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SHORT COMMUNICATION

Influence of administration of 1 % glucose solution on neonatal blood glucose concentration in cesarean section

Tomoaki Yatabe · Hiroki Tateiwa · Nobuo Ikenoue · Sonoe Kitamura · Koichi Yamashita · Masataka Yokoyama

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Abstract Perioperative administration of adequate glucose prevents hypercatabolism. However, excessive glucose administration until delivery of a fetus might cause newborn hypoglycemia in cesarean section. In this retrospective study, we investigated whether the administration of 1 % glucose solution during cesarean section influenced neonatal blood glucose concentration. We found 46 consecutive patients between 37 and 41 weeks of gestation who underwent cesarean section under combined epidural and spinal anesthesia. We divided the patients into two groups: those receiving 1 % glucose solution (group A, $N = 23$) and those receiving a solution without glucose (group B, $N = 23$) until delivery. We recorded umbilical cord blood glucose on delivery, neonatal blood glucose level 3 h after delivery, and 1- and 5-min Apgar scores. The dose of glucose administered until delivery of fetus in group A was 3.6 ± 1.7 mg/kg/min [mean ± standard deviation (SD)] and that in group B 0 mg/kg/min. Umbilical cord blood glucose concentration on delivery of fetus in group A was significantly higher than that in group B (101 ± 19 vs. 66 ± 10 mg/dl; $P < 0.0001$). Neonatal blood glucose level 3 h after delivery was not significantly different between groups (90 ± 15 vs. 90 ± 21 mg/dl; $P = 0.96$). The 1- and 5-min Apgar scores were similar between groups. In conclusion, administration of 1 % glucose solution in cesarean section might contribute to prevention of neonatal hypoglycemia.

Keywords Perioperative glucose administration · Cesarean section · Neonatal blood glucose

T. Yatabe (✉) · H. Tateiwa · S. Kitamura · K. Yamashita · M. Yokoyama
Department of Anesthesiology and Intensive Care Medicine, Kochi Medical School, Kohasu Oko-cho, Nankoku, Kochi 783-8505, Japan
e-mail: yatabe@kochi-u.ac.jp

N. Ikenoue
Department of Obstetrics and Gynecology, Kochi Medical School, Nankoku, Kochi, Japan

Introduction

Perioperative fluid therapy is considered highly important in enhanced recovery after surgery (ERAS) and in early goal-directed therapy (EGDT) [1, 2]. The fluid therapy itself is thought to have an effect on prognosis [3]. Similarly, effects of fluid type on surgical outcome have drawn attention. Yamasaki et al. [4] used acetated Ringer's solution with 1 % glucose in a study examining the effects of infusion during minor otolaryngological surgery and found that hyperglycemia was not induced and protein catabolism was reduced. Glucose administration is considered necessary during the delivery of a fetus to avoid adverse effects of increased ketone bodies in the mother and fetus [5]. In contrast, an excessive dose of glucose administered during cesarean section can cause umbilical cord blood acidosis and increase the risk of hypoglycemia in the newborn [6, 7]. Previous study show that solution with 1 % glucose caused neither hyperglycemia nor hypoglycemia on delivery in cesarean section [8], but glucose level after delivery was not studied. Nonetheless, blood glucose level after birth is important, as it decreases rapidly in the first 30–60 min after birth and subsequently rises to reach a steady level by 2–4 h [9]. However, hyperinsulinemia on delivery inhibits blood glucose recovery and leads to hypoglycemia in a few hours. Therefore, we retrospectively investigated the effect of 1 % glucose-acetated solution on fetal blood glucose level at and 3 h after delivery.

Materials and methods

The study was carried out with the approval of the ethics committee of Kochi University School of Medicine (No. 22–132). As this was a retrospective study, informed consent of patients was not required. Study participants were consecutive single-pregnancy patients who underwent scheduled cesarean section with combined spinal-epidural anesthesia, at no sooner than 37 weeks of gestation, from July 2009 through July 2011. We checked whether patients were administered glucose as a perioperative infusion and divided them into two groups depending on presence or absence of glucose infusion. Patients in group A received a solution with 1 % glucose, and those in group B received a solution without glucose. The solutions used in group A were Physio 140 (Otsuka Pharmaceutical, Tokushima) and/or Hespandar (Fresenius Kabi, Tokyo), and the solution used in group B was Bicarbon (Ajinomoto, Tokyo). Patients were allowed to eat until 9 p.m. on the evening before the operation. Clear water was allowed until 2 h before the operation. After the patient was admitted to the operating room, an epidural catheter was inserted from Th12/L1. Spinal subarachnoid anesthesia was then induced with bupivacaine, from L3/4 or L4/5. Epidural anesthesia was induced for postoperative pain management. However, individual anesthesiologists decided a detailed management strategy (e.g., dose of drugs and infusion rate of solutions). Umbilical cord blood was collected at delivery. A pediatrician recorded Apgar score. Laboratory tests for umbilical cord blood glucose and electrolytes were performed. Umbilical cord glucose was measured using the hexokinase method within 10 min at the hospital laboratory. The newborn was then transferred to the neonatal intensive care unit (NICU), and blood glucose level was measured 3 h later, according to the clinical pathway. Accu-Check Comfort (Roche Diagnostics Japan, Tokyo), which employs the glucose dehydrogenase enzyme electrode method, was used to measure glucose level. Target blood glucose level in the NICU was 60–110 mg/dl. Milk was given 6–8 h afterward. Blood glucose level <50 mg/dl and/or occurrence of symptomatic event was defined as hypoglycemia. Data on intraoperative volume of infusion were collected from the anesthesia record, and patient data were collected from the medical records. Major outcome was umbilical cord blood glucose level at delivery and 3 h after delivery. We also evaluated the following additional outcomes: electrolytes (Na^+, K^+, Cl^-, Mg^{2+}), pH, base excess (BE), HCO_3^- at delivery, and Apgar score (at 1 and 5 min). Data were expressed as mean ± standard deviation (SD). We assessed each of these parameters with the Mann–Whitney *U* test. *P* values <0.05 were considered statistically significant. Statistical analysis was carried out using JMP 9.00 (SAS Institute Japan, Tokyo).

Results

We studied 46 patients (23 in each group). Gestation week, age, body mass index, time from drug injection into the subarachnoid space to delivery of fetus, and total amount of infusion until delivery were not significantly different between groups. The total volume infused was significantly lower in group A than that in group B (2,460 ± 711 vs. 2,975 ± 599 ml, $P = 0.01$); however, the volume infused before delivery was not significantly different (Table 1). Infusion and laboratory data are shown in Table 2. Glucose dosage administered until delivery of the fetus in groups A and B was 3.6 ± 1.7 and 0 mg/kg/min, respectively. Umbilical cord blood glucose concentration on delivery was significantly higher in group A than that in group B (101 ± 19 vs. 66 ± 10 mg/dl; $P < 0.0001$). Neonatal blood glucose level 3 h after delivery was not significantly different between groups (90 ± 15 vs. 90 ± 21 mg/dl; $P = 0.96$). The 1- and 5-min Apgar scores were similar between groups (7.9 ± 0.8 vs. 8.0 ± 0.8; $P = 0.59$ and 8.8 ± 0.5 vs. 8.7 ± 0.7; $P = 0.64$, respectively). No differences were observed in Apgar score, electrolytes, pH, BE, or HCO_3^-. No hypoglycemia event occurred on delivery or 3 h after delivery.

Table 1 Patient backgrounds

	Group A ($N = 23$)	Group B ($N = 23$)	*P* value
Age (years)	31 ± 5	34 ± 5	0.05
Height (cm)	157 ± 6	157 ± 5	0.47
Weight (kg)	62 ± 12	60 ± 9	0.67
Body mass index (kg/m^2)	25 ± 4	24 ± 3	0.70
Gestation week (weeks)	38.1 ± 1.0	38.1 ± 0.5	0.62
Reasons for cesarean section			
Repeated (%)	19 (83)	16 (70)	
Breech presentation (%)	2 (9)	4 (17)	
Maternal reason (%)	2 (9)	3 (13)	
Time of operation (min)	86 ± 14	93 ± 24	0.10
Time of anesthesia (min)	121 ± 15	131 ± 29	0.07
Time of until delivery (min)	60 ± 13	64 ± 15	0.22
Birth weight (g)	2878 ± 385	2810 ± 275	0.75
Urine volume (ml)	640 ± 311	551 ± 228	0.62
Blood loss (ml)	1243 ± 411	1210 ± 418	0.61
Total infusion (ml)	2460 ± 711	2975 ± 599	0.01

We assessed each of these parameters with the Mann–Whitney *U* test

Table 2 Infusion and laboratory data

	Group A ($N = 23$)	Group B ($N = 23$)	P value
Infusion until delivery (ml)	1,441 ± 464	1,554 ± 391	0.19
Acetate Ringer's solution (ml)	1,004 ± 591	0	–
HES 70/0.55/4 (ml)	415 ± 333	0	–
Bicarbonate Ringer's solution (ml)	0	1,554 ± 391	–
Glucose until delivery (mg/kg/min)	3.6 ± 1.7	0	–
Apgar score 1 min	7.9 ± 0.8	8.0 ± 0.8	0.58
Apgar score 5 min	8.8 ± 0.5	8.7 ± 0.7	0.64
Neonatal glucose 0 h (mg/dl)	101 ± 19	66 ± 10	<0.0001
Neonatal glucose 3 h (mg/dl)	90 ± 15	90 ± 21	0.96
Umbilical cord data on delivery			
pH	7.29 ± 0.06	7.31 ± 0.03	0.10
Base excess (mmol/l)	−2.9 ± 2.0	−2.1 ± 1.2	0.10
HCO_3^- (mmol/l)	20.9 ± 1.6	21.4 ± 0.9	0.18
Na^+ (mmol/l)	136 ± 2	136 ± 1	0.42
K^+ (mmol/l)	4.5 ± 0.8	4.4 ± 0.7	0.63
Cl^- (mmol/l)	106 ± 2	106 ± 1	0.40
Mg^{2+} (mg/dl)	2.0 ± 0.7	2.0 ± 0.4	0.63

We assessed each of these parameters with the Mann–Whitney U test

Glucose until delivery dosage of glucose administration until delivery

Discussion

This study showed that administration of a solution with 1 % glucose during cesarean section could balance fetal blood glucose level at delivery and prevent hypoglycemia for up to 3 h. Furthermore, a solution with 1 % glucose did not affect Apgar scores and acid–base equilibrium of umbilical cord blood at delivery.

Glucose administration has been suggested to prevent negative effects of increased ketone bodies due to hunger in the mother and fetus during delivery [5]. By contrast, an excessive dose of glucose has been claimed to induce hyperglycemia and hyperinsulinemia in the fetus [10]. A transient decrease in blood glucose level generally occurs after delivery because the supply of glucose from the mother has ceased, but blood glucose levels subsequently recover because of glycogenolysis and gluconeogenesis in the liver [11, 12]. However, if hyperinsulinemia occurs at this time, the suppression of glycogenolysis and gluconeogenesis can result and thereby lead to hypoglycemia [12]. Therefore, hyperglycemia in the fetus is unfavorable, as it can trigger hyperinsulinemia in the infant. We did not measure insulin in this study. However, we thought that normal glycogenolysis and gluconeogenesis were maintained because of normal 3-h blood glucose level. Therefore, a solution with 1 % glucose may not result in hyperinsulinemia.

Another concern of glucose administration is that an excessive amount of solution will lead to fetal acidosis, as excess glucose increases metabolic rate and oxygen consumption [6]. However, in this study, no differences in fetal pH, BE, or HCO_3^- were observed. Based on our results, we believe that a solution with 1 % glucose does not affect normal metabolism of the fetus.

A limitation of our study was that no fluid management protocol was used because the study was retrospective. The choice of solution was left entirely to the anesthesiologist, so that a solution with 1 % glucose contained two agents. As such, the differences between crystalloid and colloid solutions might have affected the results. Furthermore, optimal blood glucose infusion was important. Therefore, 250 ml of acetated Ringer's solution with 5 % glucose (about 13 g of glucose) may be similarly effective. Future prospective studies are required to address this issue.

Conclusion

In conclusion, administration of 1 % glucose solution in cesarean section might contribute to preventing neonatal hypoglycemia.

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