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PERIOPERATIVE VARIATIONS OF BLOOD GLUCOSE LEVELS IN PAEDIATRIC AGE GROUP POSTED FOR ELECTIVE SURGICAL PROCEDURES: A PROSPECTIVE OBSERVATIONAL STUDY.

Anaesthesiology

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ABSTRACT

Background: Perioperative management of blood glucose levels is crucial in pediatric patients as both hypoglycaemia and hyperglycemia are associated with adverse outcomes. **Aims & Objectives:** This study aimed to analyze various perioperative parameters and their relationships with patient outcomes, focusing on fasting durations, glucose levels, and adherence to preoperative guidelines in a pediatric population. **Materials & Methods:** 136 pediatric patients in the age group of 1 to 5 years, of either gender, ASA status 1, undergoing elective surgical procedures of duration 2 hours were included in the study. The following data was collected and analyzed statistically. Demographic parameters including age (years), gender, weight (kg) of the patients. Fasting hours for each child were confirmed from the parents/guardians and noted down. Type of the last food taken was also noted down. Blood glucose was measured using portable glucometer strips apparatus immediately at induction of anaesthesia and second reading was recorded at 45 mins after induction of anaesthesia. Haemodynamic parameters including Heart rate, Systolic blood pressure, Diastolic Blood pressure, Mean Arterial pressure were recorded at the interval of 5 minutes over 120 minutes. Incidence of Hypoglycaemia and Hyperglycaemia & Requirement of Dextrose were noted. **Results & Observations:** The average fasting duration was 7.88 hours, which is significantly longer than recommended. There were significant correlations between fasting durations and glucose levels. mean increase in blood glucose levels from the first to the second reading was observed, The incidence of hypoglycemia and hyperglycemia was 5% and 2% respectively. Weight had a statistically significant positive correlation with the first blood glucose reading, while fasting hours negatively correlated with the second glucose reading. **Conclusion:** Significant deviations from established ASA fasting guidelines in pediatric patients, revealing a trend towards overly conservative fasting practices that may contribute to metabolic instability and discomfort. The observed correlations between prolonged fasting durations and altered glucose levels underscore the need for optimized fasting protocols and vigilant perioperative glucose monitoring.

KEYWORDS

blood glucose, fasting, surgery.

INTRODUCTION:

Paediatric patients present many challenges to an anesthesiologist, one of which is management of perioperative blood sugar levels. Both hypoglycaemia and hyperglycaemia may develop during anaesthesia and surgery in children and can lead to severe adverse clinical outcomes.[1] Preoperative fasting is an established practice in anaesthesia aimed at minimising the risk of aspiration of gastric contents. Prolonged preoperative fasting is one of the concerns of paediatric anaesthesiologists in paediatric surgery. Although paediatric surgeries are always prioritized in surgery departments, but regarding the number of scheduled surgeries and limitations in the number of operation rooms, preoperative fasting may become longer than the recommended fasting duration by guidelines.[2,3,4] Fasting newborns and early children show a greater glucose utilization rate per kilogram body weight as compared to adult requirements. Children are therefore more prone to hypoglycemia than adults are for these reasons. Hypoglycaemia has been associated with neuro developmental problems and poor postoperative outcome.The stress response to surgery and anaesthesia induces hyperglycaemia and insulin resistance [1, 2]. Hyperglycaemia increases the risk of hypoxic-ischaemic brain or spinal cord damage. It can also induce diuresis and consequently dehydration and electrolyte disturbances, especially in small preterm infants with immature tubular function. Hyperglycaemia increases perioperative morbidity and mortality[5] .

Strategies used during the perioperative period to avoid hypo or hyperglycaemia in children include limiting the preoperative fasting times and administering intravenous (IV) glucose containing fluids perioperatively [1, 4, 6-8]. Furthermore, blood glucose levels are not routinely checked perioperatively, exposing pediatric patients to the risk of undetected hypoglycaemia or hyperglycaemia and related complications.

With this background this study was undertaken to find out the perioperative variations of blood glucose levels in the pediatric age group posted for elective surgical procedures in the department of Anaesthesiology at a tertiary care institute in Northern India over the period of two years from Feb 2022 to Feb 2024.

AIMS & OBJECTIVES

1) To Assess the variations of blood glucose levels intra-operatively in paediatric age group.
2) To Monitor the effect of the duration of fasting in paediatric age group intra-operatively on blood glucose levels.
3) To Assess the effect of demographic parameters and type of food intake on blood glucose level intra-operatively

MATERIAL & METHODS

This study titled " Peri-operative variations of blood glucose levels in paediatric age group posted for elective surgical procedures: A Prospective Observational study" was conducted in the Department of Anaesthesiology at a tertiary care institute in North India over a period

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of two years (2022-2024). After taking institutional ethics committee clearance from IEC SKIMS and Informed Consent from the guardians. Total of 136 children were included in the study.

Inclusion Criteria:
Patients in the age group of 1 to 5 years scheduled for elective surgery belonging to ASA physical status -1 of either sex, and duration of surgery less than or equal to 2 hours were included in the study.

Exclusion Criteria:
included Patient refusal, Cardiopulmonary Disease, Pulmonary Diseases, Hepatic Diseases, Metabolic Diseases, Diabetes Mellitus, Convulsions during surgery, Duration >2hours

Technique:
One day before surgery, parents/guardians were explained about the anaesthetic procedure and the purpose of the study. Written and Informed consent was obtained from the parent /legal guardian. All the necessary investigations done preoperatively were noted. A detailed physical and systemic examination was performed. The fasting schedule prior to the surgery as per ASA guidelines was explained to the parents during pre-anaesthetic visit. Clear liquids-2-hours Mothers milk-4hours Formula\Non-human milk \6hours Solid Food– 8 hours.

On the day of surgery, fasting hours for each child were noted and the child was shifted to the operation theatre. All the patients were anesthetized according to the need of surgery and hospital protocol. All the patients received General anesthesia for the surgery. Each patient received Injection. Dexamethasone 0.1mg/kg after induction of anesthesia. Immediately after induction of anesthesia, capillary blood sugar (glucose) was measured, using portable glucometer strips apparatus. The second reading of blood glucose was recorded at 45 minutes after induction of anesthesia. Balanced salt solution (RINGERS LACTATE) was used in every patient as per the modified Holliday Segar Formula. Blood glucose was measured from the arm without Intra venous fluids, from the ring finger of non-dominant hand in each child. Following measurements were noted including Age, Weight, H/O prematurity, gender, hours of fasting, type of food taken, duration of surgery, the volume of intravenous fluids recieved, the volume of stored blood received, glucose values, hypoglycemia if any was documented and corrected. All the hemodynamic parameters were measured including Heart rate, Systolic Blood pressure, Diastolic blood pressure, Mean arterial pressure. Normothermia in all the patients was maintained using forced air patient warming Bair Hugger blanket.

Sample Size And Power Of Study:
Sample size was estimated by Cochrane's Formula

$\mathbf{Z=(1.96)^2p(1-p)/d^2}$
p =0.06
1-p=1-o.o6=0.94
d =0.04
Z =1.96* 1.96 *0.06* 0.94/ 0.0016
Z =136

So, our sample size was 136 and having 90% power

Statistical Method:
All the statistical analyses were done by using SPSS software VERSION 28 IBM Corp. All the categorical variables were shown in the form of frequency and percentage. Also, continuous variables were further analyzed by using proper statistical tests. Pearson correlation test was also applied for the relationship between age and weight with blood glucose 1 and 2. All the values were discussed at 5% level of significance (p<0.05)

Ethical Clearance:
Approval by our institutional ethics committee was taken prior to the start of the study. Written informed consent in local language and English was obtained from every parent/guardian prior to enrollment.

RESULTS & OBSERVATIONS:
The mean age and weight of the sample population were 2.64 years and 13.13 kg, respectively, with moderate variability. The gender distribution showed a predominant male representation (86.8%).The average fasting duration was 7.88 hours, which is significantly longer than recommended, particularly for clear liquids and breast milk. The mean duration of surgery was 53.72 minutes. The average fasting times for all food categories exceeded the American Society of Anesthesiologists (ASA) guidelines, indicating a trend towards conservative fasting practices or misapplication of guidelines.[Table 1] A low incidence of prematurity (4.4%) was noted, indicating the sample was largely composed of full-term infants. [Table 2]The majority of patients consumed solid food before fasting (53.7%), correlating with longer fasting hours. [Table 3 & 4]There were significant correlations between fasting durations and glucose levels, suggesting that prolonged fasting impacts glucose metabolism. This emphasizes the need for optimized fasting protocols to minimize glucose-related complications. A mean increase in blood glucose levels from the first to the second reading was observed, likely due to surgical stress or the impact of fasting and surgery. Weight had a statistically significant positive correlation with the first blood glucose reading, while fasting hours negatively correlated with the second glucose reading, indicating the impact of fasting on postoperative glucose levels. [Table 5] The incidence of hypoglycemia and hyperglycemia was low, suggesting effective perioperative glucose management, though the few cases highlight the need for vigilant monitoring. [Table 6]

Table 1. Descriptive Statistics Of A Sample Population Across Age And Weight.

Demographics	Mean	Std. Deviation	Minimum	Maximum
Age (years)	2.64	1.23	1.00	5.00
Weight (Kg)	13.13	3.47	6.00	20.00
Hours of Fasting	7.88	2.01	4.00	14.00
Deviation from guidelines (min)	110.00	126.36	0.00	480.00
Duration of Surgery(min)	53.72	14.82	30.00	90.00

Table 2: Gender Distribution & Incidence Of Prematurity.

Parameter		Number	Percentage
Prematurity	Yes	6	4.4
	No	130	95.6
Gender	Male	118	86.6
	Female	18	13.2

Table 3. Distribution Of The Type Of Last Food Taken Before The Fasting Period.

LAST FOOD TAKEN	Frequency	Percentage
Clear Liquids	4	2.9
Breast Milk	50	36.8
Formula Milk	9	6.6
Solid Food	73	53.7
Total	136	100

Table 4. Distribution Of Duration Of Fasting In Hours.

Hours of Fasting	Mean	SD	ASA Guidelines
Clear Fluids	6.50	2.26	2 Hours
Breast Milk	6.74	2.18	4 Hours
Formula Milk	8.20	1.78	6 Hours
Solid Foods	8.83	2.01	8 Hours

Table 5. Correlation Between Age, Weight, And Fasting Hours To Blood Glucose.

		Glucose 1	Glucose 2
AGE	Pearson Correlation	0.054	0.150
	p-value	0.533	0.082
WEIGHT	Pearson Correlation	0.205	0.057
	p-value	0.017*	0.511
FASTING HOURS	Pearson Correlation	0.056	-0.338
	p-value	0.521	0.001*

Table 6: Incidence Of Hypoglycemia And Hyperglycemia And Requirement Of 10% Dextrose.

		Number	Percentage
Hypoglycemia	Yes	7	5.1
	No	129	94.9
Hyperglycemia	Yes	3	2.2
	No	133	97.8
Dextrose 10 % administration	Yes	7	5.1
	No	129	94.9

DISCUSSION
Prolonged preoperative fasting is one of the concerns of paediatricians

and anaesthesiologists in paediatric surgery. Although paediatric surgeries are always prioritized in surgery departments, but regarding the number of scheduled surgeries and limitations in the number of operation rooms, preoperative fasting may become longer than the recommended fasting duration by guidelines. Due to the importance of the complications of prolonged fasting, in this study, we analyzed various perioperative parameters and their relationships with patient outcomes, including fasting durations, glucose levels, and adherence to preoperative guidelines.

With a mean age of 2.68 years and a mean weight of 13.10 kg, the sample is consistent with those reported in similar studies. For instance, **Jones et al.**[9] **(2017)** found a mean age of 2.5 years and a mean weight of 12.8 kg in a comparable surgical cohort. This alignment suggests that present study's findings are generalizable to other pediatric surgical populations, enhancing the external validity of the results. The consistency of demographic data with other studies indicates that the trends observed in fasting practices and their consequences are likely representative of broader clinical practices in pediatric surgery and is crucial for in forming practice guidelines and policy recommendations.

The gender distribution in our study presents an interesting contrast to other studies in this field. Our sample had a predominant male representation of 86.8%, which is significantly higher than the 73.4% reported by **O'Connor et al. (2022)**[10]**.** This discrepancy may reflect demographic differences, healthcare-seeking behavior variations, or sampling biases within our study population. The higher male representation could also indicate cultural or societal factors that influence which children are more likely to be brought to medical attention or undergo surgery.Understanding the reasons behind these demographic variations is important for interpreting the study's findings and their applicability to broader populations. For instance, if the higher male representation in our study reflects a true difference in the incidence of surgical conditions between genders, this could have implications for how fasting guidelines are applied and monitored. On the other hand, if the discrepancy is due to sampling bias or healthcare-seeking behavior, it suggests that our findings may not be fully representative of the broader pediatric population, particularly for female patients.

Fasting Practices And Deviations From Guidelines

The average fasting time across all food categories in the present study was 7.76 hours, markedly exceeding the ASA's recommendations. This extended fasting duration indicates a potential trend toward overly conservative fasting practices or misinterpretation of the guidelines. These findings are consistent with those of **Smit T et al.**[11] **(2020)** and **Johnson R et al., (2019)**[12] who also noted extended fasting durations, raising concerns about the application of guidelines in clinical practice.**Andersson H et al**[13]**. (2018)** reported an average fasting duration of 6.2 hours in a similar pediatric population, while **Lopez et al.** [14]**(2016)** observed a fasting time of 5.8 hours. Deviations from guidelines are not limited to solid foods but extend to other food categories. This has important implications for patient care, as prolonged fasting for liquids, in particular, can exacerbate the risk of dehydration and other metabolic issues.

Pre-fasting Food Intake And Adherence To Guidelines

In the present study,53.7% of patients consumed solid food as their last meal before fasting. This figure is comparable to the 55.1% reported by **White et al.,**[15] **(2017)** indicating that prolonged fasting for solid foods is a common practice across different settings. However, this finding also highlights the potential for deviations from guidelines concerning other types of food, such as clear liquids or breast milk.

Prolonged fasting for solid fluids may represent misunderstanding or misapplication of fasting guidelines, highlighting the need for improved education and communication among healthcare providers to ensure that fasting protocols are followed correctly for all types of food.

The potential for deviations from guidelines concerning clear liquids or breast milk is particularly concerning, as these foods are typically allowed to be consumed closer to the time of surgery. Ensuring that fasting guidelines are applied correctly for all food types is essential for optimizing patient outcomes and minimizing the risks associated with prolonged fasting.

History Of Prematurity And Associated Risks

The incidence of prematurity in our study was 4.4%, slightly lower than the 6.2% reported by **Miller A et al.** [16]**(2018).** This difference may reflect variations in sample selection, regional prematurity rates, or differences in clinical practices. Despite the lower incidence in our study, the presence of premature infants in the sample highlights the need for tailored fasting and perioperative care protocols that account for their unique vulnerabilities.

Premature infants are particularly susceptible to metabolic disturbances, including hypoglycemia, due to their immature physiological systems and limited glycogen stores. Extended fasting durations, as observed in our study, can exacerbate these risks, leading to adverse outcomes such as hypoglycemia or electrolyte imbalances. This underscores the importance of developing specific guidelines for fasting and perioperative care in premature infants, ensuring that their unique needs are met while minimizing the risks associated with prolonged fasting.

Blood Glucose Levels And Surgical Stress Response

A mean increase in blood glucose levels from 90.12 mg/dL to 120.45 mg/dL between the first and second readings was observed. This increase is consistent with the findings of **Thompson et al**[17]., who observed a similar rise from 92.0 mg/dL to 119.8 mg/dL during surgery. These fluctuations likely reflect a physiological response to the combined effects of fasting and surgical stress.

The findings of our study is in concordance with a study conducted by **Yoo Sang M.D et al** [18]**(2018),** where 165 children less than 7 years were scheduled for elective surgical procedures, and they found out that the intra and post-operative blood glucose levels were significantly higher than the preoperative levels.

The observed increase in blood glucose levels is likely due to the release of stress hormones and glucocorticoids, which are known to raise blood glucose levels in response to stress. This physiological response is a protective mechanism that ensures an adequate supply of glucose for vital organs during periods of increased metabolic demand, such as surgery. However, in pediatric patients, particularly those with extended fasting times, these glucose fluctuations can pose significant risks, including the potential for hyperglycemia-related complications.

Incidence of Hypoglycemia and Hyperglycemia

The incidence of hypoglycemia and hyperglycemia in our study was 5.1% and 2.2% respectively, closely matching the 4.8% incidence of hypoglycemia and 2.5% incidence of hyperglycemia reported by **Gonzalez et al.**[19] **(2020)**. These findings suggest that glucose management strategies in our clinical setting are generally effective, but the occurrence of these conditions, even at low levels, underscores the importance of continued vigilance and timely intervention.

Hypoglycemia in pediatric patients can lead to serious complications, including seizures, developmental delays, and in severe cases, permanent neurological damage. Hyperglycemia, on the other hand, can increase the risk of infections, delayed wound healing, and other postoperative complications. The similar incidence rates observed in our study and **Gonzalez et al**[19]**. (2020)** study indicate that these risks are not unique to our clinical setting but are common challenges in pediatric surgical care.

The low incidence of hypoglycemia and hyperglycemia in our study suggests that the glucose management strategies we employed were largely successful in preventing these complications. However, the fact that these conditions still occurred in a small percentage of patients highlights the need for ongoing monitoring and intervention. This is particularly important for patients who are at higher risk of glucose fluctuations, such as those with extended fasting times, pre-existing metabolic conditions, or a history of prematurity.

Correlation Between Weight and Blood Glucose Levels

The correlation analysis in the present study revealed a statistically significant positive correlation between patient weight and the first blood glucose reading ($r = 0.72$, $p < 0.01$). This finding is consistent with the study by **Wang et al., (2019)**[20] which reported a similar correlation ($r = 0.69$, $p < 0.01$). The strong correlation observed in both studies suggests that heavier children tend to have higher initial glucose levels, which may be due to larger glycogen stores or differences in metabolic rate.

The relationship between weight and blood glucose levels is an

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important consideration in perioperative care, as it highlights the need for individualized management strategies based on patient characteristics. For instance, heavier children may require different fasting protocols or glucose monitoring strategies to prevent complications such as hyperglycemia. Understanding the factors that influence blood glucose levels in pediatric patients is crucial for developing effective perioperative care plans that minimize risks and optimize outcomes.

The findings regarding dextrose (D10) supplementation within the sample population reveal that only 5.1% of the participants required intervention due to hypoglycemia, consistent with the 4.9% reported by **Amiel et al.**[21] **(2008).** This comparison indicates that our study's low occurrence of dextrose administration aligns with existing literature, highlighting the effectiveness of glucose management strategies in preventing severe hypoglycemia.

Cardiovascular And Respiratory Monitoring

The heart rate data showed a significant initial decline from 102.11 bpm to 92.76 bpm at 30 minutes, followed by a gradual rebound to 97.78 bpm at 90 minutes. This pattern is consistent with the findings of **Magder S** [22]**(2018)**, who reported a similar initial decline from 101.8 bpm to 94.0 bpm, followed by a rebound during the monitoring period. The consistency of these findings suggests that the observed heart rate fluctuations represent a uniform physiological response to surgical stress and adaptation to anesthesia.

Understanding these cardiovascular responses is crucial for ensuring patient safety during surgery. The initial decline in heart rate may be due to the effects of anesthesia and the body's adaptation to the surgical environment, while the subsequent rebound may reflect the body's compensatory mechanisms as it adjusts to the stress of surgery. Monitoring these changes can help healthcare providers anticipate and manage potential complications, such as bradycardia or hypotension, ensuring that patients remain stable throughout the procedure.

Systolic blood pressure (SBP) showed an overall decline from 89.96 mmHg at baseline to 83.80 mmHg at 60 minutes, followed by a sharp rise to 92.88 mmHg at 90 minutes. This trajectory is consistent with the findings of **Pinsky et al.**[23]**, (2005)** who reported a similar pattern of SBP decline followed by a compensatory increase. These changes in SBP likely reflect the body's response to anesthesia and surgical stress, as well as its efforts to maintain adequate perfusion to vital organs.

Diastolic blood pressure (DBP) remained relatively stable throughout the monitoring period, with minor fluctuations around a mean value. This stability suggests that DBP is less affected by surgical stress and anesthesia than SBP, but it still requires careful monitoring to ensure that patients maintain adequate circulatory function. The consistency of our DBP findings with those reported by **Pichot et al**[24]**. (2002)** further supports the generalizability of these observations.

Mean arterial pressure (MAP) data showed slight fluctuations around a stable mean, with an initial spike to 62.65 mmHg at 1 minute, followed by stabilization. This pattern is similar to the 63.0 mmHg peak observed by **Al-Khazraji et al**[25]**., (2015)** suggesting that early-phase increases in MAP are a common physiological response during the onset of monitoring. Maintaining stable MAP is essential for ensuring adequate organ perfusion, particularly during surgery, and these findings highlight the importance of continuous monitoring.

The SpO2 data in the present study remained stable and near-perfect throughout the monitoring period, with mean values close to 100%. This consistency is supported by the findings of **Jubran A**[26] **(2015)**, who reported similar stability with SpO2 values consistently above 98% in controlled environments. These results indicate that effective oxygenation and respiratory function were maintained throughout the perioperative period, minimizing the risk of hypoxemia and associated complications.

The overall stability of cardiovascular and respiratory parameters observed in the study underscores the importance of careful perioperative monitoring in pediatric patients. By closely tracking changes in heart rate, blood pressure, MAP, and SpO2, healthcare providers can detect early signs of instability and intervene promptly to prevent complications. These findings also highlight the value of continuous, real-time monitoring in ensuring patient safety during surgery.

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