Original Article

Impact of dextrose supplementation on intraoperative blood glucose levels in pediatric patients undergoing major surgeries under general anesthesia with caudal analgesia

Sruthi C. Babu, Dimple E. Thomas, Reshmy Thomas, Geethu Sebastian, Lakshmi Kumar

Department of Anaesthesiology and Critical Care, Amrita Institute of Medical Sciences, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India

Abstract

Background and Aims: In children undergoing surgery, the stress responses of surgery can result in blood glucose elevation consequent to release of cortisol and catecholamines. The use of a regional block could attenuate the stress responses and lower the blood glucose levels. We compared the blood glucose values at specified time points during surgery with and without additional dextrose to evaluate the need for glucose supplementation as our primary outcome. Intraoperative hemodynamics and the need for any intervention for correction of blood sugars were noted secondarily.
Material and Methods: Children aged between 6 months and 8 years undergoing elective major surgery were randomized to group D (received 1% dextrose in Ringer's lactate) or group P (received only Ringer's lactate). Blood sugars were measured half hourly for 2 h following intubation, and data was analyzed using Student's *t*-test and Chi-square test.
Results: Demographic variables and the duration of surgery were comparable. The baseline blood glucose value was lower in group D. Analysis of covariates test for a comparison of adjusted mean blood glucose (MBG) showed the values at 30, 60, and 90 min to be comparable. However, toward the end of surgery, the MBG value was significantly higher in group D ($P = 0.019$). Heart rate and mean arterial pressure were comparable at the same points of measurement.
Conclusion: Dextrose supplementation is not needed for children receiving caudal analgesia for major surgeries of 2–3 h duration and may raise blood sugars at the end of surgery.

Keywords: Blood glucose, caudal, dextrose, pediatric

Key Messages: Caudal analgesia could attenuate the stress response and lower the blood glucose levels. In our study, we observed that children undergoing major surgeries with caudal analgesia do not need supplemental dextrose for correction of hypoglycemia. Additional dextrose could increase blood sugars at the end of surgery.

Introduction

General anesthesia can result in elevated blood glucose levels secondary to stress response of anesthesia and surgery. This stress response elevates the endogenous catecholamines and cortisol levels, resulting in hyperglycemia due to glycogenolysis and gluconeogenesis along with reduced peripheral utilization of glucose.[1] The presence of a regional block could attenuate the blood glucose levels and shift the body metabolism toward a more physiologic state by suppressing the endogenous glucose production in comparison to those not receiving a regional block.[2,3] Administration of glucose-containing fluids without supplemental regional anesthesia could cause detrimental levels of hyperglycemia[4] that may affect tissue healing, morbidity, and postoperative course. With emerging concepts on shortening the

Address for correspondence: Dr. Lakshmi Kumar,
Department of Anaesthesiology, 1st Floor 6th Tower, Amrita Institute of Medical Sciences, Kochi, Kerala - 682 041, India.
E-mail: lakshmi.k.238@gmail.com

Access this article online	
Quick Response Code:	Website: https://journals.lww.com/joacp
	DOI: 10.4103/joacp.joacp_441_23

How to cite this article: Babu SC, Thomas DE, Thomas R, Sebastian G, Kumar L. Impact of dextrose supplementation on intraoperative blood glucose levels in pediatric patients undergoing major surgeries under general anesthesia with caudal analgesia. J Anaesthesiol Clin Pharmacol 2025;41:79-83.

Submitted: 09-Oct-2023 **Revised:** 23-Mar-2024
Accepted: 31-Mar-2024 **Published:** 15-Nov-2024

fasting duration, the need for supplementation of perioperative dextrose is controversial. We sought to determine if additional dextrose supplementation is needed among children undergoing surgery longer than 2 h with caudal analgesia.

The primary objective of the study was to compare the intraoperative blood glucose levels in groups with and without intravenous (IV) dextrose at 90 min following the start of surgery in children receiving caudal analgesia with general anesthesia. Secondary objectives were blood sugar measurements at half-hourly intervals during and at the end of surgery, heart rate (HR) and mean arterial pressure (MAP) at the same time, and the need for any intervention for correction of blood sugars.

Material and Methods

After obtaining approval from the Institutional Ethics Committee (IEC-AIMS-ANES-2020-112), this randomized controlled study was conducted from December 2020 to June 2022. Children aged 6 months to 8 years undergoing elective major surgery requiring caudal analgesia as part of their anesthetic management and lasting for more than 2 h were screened for inclusion in the study, and parental consent was obtained [Figure 1]. This study was registered at the Clinical Trial Registry of India (CTRI/2020/10/028554) dated October 22, 2020.

The patients were randomized into one of two groups by computer-generated random sequence of numbers. Group P received only plain Ringer's lactate (RL) for both maintenance and loss replacement, and group D received 1% dextrose in RL at the maintenance rate calculated as per the child's weight according to the Holliday–Segar formula. Losses were replaced with plain RL only. The anesthesiologists involved were not blinded to group allotment of patients, and the measurement of blood sugar was an objective assessment.

Children with endocrine disorders and on steroid supplementation were excluded. Children whose baseline blood glucose values were less than 70 mg/dl were excluded from the study and treated with 1 ml/kg 25% dextrose water (DW).[5] The decision for caudal analgesia was at the discretion of the consultant anesthesiologist. Sixty-seven children who met the requirements were screened for inclusion, but 11 of them were excluded from the trial due to hypoglycemia (blood sugar <70 mg/dl[5]) measured after induction of anesthesia and before group allocation.

All children were instructed to avoid solid food for 6 h and allowed clear liquids up to 2 h before surgery. Infants were allowed formula feeds 6 h before, breast milk 4 h before, and clear fluids that included water, apple juice, or filtered tender coconut water until 2 h before the surgery. As per the practice at our institute, all children had an IV cannula and received dextrose-

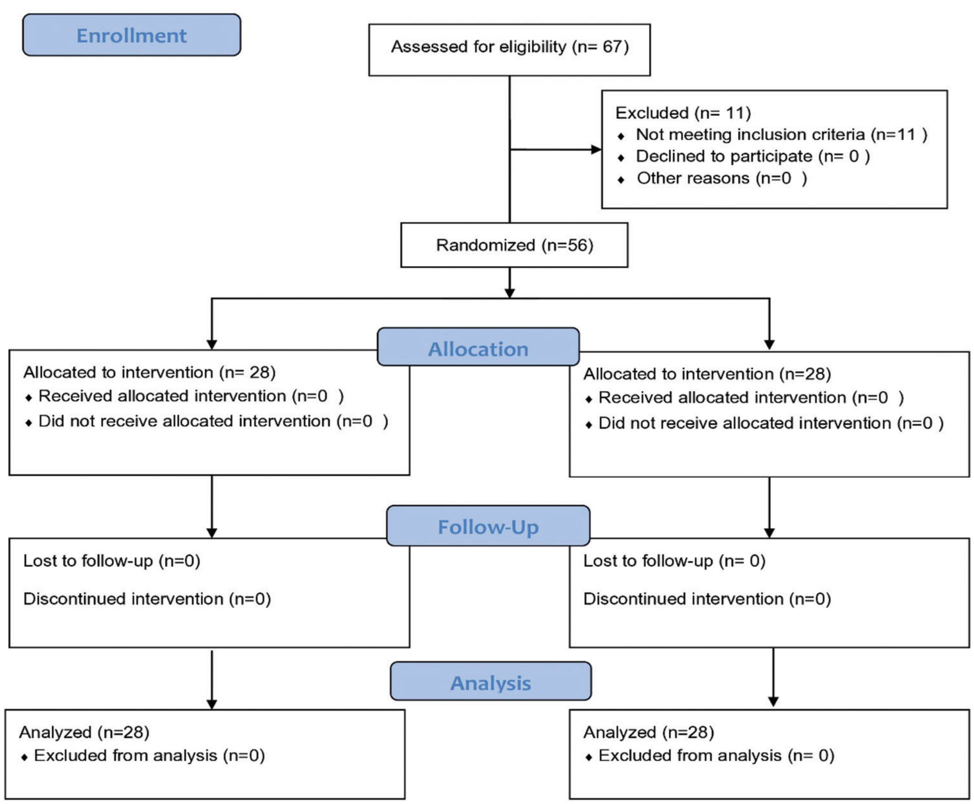

Figure 1: Flowchart for enrollment and allocation. CONSORT = Consolidated Standards of Reporting Trials

containing fluid IV at a basal rate until the time of shift for surgery. Parental separation was achieved by giving 1 mg/kg IV ketamine through the existing IV line. Older cooperative children were escorted to the operation room without premedication. In the theater, preinduction monitors that included pulse oximeter and electrocardiogram were connected. Preexisting IV lines were rechecked for patency; if resistance was found or the child showed signs of discomfort after an injection, those lines were changed with fresh ones, and the free flow of IV fluid was verified. Anesthesia was induced as per standard protocols with fentanyl 2 μg/kg, midazolam 0.02–0.03 mg/kg, and propofol titrated to loss of verbal response. Intubation was achieved using atracurium 0.5 mg/kg or cis-atracurium 0.15 mg/kg. All children were intubated with an endotracheal tube appropriate for age, and anesthesia was maintained with an air: oxygen mixture (1:1) at 1.0 1 fresh gas flow using an Avance GE CS2 workstation with a gas analyzer and inspired oxygen monitor targeting an end-tidal sevoflurane at 0.7–1.0 minimum alveolar concentration. Children included in the study were positioned laterally after intubation, and caudal analgesia was administered by the blind technique using 1 ml/kg of 0.2% ropivacaine. The allotment to either group by randomization was performed at this stage. In group D patients, the maintenance fluid calculated with Holliday–Segar formula was prepared with 1% DW (20 ml of 25% DW added to 480 ml of RL) and was given as infusion throughout surgery to allow a continuous source of glucose. Any additional fluid needed was replaced with plain RL, while the entire fluid replacement in group P was with plain RL. Glucose measurement strips on a glucometer (FreeStyle Optium H System Copyright 2015; Abbott Laboratories, Abbott Park, IL, USA) were used to estimate blood sugar levels. The first blood sugar (BS 0) reading was taken soon after the patient was induced and before initiating dextrose-containing IV fluid. Subsequent readings, that is, BS 30, BS 60, BS 90, and BS end, were taken at 30-min intervals to a maximum of 2 h of surgery. Any blood glucose value less than 70 mg/dl at any time point during surgery was treated with IV dextrose and excluded from the study. Any blood sugar value more than 200 mg/dl was to be treated with 0.1 unit/kg insulin.

The sample size was calculated based on a pilot study of 20 patients and comparing the blood glucose values at 90 min between each group. With MBG of 99.4 ± 16.06 mg/dl in group P versus 119.8 ± 34.84 mg/dl in group D (pooled standard deviation of 27.1) with a 95% confidence interval and 80% power, the estimated sample size was 28 in each group.

The Chi-square test was used to compare the categorical variables, and the independent Student's *t*-test or the Mann–Whitney test was used to compare continuous variables by the group. Analysis of covariates (ANCOVA) with post hoc Bonferroni correction was used to compare MBG at various time points in groups P and D using MBG baseline as a covariate. Statistical analyses were conducted using Statistical Package for the Social Sciences version 20.0 for Windows (IBM Corporation, Armonk, NY, USA).

Results

A total of 56 patients were included in the study, 28 in each group [Figure 1]. Demographic variables and the duration of surgery were comparable [Table 1]. The baseline blood glucose level was lower in group D (91.3 ± 13 vs. 82 ± 7.9 mg/dl). Using ANCOVA test for comparison of adjusted MBG, values at 30, 60, and 90 min were found to be comparable. At the end of surgery that corresponded to 180 min, MBG was higher in group D versus group P (120.4 ± 31.4 vs. 101.6 ± 17.8 mg/dl, $P = 0.019$) [Table 2].

MAP and HR were also comparable between both the groups at baseline and at 30, 60, 90 min, and at the end of surgery [Figures 2 and 3].

None of the patients were excluded from the study after inclusion in the trial, and none had hyperglycemia defined as blood sugars >150 mg/dl during the study.[5]

Discussion

The blood sugars in group P were comparable to group D during the surgery, except at the end of the procedure. This

Table 1: Demographics of surgical patients and mean duration of surgery

Variable	Group P (mean±SD, IQR) *n*=28	Group D (mean±SD, IQR) *n*=28
Age (years)	2.38±2.02, 0.6–6	2.03±1.6, 1–6
Weight (kg)	12.26±5.67, 5.8–29	10.79±3.51, 6–21.5
Male	20 (71.4%)	23 (82.1%)
Female	8 (28.6%)	5 (17.9%)
Duration (min)	171.6±55.75	198.29±54.1

IQR=interquartile range, SD=standard deviation

Table 2: Mean blood glucose in both groups

Mean Blood Glucose (MBG)	Group P (mean±SD) *n*=28	Group D (mean±SD) *n*=28	*P*
MBG 0, mg/dl	91.3±13	82±7.9	0.003
MBG 30, mg/dl	87.9±11.0[a]	84.9±13[a]	0.369
MBG 60, mg/dl	99.9±18.4[a]	108.7±25.2[a]	0.173
MBG 90, mg/dl	105.5±19.7[a]	117.8±32.5[a]	0.134
MBG 120, mg/dl	110.7±18.0[a]	121.4±33.9[a]	0.252
MBG end, mg/dl	101.6±17.8[a]	120.4±31.4[a]	0.019

[a]*Adjusted mean using ANCOVA. ANCOVA=analysis of covariates, MBG=mean blood glucose, SD=standard deviation*

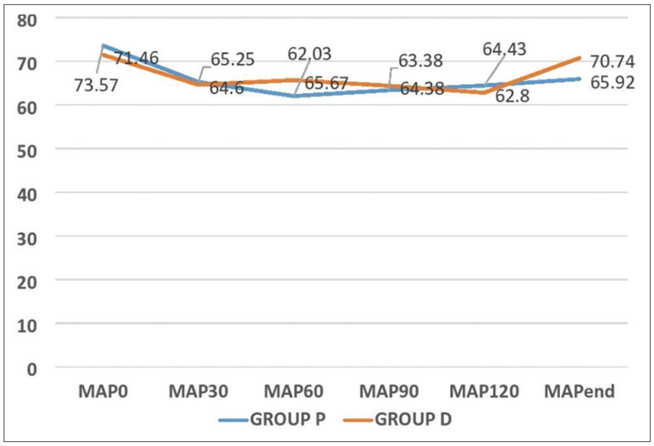

Figure 2: Comparison of MAP between the groups. MAP = mean arterial pressure

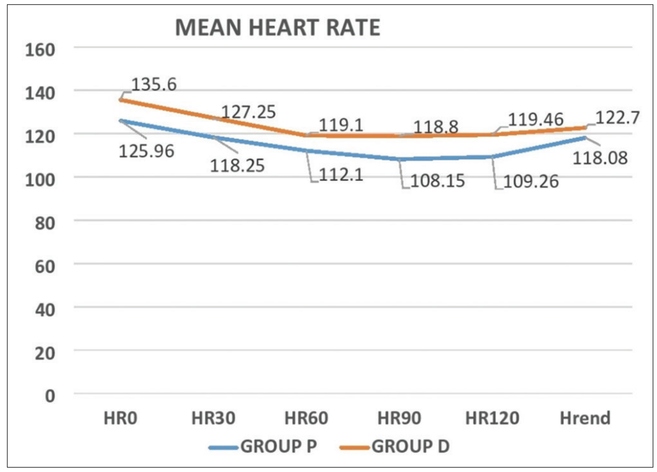

Figure 3: Comparison of HR between the groups. HR = heart rate

would imply that routine supplementation of dextrose is not required in short-duration surgeries under general anesthesia with caudal analgesia.

Clinical evidence suggests that combining general and regional anesthesia improves hemodynamic and overall patient stability, reducing perioperative stress and promoting children's early recovery and rehabilitation. [6-8]

In our study, we administered caudal analgesia to all children by using the blind technique as it has a compelling success rate.[9,10] Benka *et al.*[11] have shown that caudal block, when administered before surgery, reduces postoperative blood sugar and plasma cortisol levels. Our study sought to assess the impact of caudal analgesia on blood sugars perioperatively. However, we did not find perioperative hypoglycemia or a difference between groups that received additional supplemental glucose when glucose was administered in a calculated dose of 1% solution. However, a trend toward rising blood glucose was seen after 60 min in group D and the sugars were significantly higher at the end of surgery corresponding to about 3 h of surgery.

Guidelines created by the American Society of Anesthesiologists allow adequate fluid and even calorie replacement until 1–2 h before surgery.[12] Parents' refusal to follow instructions to allow only clear fluids is usually on account of fear of postponement of procedures due to inadequate fasting resulting in unanticipated delays.[13] According to reports, lengthy fasting periods are unnecessary and might lead to consequences such as postoperative nausea and vomiting, increased insulin resistance, dehydration, headaches, hypoglycemia, and electrolyte imbalance.[14-16] Our institutional protocol involves infusion of 5% dextrose in 0.9% normal saline with added potassium chloride (10 mEq in 500 ml normal saline) as a maintenance fluid from midnight to prevent hypoglycemia or dehydration. However, positioning flow through small veins may have had an impact on the replacement, resulting in fasting hypoglycemia that was seen in 11 patients screened.

The Holliday–Segar formula for maintenance therapy continues to be recommended by the Association of Pediatric Anesthetists and the National Institute for Health and Care Excellence guidelines.[17] Both hypoglycemia and hyperglycemia in pediatric patients might result in brain impairment that can cause lifelong harm if undetected.[18] Mathew and Rai[19] suggest that isotonic fluids with glucose concentrations between 1% and 2.5% may be the best choice for perioperative glucose management.

While most practitioners would agree that short-duration surgeries where children are given oral fluids until 2 h preoperatively do not need dextrose supplementation, the need for additional dextrose among children receiving a regional anesthesia remains unresolved.

Caudal analgesia offers hemodynamic stability in a population of high-risk children with cardiovascular compromises, prematurity, and reduced perioperative need for opioids, allowing early recovery.[6] Adler *et al.*.[18] have shown that HR variations after a caudal block in children under 6 years of age who were anesthetized with sevoflurane are not a reliable sign of a successful block. Another study found that the administration of caudal anesthesia resulted in no appreciable changes in HR or MAP, but did result in a decrease in descending aortic flow and a reduction in systemic vascular resistance.[20] We did not observe any alteration in hemodynamic responses among the children included in our study.

Contrary to other studies,[5] we did not see any difference or increase in blood sugars in the group that received dextrose supplementation compared to the one that did not. This would be probably because infusion of 1% dextrose was given through an infusion pump, making sure that we have not given any additional amount of glucose as per anesthesia management. In both the groups, the rise in blood sugar levels was seen after 1 h and was significantly higher in the group that received glucose supplementation at 3 h, although the levels remained in the physiologic range. This highlights that regular supplementation of dextrose may be unnecessary in pediatric surgeries with caudal analgesia of shorter duration, but emphasizes the need for glucose monitoring during surgery.

We acknowledge the limitations of our study. Our study was limited to a small group of children undergoing surgery between 2 and 3 h. We did not include longer-duration surgeries to assess the impact of continued infusion of 1% DW in RL. Although the intraoperative blood glucose was regulated, we were unable to standardize the fasting duration as children had variable time for clear liquid intake.

Conclusion

Routine supplementation of dextrose is not needed in children undergoing abdominal surgeries of 2-3 h duration under general anaesthesia with caudal analgesia and can raise blood sugars after 3 h . We recommend that routine blood sugar monitoring should be practiced in children undergoing surgeries of intermediate duration.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Desborough JP. The stress response to trauma and surgery. Br J Anaesth 2000;85:109-17.
2. Kahveci K, Ornek D, Doger C, Aydin GB, Aksoy M, Emre C, *et al*. The effect of anaesthesia type on stress hormone response: Comparison of general versus epidural anaesthesia. Niger J Clin Pract 2014;17:523-7.
3. Milosavljevic SB, Pavlovic AP, Trpkovic SV, Ilić AN, Sekulic AD. Influence of spinal and general anaesthesia on the metabolic, hormonal, and hemodynamic response in elective surgical patients. Med Sci Monit 2014;20:1833-40.
4. Aggo AT, Fyneface-Ogan S, Mato CN. The differential impact of two anaesthetic techniques on cortisol levels in Nigerian surgical patients. Niger J Clin Pract 2012;15:68-74.
5. Barua K, Rajan S, Paul J, Tosh P, Padmalayan A, Kumar L. Effect of using Ringer's lactate, with and without addition of dextrose, on intra-operative blood sugar levels in infants undergoing facial cleft surgeries. Anesth Essays Res 2018;12:297-301.
6. Wiegele M, Marhofer P, Lönnqvist PA. Caudal epidural blocks in paediatric patients: A review and practical considerations. Br J Anaesth 2019;4:509-17.
7. Bosenberg A. Benefits of regional anesthesia in children. Pediatr Anesth 2012;22:10-8.
8. Bosenberg A. Pediatric regional anesthesia update. Paediatr Anaesth 2004;14:398-402.
9. Polaner DM, Taenzer AH, Walker BJ. Paediatric Regional Anesthesia Network (PRAN): A multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. Anesth Analg 2012;115:1353-64.
10. Mirjalili SA, Taghavi K, Frawley G, Craw S. Should we abandon landmark-based technique for caudal anesthesia in neonates and infants. Paediatr Anaesth 2015;25:511-6.
11. Benka AU, Pandurov M, Galambos IF, Rakić G, Vrsajkov V, Drašković B. Effects of caudal block in pediatric surgical patients: A randomized clinical trial. Braz J Anesthesiol 2020;2:97-103.
12. Abebe WA, Rukewe A, Bekele NA, Stoffel M, Dichabeng MN, Shifa JZ. Preoperative fasting times in elective surgical patients at a referral Hospital in Botswana. Pan Afr Med J 2016;23:102.
13. Sadhoo A, Rajan S, Jain S, Barua K, Kumar L. Effect of supplemental caudal analgesia on intraoperative blood glucose levels in pediatric patients undergoing urological surgery under general anesthesia. An observational study. Bali J Anaesthesiol 2021;5:1-5.
14. Bothamley J, Mardell A. Preoperative fasting revisited. Br J Perioper Nurs 2005;15:370-4.
15. Khoyratty S, Modi BN, Ravichandran D. Preoperative starvation in elective general surgery. J Perioper Pract 2010;20:100-2.
16. Khoyratty S, Din AH, Spendlove R, Teehan M, Arhi C, Modi BN, *et al*. The impact of discussing preoperative fasting with patients. J Perioper Pract 2011;21:284-6.
17. Sümpelmann R, Becke K, Zander R, Witt L. Perioperative fluid management in children: Can we sum it all up now? Curr Opin Anesthesiol 2019;32:384-91.
18. Adler AC, Schwartz DA, Begley A, Friderici J, Connelly NR. Heart rate response to a caudal block in children anesthetized with sevoflurane after ultrasound confirmation of placement. Pediatr Anesth 2015;25:1274-9.
19. Mathew A, Rai E. Pediatric perioperative fluid management. Saudi J Anaesth 2021;15:435-40.
20. Larousse E, Asehnoune K, Dartayet B, Albaladejo P, Dubousset AM, Gauthier F, *et al*. The hemodynamic effects of pediatric caudal anesthesia assessed by esophageal Doppler. Anesth Analg 2002;94:1165-8.