

Is intraoperative supplementation of dextrose essential for infants undergoing facial cleft surgeries?

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Abstract

Background and Aims: Dextrose is commonly added to the intraoperative maintenance fluids of pediatric patients. The primary objective was to evaluate the effect of addition of 1% dextrose to Ringer's lactate (RL) on blood glucose levels in infants undergoing facial cleft surgeries.

Material and Methods: This prospective, randomized, single blinded study was conducted in forty infants undergoing either cheiloplasty or palatoplasty. Random blood sugar (RBS) was assessed using a glucometer after induction of anaesthesia, and at 1 and 2 hours later. Group R received RL and Group D received RL with 1% dextrose as intraoperative maintenance fluid. Hypoglycemia was defined as RBS <70 mg/dL and hyperglycemia as RBS >150 mg/dL.

Results: Baseline RBS levels and those at 60 min and 120 min post-induction were comparable in both groups. The increase in blood sugar levels from baseline to 60 min and to 120 min in each group was significant. Incidence of hyperglycemia was comparable in both groups. There were no episodes of hypoglycemia, intraoperatively.

Conclusion: Use of Ringer lactate alone or with addition of 1% dextrose resulted in comparable intraoperative blood sugar levels when used as maintenance fluid in infants undergoing facial cleft surgeries.

Keywords: Dextrose, hyperglycemia, hypoglycemia, infants, ringer lactate

Introduction

Intraoperative maintenance fluids in pediatric patients usually have addition of dextrose mainly, due to concern of hypoglycemia under the assumption that if fasting, neonates and young children may not maintain normal plasma glucose levels and manifest a progressive decline in plasma glucose to hypoglycemic levels.^[1] Possible association between moderate to severe hypoglycemia and poorer neurodevelopmental outcomes has been suggested in infants undergoing cardiac surgeries.^[2]

Anesthesia and surgery as well as interruption of glucose supply evoke neuroendocrine responses. This results in a rise

in catecholamines, cortisol, glucagon, and vasopressin in blood with a reduction in insulin leading to a rise in blood glucose levels through gluconeogenesis, fat mobilisation, and protein catabolism.^[3] Supplementing glucose may prevent utilisation of these energy reserves. But there has been no consensus whether dextrose should be added to intraoperative maintenance fluids, and, if being supplemented, what concentration provides optimal glyceemic levels.

The primary objective of the present study was to evaluate the effect of addition of 1% dextrose to intra-operative maintenance fluids (Ringer's lactate) on blood glucose levels in infants undergoing facial cleft surgeries. The secondary objectives included assessment of development of hypoglycemia or

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hyperglycemia in these patients when intraoperative fluids were used with and without added dextrose.

Material and Methods

The present study was a prospective, randomized, single blinded study conducted after obtaining clearance from Institutional Ethical Committee and consent from parents of the patients. It was registered in Clinical Trial Registry of India (CTRI/2019/01/016984). Forty infants of American Society of Anesthesiologists (ASA) physical status 1 undergoing cheiloplasty or palatoplasty were recruited in the study and were randomly allocated to either Group D or Group R based on computer generated random sequence of numbers. Allocation concealment was ensured using sequentially numbered, opaque-sealed envelopes. Infants of diabetic mothers and those with endocrine disorders, hyperglycemia, and anticipated difficult airway were excluded. Infants in Group R received Ringer's lactate (RL) while those in Group D received RL with 1% dextrose as intraoperative maintenance fluid. RL with 1% dextrose was prepared by discarding 20 mL of RL from 500 mL RL bottle and then adding 20 mL of 25% dextrose to it.

After a detailed pre-anesthetic evaluation, the infants were kept fasting for 6 hours for solids and formula feeds, 4 hours for breast milk and 2 hours for clear fluids. No patient had received any intravenous fluid preoperatively. General anesthesia was induced with 8% sevoflurane in oxygen using a Jackson Rees circuit after attaching routine pre-induction monitors. Random blood sugar (RBS) was then assessed using a glucometer before initiating administration of intravenous fluids. After induction, sevoflurane was reduced to 2%, glycopyrrolate 0.01 mg/kg, fentanyl 2 mcg/kg, propofol 1 mg/kg and succinylcholine 1.5–2 mg/kg were given intravenously and trachea was intubated with an appropriate sized preformed oral tube following a quick and gentle laryngoscopy. Anaesthesia was maintained with oxygen-nitrous oxide mixture (1:2) and 1–1.5% isoflurane with vecuronium as muscle relaxant. Persistent tachycardia and/or hypertension was managed with transiently increasing volatile agent concentration and if unresponsive with additional fentanyl 0.5 mcg/kg. The test fluid, RL in Group R and RL with 1% dextrose in Group D, was used as intraoperative maintenance fluid. Fluids were administered according to body weight based on Holliday and Segar formula. In both the groups Ringer's lactate was used to replace preoperative fluid deficit, at the rate of 10 mL/kg/h, and surgical loss was replaced with RL.

Blood sugar values were checked using a standard glucose meter (FreeStyleOptium H System, Copyright© 2015 Abbott Laboratories, Abbott Park, Illinois, USA) with test strips hourly for 2 hours. Hypoglycemia was defined as RBS < 70 mg/dL^[4]

and hyperglycemia as RBS > 150 mg/dL.^[5] If the RBS was below 70 mg/dL in either of the groups at any point during the study, 2.5 mL/kg of 10% dextrose was administered intravenously (IV) as a bolus to correct hypoglycemia and these patients were excluded from the study.

Hours of fasting, type of surgery, and the total volume of IV fluid used were documented. The heart rate (HR) and mean arterial pressure (MAP) were documented every 30 min. Volume and the number of times 10% dextrose bolus was administered, were also noted. We ended the study at 2 hours as the average duration of cheiloplasty and palatoplasty in our institute is 120–150 min.

Based on a study by Dubois *et al.*^[6] in which the blood glucose levels following use of RL versus RL with 1% dextrose in children were 91.8 ± 14.4 vs. 117 ± 37.8 mg/dL, the estimated sample size to obtain statistically significant results with 80% confidence interval and 90% power was forty.

Independent sample *t*-test was used to analyse and compare the baseline RBS values and values at 60 and 120 min between the two groups. Repeated measures ANOVA with a Greenhouse-Geisser correction was used to compare the blood glucose values at different time points with the baseline in each group. Pearson's Chi-square test was applied to calculate the incidence of hyper and hypoglycemia. The statistical analysis was done using IBM SPSS Statistics 20 for Windows 8 (SPSS Inc. Chicago, USA).

Result

Data from 40 patients were analysed. No patient was excluded from the study. Demographic data, duration of fasting, surgery duration, volume of intravenous fluid used and the types of surgeries the infants underwent are shown in Table 1.

There was no significant difference in the baseline RBS levels as well as RBS at 60 min and 120 min after induction of anesthesia in the two groups [Table 2]. The mean blood glucose values increased significantly at 60 and 120 min from the baseline in both Groups R and D.

No patient had hyperglycemia at induction. The incidence of hyperglycemia was not significantly different in Group D and Group R at 60 min and at 120 min [Table 3]. There were no episodes of hypoglycemia and no infant received 10% dextrose, intraoperatively. Mean HR and MAP in both groups were comparable throughout the study period [$P > 0.05$, Table 4].

Table 1: Demographics, duration of fasting and surgery, type of surgery and volume of intravenous fluids infused in 2 h in the two groups

Variables	Group R	Group D
Age (months)	8.4±3.7	8.3±3.6
Weight (Kg)	8.8±2.5	8.3±2.0
Gender		
Male	11 (55)	13 (65)
Female	9 (45)	7 (35)
Duration of fasting (h)	4.2±0.3	4.3±0.3
Duration of surgery (min)	143.3±11.9	139.3±23.7
Mean IV fluid volume (mL)	179±42.8	154.5±61.4
Type of surgery Cheiloplasty	10 (50)	6 (30)
Palatoplasty	10 (50)	14 (70)

The data is presented as Mean±SD or number (%)

Table 2: Comparison of blood sugar values at different time points between groups and within each group

Time	Group R	Group D	P (Group R vs. Group D)
Induction (a)	97.2±15.2	96.3±15.2	0.861
60 min (b)	109.3±14.5	114.9±23.3	0.364
120 min (c)	125.1±25.3	122.1±28.3	0.721
P: (within group comparison)			
(a) vs. (b)	0.008	0.004	
(a) vs. (c)	0.001	0.002	

The data are presented as Mean±SD

Table 3: Comparison of incidence of hyperglycaemia at 60 min and 120 min between the two groups

Time	Group R	Group D	P
60 min	0 (0)	3 (15)	0.231
120 min	3 (15)	5 (25)	0.695

The data is presented as number (%)

Table 4: Comparison of hemodynamic parameters

Time	Group R	Group D	P
Heart rate			
Induction	145.1±16.2	142.8±15.3	0.310
30 min	141.9±13.8	139.6±16.1	0.252
60 min	137.7±14.4	138.2±14.5	0.814
90 min	135.9±16.1	134.0±15.1	0.542
120 min	144.9±17.3	141±13.8	0.209
Mean arterial pressure			
Induction	71.5±14.7	67.9±13.4	0.523
30 min	68.4±11.2	66.7±10.5	0.343
60 min	65.5±12.5	64.3±11.1	0.489
90 min	63.6±11.7	62.8±9.5	0.236
120 min	65.9±13.1	63.3±9.4	0.189

The data is presented as Mean±SD

Discussion

In the present study it was seen that use of RL alone and with addition of 1% dextrose as intraoperative maintenance

fluid resulted in increases in blood sugar levels at 60 and 120 min from baseline values. Incidence of hyperglycemia was comparable in both groups. Intraoperative hypoglycemia did not occur in either group.

Intraoperative glucose supplementation came into practice aiming to reduce ketogenesis, postoperative insulin resistance, and protein catabolism.^[7,8] The practice now shows a decline due to evidence of high blood sugar levels intraoperatively due to stress induced hyperglycemia and insulin resistance even when glucose free fluids are administered.^[9]

Higher concentrations of dextrose, 5–2.5%, were initially used in infants and had shown to have high incidence of hyperglycemia, intraoperatively.^[10] It was observed that use of 2% dextrose during surgical procedures resulted in an increase in blood glucose values from baseline in children, but subsequent values remained within normal range.^[11] Various studies which used 1% dextrose added to maintenance fluids in infants and older children had also demonstrated similar results.^[6,12,13] Though this hyperglycemia is usually transient and returns to normal in the postoperative period in one hour, it could lead to osmotic diuresis, impairment of neurological outcome, and risk of hypoxic episodes under anesthesia as well.^[6] Though one study made an observation that use of 2.5% dextrose solution in infants did not result in intra-operative hyperglycemia,^[12] a rise in blood glucose was observed in most neonates undergoing surgery, even with the intraoperative use of plain Ringer acetate.^[14,15] At the same time use of 1% dextrose-containing isotonic balanced salt solution in neonates undergoing major surgeries, given at a rate of 10 ml/kg/min, had shown to maintain blood glucose levels in a normoglycemic range.^[16]

Studies have shown that use of RL alone during peri-operative period did not result in hypoglycemia.^[17] But interruption of glucose supply in neonates and infants may lead to hypoglycemia, hypercatabolism, ketogenesis, and delayed hyperglycemia. Impairment of gluconeogenesis has been implicated as the cause of hypoglycemia in neonates.^[18] Small-for-gestational-age (SGA; weight at less than the 10th percentile) infants, large-for-gestational-age (LGA; weight at more than the 90th percentile) infants and preterm infants comprise a higher risk group for perioperative hypoglycemia.^[19] Hypoglycemia limits blood glucose utilisation, which leads to activation of adrenergic responses and increased cerebral blood flow, which probably is the mechanism of neurological damage.^[20] Hence it had been suggested that patients of this age group may benefit from dextrose supplementation during surgery, but at a lower level than their normal requirement. Considering a better

biochemical and metabolic stability, addition of 1-2.5% dextrose to intraoperative maintenance fluids for neonates and infants had been stated to be prudent, but the concentration of dextrose used and the rate of infusion must be adjusted according to individual surgical needs.^[5]

The major drawback of our study was that the blood glucose estimation was done with capillary blood using glucometer with test strips. Glucose measurement of arterial blood samples using blood gas analysers would have yielded more accurate results. We did not take arterial samples as surgeries like cheiloplasty and palatoplasty usually don't require invasive blood pressure monitoring and also because obtaining intermittent arterial blood samples intraoperatively was difficult in an infant undergoing these surgeries. We are uncertain whether the depth of anaesthesia was uniform in all patients to compare blood sugar levels and avoid stress induced hyperglycemia. In our study the depth of anaesthesia was assessed based on intraoperative hemodynamic parameters only. Use of BIS monitoring would have provided more reliable information regarding the same.

Though our study showed a rise in blood sugar levels with addition of 1% dextrose this was comparable to levels when dextrose was not added to RL. Considering this and in view of uninterrupted substrate supply to prevent utilisation of other energy resources, addition of 1% dextrose to maintenance fluids of infants undergoing facial cleft surgeries appears prudent. Moreover, it protects the infant from unidentified episodes of hypoglycemia, if measures to monitor blood glucose levels are not immediately available.

Conclusion

Intraoperative blood sugar levels showed no significant difference when Ringer lactate was used alone or with addition of 1% dextrose as maintenance fluid in infants undergoing facial cleft surgeries.

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Conflicts of interest

There are no conflicts of interest.

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