RESEARCH

The Comparison between Preoperative Maltodextrine and Sugar Water Administration on Random Blood Glucose Levels in Enhanced Recovery After Cesarean Surgery (ERACS) Patients

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ABSTRACT
Background: Oral carbohydrate administration reduces post-operative insulin resistance and improves post-operative recovery. Sugar water and maltodextrin are oral carbohydrates that can be given to enhanced recovery after caesarean surgery (ERACS) patients.
Objective: To compare the effect between pre-operative maltodextrin treatment and sugar water treatment on random blood glucose (RBG) levels in enhanced recovery after caesarean section (ERACS) patients.
Methods: A randomized control study with pre-test and post-test design was used on 48 patients who underwent ERACS surgery at Dr. Kariadi hospital Semarang Indonesia and met the inclusion and exclusion criteria. Study subjects were divided into two groups: a pre-operative maltodextrin treatment group (n=24) and a pre-operative sugar water control group (n=24). RBG levels were checked with point-of-care testing (POCT) at soon before surgery and at 2 hours after surgery. Mann-Whitney test was used to analyse the difference of RBG levels between group with Maltodextrin and group with sugar water. Wilcoxon test was used to analyse the difference of RBG levels before surgery (pre-operative RBG) and 2 hours after surgery (post-operative RBG). The p value of <0.05 was considered as statistically significant.
Result: There were significant lower RBG levels in group with pre-operative maltodextrin treatment compared to group with pre-operative sugar water at soon before surgery (pre-operative) (83.5 ± 9.73 vs 96.2 ± 12.99 mg/dL, p=0.003) and at 2 hours post-operative (101.7 ± 15.81 vs 118.9 ± 28.38, p=0.035) in ERACS patients.
Conclusion: If confirmed by further studies, pre-operative maltodextrin administration might provide better outcome in reducing post-operative catabolic status by reducing post-operative insulin resistance and improving RBG levels before and after ERACS compared to sugar water control.

Keywords: carbohydrate; caesarean surgery; ERACS; maltodextrin; random blood glucose

INTRODUCTION

Caesarean delivery or caesarean section is a method of delivery through an open abdominal incision (laparotomy) and an incision in the uterus (hysterotomy).[1,2] In 2011, World Health Organization (WHO) reported a 5 time increase in the number of caesarean sections compared to previous years, with an average incidence rate in each country of 5–15% per 1000 births worldwide. The caesarean birth rate in Indonesia increased from 9.8% to 17.6%.[1,2] A study shows that single-dose spinal anaesthesia is the most common type of anaesthesia chosen for elective and emergency caesarean deliveries in Indonesia.[1]

Enhanced recovery after caesarean surgery (ERACS) is a concept that combines various evidence-based aspects of perioperative care to speed up the recovery of patients who undergo caesarean section operation.[3] Recovery enhancement principles encompass the entire perioperative care pathway and component interventions occur during the pre-operative, intra-operative, and post-operative phases of care. Figure 1 showed several components of enhanced recovery protocol for caesarean delivery during the pre-operative, intra-operative, and post-operative phases of care.[3]

Elective surgery is generally performed with the patient in a fasting state which aims to reduce gastric volume during anaesthesia to prevent aspiration.[3] Fasting adds catabolic stress conditions for the patient. Both pre-operative and intra-operative fasting cause a significant decrease in insulin sensitivity. Decreased insulin sensitivity can persist for up to 5 days after major surgery and takes up to 3 weeks to completely return to normal.[3,4] The most important factor in the incidence of insulin resistance has been identified, namely hypocaloric nutrition. Decreased insulin sensitivity in peripheral tissues, especially in muscle. skeletal muscle causes decreased glucose uptake and decreased oxidative glucose utilization.[4] These changes in skeletal muscle cause decreased carbohydrate oxidation and increased fat oxidation, leading to glucose storage during fasting.[5]

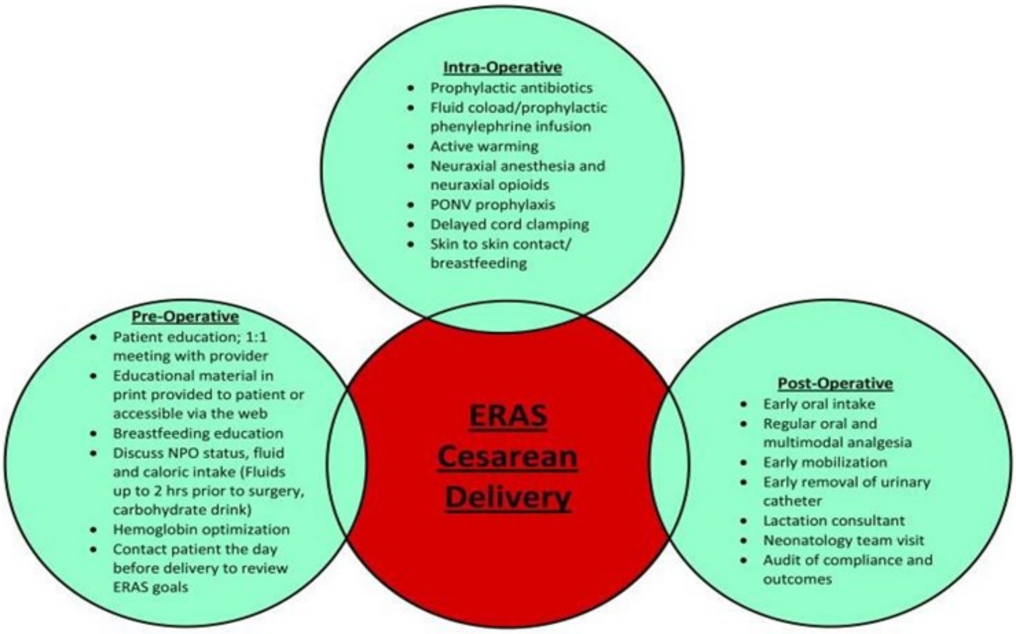

Figure 1. The Components of enhanced recovery protocol for cesarean delivery

A decrease in the inhibitory effect of insulin on protein breakdown results in a net loss of nitrogen.[4] During stressful conditions, insulin clearance also increases, further complicating the state of insulin resistance. Hormones such as cortisol, catecholamines, and glucagon are released during stressful conditions and during elective surgery that have metabolic effects opposite to insulin. All these effects lead to a state of hyperglycaemia in the patient, increased lipolysis and breakdown of amino acids, depletion of muscle mass and net nitrogen loss. These changes contribute to increased infectious complications, morbidity, mortality, and increased length of hospital stay.[4,5]

Pre-operative carbohydrate loading is known to reduce insulin resistance by up to 50% and improve metabolic function.[5] This carbohydrate administration causes an increase in insulin before or during surgery which is consistently associated with improved post-operative insulin sensitivity.[4] Increased insulin levels due to pre-operative carbohydrate loading increase the ratio of insulin: glucagon, which causes a decrease in the breakdown of body glycogen and amino acids, a decrease in the synthesis of glucose from fat or protein, and a decrease in fat oxidation, thereby preserving the body's protein and fat stores. Additionally, increasing the insulin ratio leads to increased glycogen synthesis, lipogenesis, and glycolysis.[6]

Administration of 800 ml (12.5%) of an oral carbohydrate drink (100 g) the evening before surgery and 400 ml (50 g) approximately 2–3 hours before anaesthesia was found to be equivalent to intravenous dextrose infusion in reducing post-operative catabolic status by reducing post-operative insulin resistance. Additionally, oral drinking has the benefit of being non-invasive and more convenient for the patient.[7] Evening carbohydrate loading increases glucose stores and should be initiated the evening before surgery. Intake of 400 ml of carbohydrate drink 2–3 hours before anaesthesia does not increase the acidity or volume of gastric contents and therefore does not increase the risk of aspiration pneumonia.[8]

Sugar water was used as standard treatment for the control group in this study since it was one of carbohydrate drink that had been used as a pre-operative standard of care as carbohydrate oral loading before the era of maltodextrin. Meanwhile, maltodextrin is a compound of maltose and dextrin (glucose polymer chains) made from partial hydrolysis of corn starch and has a dextrose equivalent of less than 20. Maltodextrin is often used as a carbohydrate supplement in sports nutrition in the hope of maximizing glycogen storage. Maltodextrin can provide sufficient glucose to stimulate insulin secretion to restore glycogen stores, similar to the effect of eating.[9]

Pre-operative oral carbohydrates reduce post-operative insulin resistance and improve post-operative recovery in caesarean section surgery. Based on this background, researchers aimed to know the comparison of pre-operative use of sugar water and maltodextrin on random blood glucose (RBG) levels in ERACS patient.

METHOD

This study was a randomized pre-test and post-test-controlled group study on patients undergoing elective ERACS caesarean section surgery at Dr. Kariadi hospital Semarang. This study involved 48 patients who were divided randomly into 2 groups of equal size, namely the control group that was treated with sugar water (n=24) and the treatment group that was treated with maltodextrin (n=24). All patients aged ≥18 years, with an ASA score of I–II, body mass index (BMI) 20–35 kg/m^2, body temperature ≤37.5^{o}C, and agreed to take part in this study by signing a written informed consent were included in this study. Patients with history of diabetes mellitus, thyroid disease, autoimmune disease or immunosuppressive conditions, preeclampsia or use of magnesium sulfate before surgery, corticosteroids or non-steroidal anti-inflammation medication use other than acetaminophen before surgery, and smoking were excluded from this study.

Baseline characteristics information of all study subjects were collected before surgery. Patients in the control group consumed 800 mL of sugar water (12.5 g/100 mL of simple carbohydrates) at 8 hours before surgery and 400 mL of sugar water at 2 hours before surgery. The maltodextrin treatment group received an oral iso-osmolar carbohydrate solution recommended by Enhanced Recovery After Surgery (ERAS) Society containing 12.5% maltodextrin 800 ml (100 g maltodextrin) at 8 hours before surgery, and maltodextrin 400 ml (50 g maltodextrin) at 2 hours before surgery.

All study subjects had their RBG levels checked using POCT method at soon before surgery and at 2 hours after surgery. All patients then underwent elective caesarean section surgery according to the standard protocol at Dr. Kariadi hospital Semarang.

Data were processed using the Statistical Package For The Social Sciences (SPSS) software. Categorical data were presented as proportion (frequency distributions) and percentage, meanwhile numerical data were presented as mean and standard deviations. Independent *t*-test was used to analyze the mean difference of several variables between group with sugar water and group with maltodextrin if the data were normally distributed. Non-parametric Mann Whitney test was used to analyse the difference of RBG levels between group with sugar water and group with maltodextrin since the data were not normally distributed. Wilcoxon test was used to analyse the difference of RBG levels before surgery (pre-operative RBG) and 2 hours after surgery (post-operative RBG) within groups since the data were not normally distributed. The p value of <0.05 was considered as statistically significant.

RESULT

The mean age and the mean body mass index (BMI) of all study subjects were 27.1 ± 5.72 years and 26.9 ± 1.99 kg/m^2, consecutively. There were no difference in the baseline characteristics between group with maltodextrin and that with sugar water (control) (Table 1).

There were significant differences in pre-operative RBG levels (83.5 ± 9.73 vs 96.2 ± 12.99 mg/dL, p=0.003) and in 2 hours post-operative RBG levels (101.7 ± 15.81 vs 118.9 ± 28.38, p=0.035) between group with maltodextrin treatment and group with sugar water treatment (Table 2, Figure 2). These results showed that there were significant lower RBG levels in group with pre-operative maltodextrin treatment compared to group with pre-operative sugar water at soon before surgery (pre-operative) (83.5 ± 9.73 vs 96.2 ± 12.99 mg/dL, p=0.003) and at 2 hours post-operative (101.7 ± 15.81 vs 118.9 ± 28.38, p=0.035) in ERACS patients (Table 2, Figure 2).

There were significant increases in RBG at 2 hours after surgery compared to before surgery either in group with maltodextrin treatment (101.7 ± 15.81 vs 83.5 ± 9.73, *p*=0.001) or in group with sugar water (control) (118.9 ± 28.38 vs 96.2 ± 12.99, *p*=0.003). However, the increase seemed higher in group with sugar water (control) compared to group with maltodextrin (Table 2, Figure 2).

Table 1. Baseline characteristics of all study subjects

Variables	Group with Sugar Water Treatment (n=24)	Group with Maltodextrin Treatment (n=24)	*p*	Total study subjects (n=48)
Age (years)	27.7 ± 5.70; 27.5 (20.0 – 36.0)	26.5 ± 5.79; 26.5 (18.0 – 35.0)	0.640 §	27.1 ± 5.72; 27.0 (18.0 – 36.0)
BMI (kg/m^2)	26.2 ± 2.19; 26.5 (22.8 – 29.8)	27.6 ± 1.50; 27.5 (24.2 – 29.8)	0.243 §	26.9 ± 1.99; 26.5 (22.8 – 29.8)
Systolic blood pressure (mmHg)	118.2 ± 10.56; 121.0 (99.0 – 128.0)	117.6 ± 10.31; 119.0 (92.0 – 134.0)	0.941 §	117.9 ± 10.53; 116.0 (92.0 – 134.0)
Diastolic blood pressure (mmHg)	71.1 ± 10.24; 71.0 (66.0 – 83.0)	69.7 ± 10.63; 69.0 (64.0 – 81.0)	0.342 §	70.3 ± 10.12; 70.0 (64.0 – 83.0)
Mean Arterial Pressure (mmHg)	85.1 ± 11.04; 85.0 (67.0 – 95.0]	84.5 ± 10.17; 84.0 (70.0 – 95.0)	0.761 §	84.8 ± 10.46; 84.5 (67.0 – 95.0)
Temperature (Celcius)	36.4 ± 0.35; 36.5 (36.0 – 37.0)	36.5 ± 0.18; 36.5 (36.0 – 37.0)	0.754 §	36.5 ± 0.29; 36.5 (36.0 – 37.0)
ASA Physical Status	1.5 ± 0.51; 1.0 (1.0 – 2.0)	1.6 ± 0.49; 1.0 (1.0 – 2.0)	0.973 §	1.6 ± 0.50; 1.0 (1.0 – 2.0)
8 hours pre-operative RBG levels (mg/dL)	84.1 ± 8.41; 84.0 (79.0 – 93.0)	83.8 ± 5.96; 83.0 (78.0 – 90.0)	0.392 ^^	83.9 ± 6.74; 83.5 (78.0 – 93.0)

Table 2. The comparison of random blood glucose (RBG) levels between group with maltodextrin treatment and group with sugar water treatment at soon before surgery (pre-operative) and 2 hours post-operative

	Treatment		*p* (between group with sugar water and group with Maltodextrin)	Total study subjects (n=48)
	Group with Sugar Water Treatment (n=24)	Group with Maltodextrin Treatment (n=24)		
Pre-operative RBG levels (mg/dL)	96.2 ± 12.99; 93.5 (80.0 – 118.0)	83.5 ± 9.73; 87.0 (65.0 – 98.0)	0.003 *^{M}	89.8 ± 13.03; 91.0 (65.0 – 118.0)
2 hours post-operative RBG levels (mg/dL)	118.9 ± 28.38; 106.5 (90.0 – 166.0)	101.7 ± 15.81; 98.5 (80.0 – 128.0)	0.035 *^{M}	110.3 ± 24.35; 115.0 (80.0 – 166.0)
p (between pre-operatively and post-operatively)	0.003 *^{W}	0.001 *^{W}		

Numerical data were presented as mean ± SD; median (minimum – maximum). SD: standard deviation. RBS, Random Blood Glucose.
^{M} Non-parametric Mann-Whitney test. ^{W} Wilcoxon test. *p<0.05 was considered statistically significant.

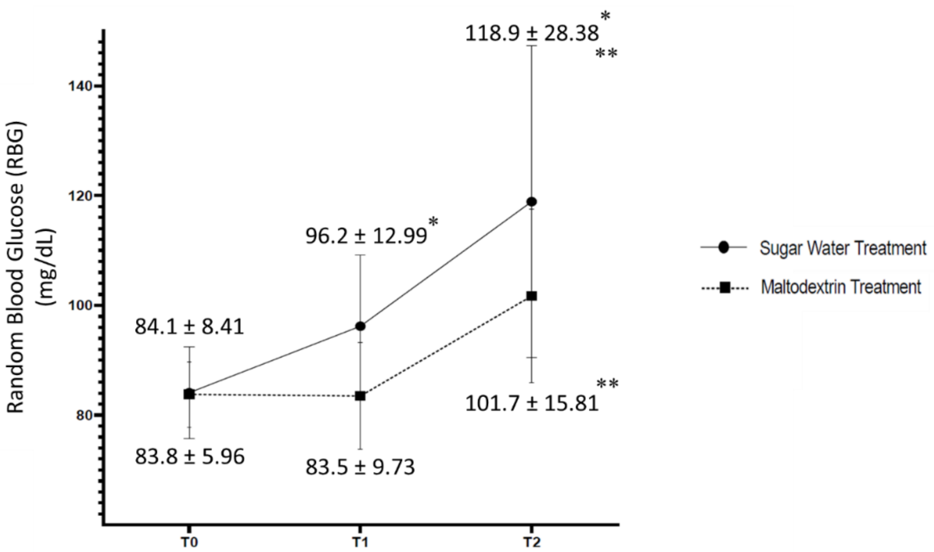

Figure 2. The comparison of random blood glucose (RBG) levels between group with maltodextrin treatment and group with sugar water treatment (control) at 8 hours before surgery (T0), at soon before surgery (pre-operative) (T1), and at 2 hours after surgery (post-operative) (T2). Numerical data were presented as mean ± SD. *p<0.05 was considered statistically significant between group with maltodextrin and group with sugar water treatment (control) by Non-parametric Mann-Whitney test. **p<0.05 was considered statistically significant between T2 and T1 as well as T2 and T0 by Wilcoxon test.

DISCUSSION

This study revealed that the use of pre-operative maltodextrin showed better results on blood glucose levels before and during ERACS surgery. These results were in line to the study by Tzeng et al.[10] in which a steady-fiber granule (SGF) solution containing maltodextrin given to the study subjects could lower their blood sugar levels. By giving this solution for 4 weeks, fasting blood glucose and HbA1c levels were significantly reduced in the experimental mice. Study by Faria et al.[11] showed that the serum blood glucose levels and insulin levels in control group were significantly higher than the maltodextrin group. HOMA-IR values were significantly greater in conventional fasting patients than in the maltodextrin group.[11]

Our study also showed significant differences in random blood glucose levels before and after surgery after administration of maltodextrin in ERACS. This might occur due to the underlying mechanism mediated by increased propionate in the colon and GLP-1 excretion. The effect of GLP-1 on the pancreas could be seen in the secretion of glucose-dependent insulin. Due to this mechanism, maltodextrin could participate in reducing postprandial blood glucose levels. In addition, the effect of GLP-1 on the hypothalamus also helped suppress appetite and food intake.[12–15]

This study was the first study to compare between maltodextrin and sugar water in determining the potential of maltodextrin in reducing the incidence of post-operative hyperglycemia. However, our study had several limitations which should be considered. Since it was only carried out in a single-centered manner, the study results might not directly represent a larger population. Other study limitation was that it did not standardize the meals or beverages consumed by study subjects at 1–2 day before the study was carried out which could influence the study data. Further study was needed to be carried out in a multicenter manner with a larger number of study subjects so that the study results could be generalized.

CONCLUSION

Maltodextrin administration showed better outcome in reducing post-operative catabolic status by reducing post-operative insulin resistance and improving RBG levels before and after ERACS surgery compared to sugar water control. It might reduce the incidence of post-operative hyperglycemia. Thus, maltodextrin might be considered as a substitute for sugar water in drinks before surgery.

REFERENCES

1. Aryasa TEM, Rehatta NM, Isngadi I, Sari D, Lestari MI, Liberty IA, et al. Obstetric anesthesia services profile in cesarean section in Indonesian population: A prospective, observational, multicenter Rstudy. Bali J Anaesthesiol. 2023;7(4):215–9.
2. Ituk U, Habib AS. Enhanced Recovery After Cesarean Delivery. F1000Res. 2018:7: F1000 Faculty Rev–513.
3. Noblett SE, Watson DS, Huong H, Davison B, Hainsworth PJ, Horgan AF. Pre-Operative Oral Carbohydrate Loading in Colorectal Surgery: A Randomized Controlled Trial. Colorectal Dis. 2006;8(7):563–9.
4. Singh J. Preoperative Oral Carbohydrate Drink Improves Surgical Outcome. MOJ Surg. 2018;6(2):72–3.

5. Awad S, Constantin-Teodosiu D, Constantin D, Rowlands BJ, Fearon KCH, Macdonald IA, et al. Cellular Mechanisms Underlying the Protective Effects of Preoperative Feeding: A Randomized Study Investigating Muscle and Liver Glycogen Content, Mitochondrial Function, Gene and Protein Expression. Ann Surg.2010;252(2):247–53.
6. Awad S, Fearon KCH, Macdonald IA, Lobo DN. A Randomized Cross-Over Study of The Metabolic and Hormonal Responses Following Two Preoperative Conditioning Drinks. Nutrition. 2011;27(9):938–42.
7. Yuill KA, Richardson RA, Davidson HIM, Garden OJ, Parks RW. The Administration of An Oral Carbohydrate-Containing Fluid Prior To Major Elective Upper-Gastrointestinal Surgery Preserves Skeletal Muscle Mass Postoperatively- A Randomised Clinical Trial. Clin Nutr. 2005;24(1):32–7.
8. Hausel J, Nygren J, Lagerkranser M, Hellström PM, Hammarqvist F, Almström C, et al. A Carbohydrate-Rich Drink Reduces Preoperative Discomfort in Elective Surgery Patients. Anesth Analg. 2001;93(5):1344–50.
9. Ding T, Deng C-M, Shen X-F, Bai Y-W, Zhang X-L, Liu J-P, et al. Effect of A Carbohydrate-Rich Beverage on Rate of Cesarean Delivery in Primigravidae with Epidural Labor Analgesia: A Multicenter Randomized Trial. BMC Pregnancy Childbirth. 2022;22(1):339.
10. Tzeng HP, Chiu CY, Liu SH, Chiang MT. Improvement of Glycemic Control by a Functional Food Mixture Containing Maltodextrin, White Kidney Bean Extract, Mulberry Leaf Extract, and Niacin-Bound Chromium Complex in Obese Diabetic db/db Mice. Metabolites. 2022;12(8):693.
11. Faria MSM, de Aguilar-Nascimento JE, Pimenta OS, Alvarenga Jr LC, Dock-Nascimento DB, Slhessarenko N. Preoperative Fasting of 2 Hours Minimizes Insulin Resistance and Organic Response to Trauma After Video-Cholecystectomy: A Randomized, Controlled, Clinical Trial. World J Surg. 2009;33(6): 1158–64.
12. Perrone F, da-Silva-Filho AC, Adôrno IF, Anabuki NT, Leal FS, Colombo T, et al. Effects of preoperative feeding with a whey protein plus carbohydrate drink on the acute phase response and insulin resistance. A randomized trial. Nutr J. 2011;10:66.
13. Hofman DL, van Buul VJ, Brouns FJ. Nutrition, Health, and Regulatory Aspects of Digestible Maltodextrins. Crit Rev Food Sci Nutr. 2016;56(12):2091–100.
14. Bogossian PM, Tescaro Piffer ML, Maschietto FB, Martins TR, de Oliveira Araujo DA, Oliveira TM, et al. Effect of maltodextrin supplementation on blood glucose, lactate, insulin, and cortisol levels in horses subjected to submaximal incremental exercise test. Rev Acad Cienc Anim. 2019;17:e17005.
15. Qin H, Ji J, Miao Y, Liu T, Zhao D, Jia Z, et al. Efficacy of the Oral Administration of Maltodextrin Fructose Before Major Abdominal Surgery: A Prospective, Multicenter Clinical Study. World J Surg. 2022 Sep;46(9):2132–40.