Research Paper

The Effect of Intravenous Glucose Solutions on Neonatal and Mother Blood Glucose Levels after Cesarean Delivery

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ABSTRACT:

BACKGROUND:

Intravenous glucose fluids may be given to patients undergoing caesarean delivery to provide energy to the mother and fetus while maintain hemodynamics. Different intravenous solution loads before operation, however, may cause maternal and fetal hyperglycemia or hypoglycemia .

OBJECTIVE:

To compare the blood glucose level of the mother and the fetal after giving ringer lactate have (0, 1, and 5%) glucose to the mother before induction and completed after delivery to minimize the effect of both fasting and to mark the optimal glucose concentration for both mother and fetus.

PATIENTS AND METHODS:

Sixty pregnant women aged 18-35 years underwent elective cesarean delivery are randomly distributed into three groups. Group A received Ringer lactate with 0 % glucose (0 g), Group B received 1 % glucose (5 g), and Group C received 5 % (25 g) glucose. Once the patients were in the operating room, each group of them received an infusion of 500 ml of test solution before induction, and the administration ended after delivery.

RESULTS:

The mean maternal glucose level before the intravenous infusion was 80.21±11.32 in the study groups. After the intravenous infusion finished, maternal blood glucose levels were group A 72.3 (±5.6), group B 100.1 (±10.3), and group C 243.7 (±40.3). For neonatal capillary blood glucose levels immediately after delivery were Group A 54.7 ± 7.74, Group B 82.4 ±10.06 and Group C 184.2 ±12.89.

CONCLUSION:

Ringer lactate with 1 % glucose solution was the ideal fluid to maintain the appropriate blood glucose level in the mother and fetus and maintain maternal hemodynamics and provide power for both mother and fetus.

KEYWORDS: glucose ringer solution, blood sugar level, preoperative infusion.

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INTRODUCTION:

For living organisms, glucose is the primary source of power. It occurs naturally and can be found in fruits and other plant parts in their natural state. Glucose is produced in animals through the destroy of glycogen, a process known as glycogenolysis(1).

Glucose has the molecular formula $C6H12O6$. It is the most common monosaccharide, a type of carbohydrate(2).

Glucose is primarily produced by plants, and the naturally revolving form of glucose is d-glucose, whereas l-glucose is synthesised in relatively small amounts and is of lesser importance. Because glucose is a monosaccharide with six carbon atoms and an aldehyde group, it is also famous as an aldohexose.

The glucose molecule can be found in both unfold-chain (acyclic) and ring (cyclic) forms, with the latter formed by an intramolecular reaction between the aldehyde C atom and the C-5 hydroxyl group to form an intramolecular hemiacetal. Both forms are in balance in water solution, with the cyclic one dominating at pH 7(3).

During pregnancy, rising estrogen levels stimulate insulin production by the pancreas B cells, causing changes in glucose metabolism. As the fetal consumes mother fat stores, ketosis can develop and cause to decrease blood suger level, mostly during fasting period(4).

In the fetus, serum glucose is about 70% of those in the mother (i:e. babies glucose is about 70 when the mother is 100), and almost all of this comes from normally facilitating mothers with a blood glucose level of 40 mg/dl or lower. A fetus with a level of 30 mg/dl or lower is diagnosed as having hypoglycemia[5].

Neonatal hypoglycemia is easily treated in most cases if it is recognized, but untreated hypoglycemia can have serious consequences for infants as glucose is the primary source of power in all organs and is almost entirely responsible for cerebral metabolism. Neonatal hypoglycemia is a popular condition. The incidence is stated to be 1 to 5 per 1000 births, but it is significant in certain subgroups. 8% in large for gestational age infants and approximately 15% in small for gestational age infants (i:e., those with intrauterine growth retardation)[6].

Prospective studies of infants who taked glucose infusion during induction of general anaesthesia before cesarean section delivery have also shown postoperatuvely fall in blood glucose levels of such infants[7, 8].

Hypoglycemic newborn infants may current with a variety of symptoms or asymptomatic. Apnea, lethargy, exaggerated irritability, poor sucking or feeding, cyanosis, or coma are all potential symptoms[9].

The experimental studies found that infusing glucose into pregnant women causes mother and transplacental hyperglycemia[10].

In terms of the pathophysiology of glucose metabolism in the neonate, various method of gluconeogenesis, metabolism, insulin secretion, and 'counter regulatory' hormones maintain a steady state glucose level. This homeostasis is maintained not only by insulin and glucagon but also by hormones such as catecholamines, growth hormones, and cortisol that determine its uptake and utilization. Ingestion of feed or infusion of glucose in the form of carbohydrate contributes to increasing glucose concentration in the body which in turn activates glucokinase and β cell glycolysis[11]. This process eventually product acetyl-coenzyme A (acetyl CoA), which is a byproduct of glycolysis, protein degradation, and lipolysis. Acetyl Co-A enters the Kreb's cycle which then provides the adenosine triphosphate (ATP) and supports all cell functions[12].

AIM OF THE STUDY:

This study was designed to compare the blood glucose level of the mother and the neonate after giving ringer lactate containing (0, 1, and 5 %) glucose to the mother before induction and completed after delivery to minimize the effect of fasting and to mark the optimal glucose concentration for both mother and fetus, to maintain maternal hemodynamically and to provide energy for the mother and fetus

PATIENTS AND METHOD:

Study design and setting: After obtaining approval from the Iraqi scientific council of anaesthesia and intensive care, this randomized comparative clinical study was conducted on patients who were admitted to maternity and gynaecology hospital in Erbil Government and undergoing elective cesarian section between March to September 2019.

Ethical consideration: The patients were fully informed about the study in detail, and informed consent was gained from every patient. As this study was single-blind and the group size was specific, randomization was done on the basis of allocating alternate patients to each group.

Study population:

Sampling: The current study enrolled a convenient sample of 60 pregnant women who are scheduled to have an elective caesarean section under general anaesthesia and met the inclusion criteria and were randomly assigned to three groups:

Group A: Ringer lactate and 0 glucose (20 pregnant women)

Group B: Ringer lactate and 1% glucose (20 pregnant women)

Group C: Ringer lactate and 5% glucose (20 pregnant women)

Inclusion criteria:

1. Aged (18 – 35) years.
2. ASA II
3. Weight of 65–100 kg.
4. Term pregnancy.

Exclusion criteria:

1. Patient refusal.
2. History of diabetes mellitus.
3. Pregnant with endocrine diseases.

Procedures and data collection:

All patients were fasting for 9 hours before their scheduled surgery. When the patient was in the operation room, the patient was positioned with the left lateral tilt to avoid aortocaval compression and preoxygenation with 100 % for 3 minutes. Each patient received thiopental 5 mg / kg, rocuronium 1 mg / kg and ketamine 0.4 mg / kg. The airway was secured with an endotracheal tube.

An intravenous cannula was inserted. Each group of them received an infusion of 500 ml of test solution before induction, and the administration was completed at the end of the delivery.

Test solutions were administered ringer lactate and 0 glucose, ringer lactate and 1 % glucose, or ringer lactate and 5 % glucose, according to the study group.

Regarding neonatal data, neonatal capillary blood samples were taken with heel sticks to determine blood glucose levels (by glucose analyzer).

Statistical analysis

After data collection, the statistical presentation and analysis were proceeded by using SPSS 20.3, Graph Pad Prism 7.0 software package, (P-value considered when appropriate to be significant if less than 0.05).

The quantitative data were presented as mean +-standard deviation and median (minimum-maximum).

Differences in the patient's demographic characteristics were considered significant at the (0.15) level.

RESULTS:

The demographic data of the three groups are statistically compared for (weight, age, height, anaesthesia time, and BMI), no significant differences were obtained between the study groups (Table 1).

Table 1: Baseline Characteristics of the participants.

	Group A (N= 20)	Group B (N= 20)	Group C (N=20)	P value
Age (y)	29.20 ± 5.88	29.95 ± 5.89	30.1 ±4.5	0.17
Weight (kg)	75.17 ± 9.30	77.23 ± 11.85	69.2 ±4.3	0.72
Height (cm)	160.50 ± 5.46	160.35 ± 5.78	158.0 ±3.5	0.83
BMI (kg/m^2)	29.19 ± 3.39	29.93 ± 3.57	31.88 ±4.6	0.63
Anaesthesia time (min)	30.6 ± 35.2	31.3 ± 41.6	28.1 ± 40.8	0.07

Regarding the neonate, there are no significant differences in Apgar score or body weight (Table 2).

Table 2: Baseline neonatal characteristics.

	Group A (N=20)	Group B (N=20)	Group C (N=20)	P value
Neonatal body weight (g)	3678.0 ± 566.3	3234.0 ± 632.6	3234.0 ± 632.6	0.49
Apgar score 1 min	9 (7–9)	9 (8–9)	9 (7–9)	0.52
Apgar score 5 min	10 (9–10)	10 (9–10)	10 (9–10)	0.52

The maternal body glucose levels were recorded before the intravenous infusion was started at a rate ranging from (70 – 90) mg/dl, mean and standard deviation (80.21±11.32) and no significant differences between the study groups.

According to collected data after the surgery, there was a significant difference between the study groups regarding the maternal level of blood glucose (P-value < 0.001). As shown in table 3 and figure 1.

Table 3: Postoperative maternal blood glucose level in the study groups.

	Group A (n = 20)	Group B (n =20)	Group C (N=20)	P-value
Maternal blood glucose (mg/dL) after the surgery	72.31±5.66	100.11±10.38	243.78±40.43	< 0.001

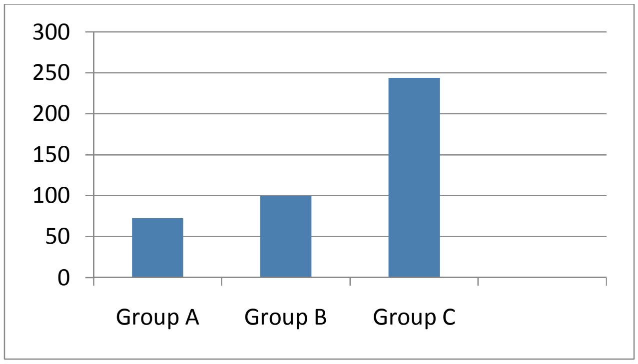

Figure 1: Mean maternal blood glucose level in the study groups after surgery (mg/dl)

Regarding Neonatal blood glucose levels, there were significant differences among the study groups (Table 4 and figure 2)

Table 4: Neonatal blood glucose level after delivery in the THREE groups.

	Group A (n = 20)	Group B (n =20	Group C (N=20)	P-value
Neonatal blood glucose mg/dl	54.7 ± 7.74	82.4 ± 10.06	184 ± 12.79	0.001

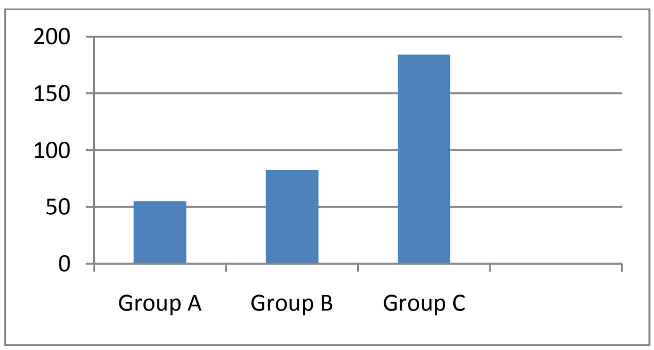

Figure 2: Mean neonatal blood glucose level in the study groups (mg/dl)

DISCUSSION:

The current study showed that women who received Ringer lactate and 0 glucose (group A) had the lowest glucose levels than other groups with a significant difference. While the highest level was in those who received Ringer lactate and 5 % glucose (group C). At the same time, Ringer lactate with 1% glucose was the ideal fluid infusion for the mothers undergoing cesarian delivery. In comparison, Kenepp et reported that a glucose load of 25 g or more resulted in maternal hyperglycemia[7].

Sharma et al. and shrivastava et el. showed by administration of high energy solution during the preoperative period, glucose-based solutions have been shown to eliminate the effect of fasting and maintain liver glycogen and reduce stress responses and increase insulin sensitivity to stress[13, 14].

In addition, Simin et al. found that adding 1% glucose to crystalloid solution improves the hemodynamic status and decreases post-spinal anaesthesia complications without significant changes in the maternal blood sugar level[15]. The same finding was obtained by Fukuda et al. who reported that administration of Ringer lactate and 1 % glucose to women undergoing cesarian delivery with epidural anaesthesia does not cause maternal hyperglycemia, and it properly maintains the level of blood glucose[16].

The current study showed that a significant lowest neonatal blood glucose level was in group A. While the highest level was in those belonged to mothers who received Ringer lactate and 5 % glucose (group C). At the same time, Ringer lactate with 1% glucose was an ideal fluid infusion for a neonatal blood glucose level.

In agreement with the current study, Fukuda et al. concluded that an intravenous solution with 1 % glucose was appropriate to maintain neonatal blood glucose levels without causing reflex hypoglycemia until the neonate develops the ability to produce or intake glucose[16].

In comparison, Kenepp et reported that a glucose load of 25 g or more resulted in neonatal hyperglycemia and neonatal hypoglycemia after two hours when an intravenous solution with 5 % glucose was used before cesarean section(7).

Sunit et al. concluded that intrapartum infusion of glucose 5 % solution to mothers during normal labour affects neonatal blood glucose levels adversely and predisposes the infants to an increased risk of hypoglycemia at two hours of age[17].

At term, Peter et found that the fetal pancreas responds to elevated blood glucose levels by increasing plasma insulin and there was a direct correlation between blood glucose and plasma insulin concentration[18].

CONCLUSION:

Ringer lactate with 1 % glucose solution was the ideal fluid to maintain the appropriate blood glucose level in the mother and fetus, to maintain maternal hemodynamics, and to provide energy for both mother and fetus.

Recommendations

The glucose-containing fluid of no more than 1 % should be used as an optimal solution for maintaining both maternal and fetal blood glucose level

REFERENCES:

1. Cura AJ, Carruthers A. The role of monosaccharide transport proteins in carbohydrate assimilation, distribution, metabolism and homeostasis. Comprehensive Physiology. 2012;2:863.
2. BeMiller JN. Carbohydrate chemistry for food scientists: Elsevier; 2018.
3. Wiercigroch E, Szafraniec E, Czamara K, Pacia MZ, Majzner K, Kochan K, et al. Raman and infrared spectroscopy of carbohydrates: A review. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy. 2017;185:317-35.
4. Gabbe SG, Niebyl JR, Simpson JL, Landon MB, Galan HL, Jauniaux ER, et al. Obstetrics: normal and problem pregnancies e-book: Elsevier Health Sciences; 2016.
5. Heck LJ, Erenberg A. Serum glucose levels in term neonates during the first 48 hours of life. The Journal of pediatrics. 1987;110:119-22.
6. Rozance PJ, Hay WW. Hypoglycemia in newborn infants: features associated with adverse outcomes. Neonatology. 2006;90:74-86.
7. Kenepp N, Shelley WC, Gabbe S, Kumar S, Stanley C, Gutsche B. Fetal and neonatal hazards of maternal hydration with 5% dextrose before caesarean section. The Lancet. 1982;319:1150-52.
8. Mendiola J, Grylack LJ, Scanlon JW. Effects of intrapartum maternal glucose infusion on the normal fetus and newborn. Anesthesia and analgesia. 1982;61:32-5.
9. Fenichel GM. Clinical pediatric neurology: a signs and symptoms approach: Elsevier Health Sciences; 2009.
10. Beard R, Turner R, Oakley N. Fetal response to glucose loading. Fetal blood glucose and insulin responses to hyperglycaemia in normal and diabetic pregnancies. Postgraduate Medical Journal. 1971:Suppl: 68-78.
11. Sweet CB, Grayson S, Polak M. Management strategies for neonatal hypoglycemia. The Journal of Pediatric Pharmacology and Therapeutics: JPPT. 2013;18:199.
12. Sharma A, Davis A, Shekhawat PS. Hypoglycemia in the preterm neonate: etiopathogenesis, diagnosis, management and long-term outcomes. Translational pediatrics. 2017;6:335.
13. Sharma C, Kalra J, Bagga R, Kumar P. A randomized controlled trial comparing parenteral normal saline with and without 5% dextrose on the course of labor in nulliparous women. Archives of gynecology and obstetrics. 2012;286:1425-30.
14. Shrivastava VK, Garite TJ, Jenkins SM, Saul L, Rumney P, Preslicka C, et al. A randomized, double-blinded, controlled trial comparing parenteral normal saline with and without dextrose on the course of labor in nulliparas. American journal of obstetrics and gynecology. 2009;200:379. e1-. e6.
15. Atashkhoei S, Abri R, Naghipour B, Marandi PH, Danesh MTF. Effect of glucose containing crystalloid infusion on maternal hemodynamic status after spinal anesthesia for cesarean section. Anesthesiology and Pain Medicine. 2018;8.

16. Fukuda I, Matsuda H, Sugahara S, Kazama T. The effect of intravenous glucose solutions on neonatal blood glucose levels after cesarean delivery. Journal of Anesthesia. 2013;27:180-85.
17. Singhi S. Effect of maternal intrapartum glucose therapy on neonatal blood glucose levels and neurobehavioral status of hypoglycemic term newborn infants. 1988.
18. Obenshain SS, Adam PA, King KC, Teramo K, Raivio KO, Räihä N, et al. Human fetal insulin response to sustained maternal hyperglycemia. New England Journal of Medicine. 1970;283:566-70.