anxiety.[29] Moreover, POCA prevents muscle loss of nitrogen and protein, and maintains nitrogen balance.[30,31] In our study, the rate of patient crying was significantly lower in the POCA groups pre-operatively. Thirst and hunger may be the main cause of crying and dysphoria, so POCA is likely to reduce thirst and hunger and reduce crying. At the same time, a reduction in crying can reduce pre-operative energy consumption. Moreover, pre-operative crying causes the accumulation of large amounts of gas in the gastrointestinal tract. During laparoscopic surgery, gastrointestinal flatulence leads to peritoneal space narrowing and will affect the surgery or interfere with the surgical procedure.

In adult studies, POCA has been shown to alter patients' metabolic state from a long-term fast, avoiding decreased glycogen reserves, which raise the body's ability to mount stressresponse.[32,33] Moreover, POCA reduces postoperative discomfort, preserves muscle and respiratory function, and accelerates the recovery process; thus, some studies have shown that POCA can reduce the number of days in hospital.[33,34] However, other studies have demonstrated that POCA had no effect on the length of hospital stays.[35-37] Based on these different points of view regarding the effect of POCA on the length of hospital stay, we studied the POCA on the length of hospital stay following pediatric surgery. The results showed that the difference in the length of hospital stay was not significant between the groups.

Blood glucose was significantly higher in the POCA group at the time of anesthesia, but was not significantly different at other time points. Therefore, POCA did not increase the post-operative blood glucose. Peri-operative trauma, stress, and long fasting can cause metabolic disorders, blood glucose fluctuation, and POCA can reduce blood glucose fluctuation before and during surgery, and reduce metabolic abnormalities. These indicators had significant changes in the peri-operative period of adults, but some indicators were not significantly changed in infants. Perhaps it is time for a change, as we have demonstrated that POCA will benefit infants.

In conclusion, POCA in infants is well tolerated at a dose of 10 mL/kg and was not associated with increased risks of vomiting/aspiration during surgery.

ACKNOWLEDGEMENTS

We thank Professor Fei Jian for providing anesthesia support.

AUTHOR DISCLOSURES

The authors declare no conflict of interest. This study was supported by the National Natural Science Foundation of China

(81100318), the Jiangsu Provincial key research and development program (BE2017609), Jiangsu youth medical talent project (QNRC2016081), and Children's Hospital of Nanjing Medical University youth medical talent project (ETYYQM2014009).

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