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Preoperative fasting duration and incidence of hypoglycemia and hemodynamic response in children

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ABSTRACT

Studies of the effects of preoperative starvation on blood glucose levels in children have produced apparently conflicting results. The study which we conducted, investigated the incidence of hypoglycaemia and hypoglycaemic signs in the children fasted for various periods. It also studied the hemodynamic responses in the perioperative period in relation to the duration of fasting and reliability of hypoglycaemic signs to identify biochemically demonstrable hypoglycaemia. One hundred children with physical status ASA-I and II between 6 months to 6 years of age who underwent elective surgical procedures for like herniotomy, cleft lip repair etc, were included in the study after taking institutional ethics committee approval and written informed consent. The patients were randomly allocated to one of the below mentioned two groups of 50 patients each for the purpose of this study. Group –I constituted children who were kept fasting after midnight for morning surgery. Children in Group-II were given 5% Dextrose water as oral feed 10ml per kg of body weight 3-4 hours before the expected time of start of surgery. Standard anaesthesia technique was used in all the patients. No incidence of hypoglycaemia was found in both the study groups during perioperative period i.e. immediately before induction of anaesthesia and 20 minutes after induction of anaesthesia. The incidence of hypotension and low blood pressure was more in the overnight fasting group as compared to 3-4 hours fasting group, although all the readings were not statistically significant. On the basis of our observations, we recommended that prolonged or overnight fasting in the healthy paediatric age group (ASA I and II) between the age of 6 months to 6 years is to be avoided and oral feed of 5% Dextrose 10ml per Kg of body weight can be given 3-4 hours before surgery as the patient comfort is increased without compromising on safety and these patients had a better hemodynamic response in the perioperative period.

INTRODUCTION

Hypoglycemia is recognized as being a perioperative danger in paediatric practice predisposing to lethargy, irritability and metabolic acidosis with resultant anaesthetic problems including seizures. During surgery, there is a rise in the plasma glucose level in normal adult, but it has been shown that children do not respond with a hyperglycemic reaction to the same degree. The mean normal fasting glucose concentration at birth is 54 mg/dl with a range of 28-96 mg/dl [1]. The concentration increases in childhood to mean of 77mg/dl at 2 years and 92 mg/dl at 15 years. After the third day of life, hypoglycemia is defined as blood glucose concentration less than 40mg/dl [2] . Other authors have suggested higher limits of 50mg/dl [3] and 60mg/dl [1] . Allison et al [4] considered 3.3 mmol/l (60mg/dl) to be lower limit of normoglycemia; levels below 2.8 and 2.2mmol/l (50 and 40mg/dl) being designated as 'moderate' and 'severe' hypoglycemia, respectively. Hypoglycemia is provoked by fasting though it is not inevitable consequence of withholding food. The body conserves glucose by a decrease in concentration of circulating insulin and an increase in the concentration of counter regulatory hormones – growth hormones, glucogon, cortisol and adrenaline .

The relationship between hypoglycemia and hypoglycemic signs has been studied by Gupta et al [5] . Signs like sweating, headache, excessive crying have been reported to be indicators of hypoglycemia. Older children may complain of these, which may alert the clinicians towards hypoglycemia. In this study, it was found that these signs had a high false positive rate (66.66%) in predicting the actual hypoglycemia.

An area that has attracted a great deal of recent study is that of preoperative fasting [6] . An accepted prerequisite for all elective surgery, it is greatly disliked by children and may cause delays to surgical operating lists [7]. While patient comfort is enhanced by reduction of preoperative fasting period, this concern must be balanced against the important issue of patient safety [8] .

To overcome the controversies regarding the fasting guideline preoperatively in different countries and to adopt a uniform approach, worldwide practice guidelines were published by the American Society of Anesthesiologist Task Force on Preoperative Fasting. The summary of fasting recommendations is as under [9] :

Ingested Material	Minimum fasting period (hours.)
Clear liquids	2
Breast milk	4
Infant formula	6
Non-human milk	6
Light meal	6

These recommendations apply to healthy patients who are undergoing elective procedures. These are not intended for women in labour. Following the guidelines does not guarantee complete gastric emptying. The fasting periods noted above apply to all ages. Examples of clear liquids include water, fruit juices without pulp, clear tea and black coffee. The purpose of these guidelines are to enhance the quality and efficiency of anaesthesia care, stimulate evaluation of individual practices, and reduce the severity of complications related to pulmonary aspiration of gastric contents, should it occur.

Studies of the effects of preoperative starvation on blood glucose levels in children have produced apparently conflicting results. Apart from hypoglycemia and pulmonary aspiration, other attendant problems associated with the duration of fasting in the perioperative period are risk of metabolic acidosis, hemodynamic instability in the perioperative period, changes in the gastric pH, and speed of recovery from anaesthesia. Robert H.Friesen et al [10] hypothesized that the duration of perioperative fast affects blood pressure observed in infants during halothane anaesthesia. The study which we conducted, investigated the incidence of hypoglycemia and hypoglycemic signs in the children fasted for various periods. It also studied the hemodynamic responses in the perioperative period in relation to the duration of fasting and reliability of hypoglycemic signs to identify biochemically demonstrable hypoglycemia.

Experimental Section:

After approval from institutional ethics committee one hundred children with physical status ASA-I and II between 6 months to 6 years of age who underwent elective surgical procedures for like herniotomy, cleft lip repair etc, were included in the study. The patients were randomly allocated to one of the below mentioned two groups of 50 patients each for the purpose of this study.

Group –I : This group constituted children who were kept fasting after midnight for morning surgery.

Group-II : Children in Group-II were given 5% Dextrose water as oral feed 10ml per kg of body weight 3-4 hours before the expected time of start of surgery.

Exclusion Criteria:

1. Patients with known cardiac disease, pulmonary disease, disease affecting fluid and electrolyte balance of the body e.g. gastrointestinal obstructive or inflammatory disease, were excluded from the study.

2. Patients with any metabolic disease were also excluded from the study.

Written and informed consent to participate in the study was taken from any of the parents. No premedication was advised on arrival to the operating room. Topical anaesthesia gel (prilox gel) was applied 1 hour before induction time on the possible puncture site for institution of intravenous access. One of the parents was allowed in the operating room to attain co-operation of the child before anaesthesia was induced. After establishing intravenous line patients were connected to Datex Ohmeda Monitor for monitoring electrocardiography, heart rate, non invasive blood pressure and saturation of oxygen. Baseline values of these were recorded.

Standard anaesthesia technique was followed in all the patients. At the induction of anaesthesia, injection Morphine Sulphate 100μgms/kg body weight was given intravenously. Induction of anaesthesia was done with Sodium Thiopentone 4-6 mg/kg body weight followed by rocuronium 0.8mg/kg body weight to facilitate endotracheal intubation. Anaesthesia was maintained with

60% Nitrous Oxide in oxygen supplemented with isoflurane as inhalational agent. Muscular relaxation was maintained with additional rocuronium doses as required. Additional analgesia in form of paracetamol suppository 10-15 mg per kg body weight was used. Maintenance fluid given initially for the first 20 minutes was normal saline as per the calculated requirement. Dextrose containing fluids were given only 20 minutes after the induction of anaesthesia as per the calculated requirements intraoperatively.

At the end of surgery, the neuromuscular block was reversed with atropine (0.02mg/kg) and neostigmine (0.07mg/kg) injected intravenously and children were extubated by lying on their sides.

The first blood glucose estimation was performed prior to induction of anaesthesia. After intravenous catheter was inserted, the blood which returned to the hub of needle was drawn for glucose analysis. Glucose analysis was performed using accu-chek sensor comfort glucometer which uses amperometry as the test principle. The second blood glucose estimation was performed 20 minutes after induction of anaesthesia by obtaining venous sample and testing with accu-chek glucometer.

For the purpose of this study, hypoglycemia was defined as a blood glucose concentration of less than 50 mg/dl and hyperglycemia was defined as blood glucose concentration of more than 150 mg/dl [11] .

Following parameters were noted for study purposes:

1) The parents and the concerned staff were explained in detail to observe for the following signs of hypoglycemia:
    I) Sweating
    II) Lethargy
    III) Excessive crying
    IV) Pallor

2) Blood glucose levels at:
    I) Prior to induction of anaesthesia
    II) 20 minutes after induction of anaesthesia.

3) Duration of fasting in hours

4) Hemodynamics:
    I) Heart rate
    II) Systolic arterial pressure
    III) Mean arterial pressure

Above variables were recorded just before induction and thereafter every 5 minutes for 20 minutes after induction of anaesthesia for the purpose of this study.

5) Complications encountered during the course of anaesthesia, if any, for example :
    I) Features of pulmonary aspiration

II) Hypoglycemia
III) Hypotension
IV) Seizures

The results were analyzed statistically and inference was drawn from the results obtained.

RESULTS

The comparison of blood glucose levels prior to induction of anaesthesia to blood glucose levels 20 minutes after induction of anaesthesia in both the groups (I&II) was statistically significant. There was significant increase in the blood glucose levels 20 minutes after induction of anaesthesia in both the groups (I&II), as depicted in table No. 1.

The mean blood glucose levels (mg/dl) in group I and group II were 79.22 ± 11.22 and 82.96 ± 6.02 respectively before the induction of anaesthesia. The difference in the mean blood glucose levels before the induction of anaesthesia in both the groups (I & II) was not significant statistically. (Table 2).

The blood glucose levels (mg/dl) in group I and II, 20 minutes after induction of anaesthesia were 85.52 ± 11.73 and 93.28 ± 8.89 respectively. The blood glucose levels were higher in group II as compared to group I, 20 minutes after induction of anaesthesia and the difference was statistically significant with a p-value of 0.001. (Table 3).

The comparison of pulse rate (beats/minute) in group I and group II was statistically non-significant (p = 0.348) just before induction of anaesthesia. The non significant difference in pulse rate among group I and group II persisted at 5 minutes, 10 minutes, 15 minutes and 20 minutes after induction of anaesthesia.(Table 4) .

The mean systolic blood pressure before induction of anaesthesia in group I was 105.62 ± 9.39 and in group II it was 107.60± 8.93. The difference in the mean systolic blood pressure in two groups was statistically not significant prior to induction of anaesthesia although it was higher in group II (p=0.266). 5 minutes after induction of anaesthesia, the mean systolic blood pressure in group I and II were 95.30±13.03 and 100.34±8.62 respectively. The difference was statistically significant and higher in group II with a p-value of 0.027. 10, 15 and 20 minutes after induction of aneasthesia, the difference in the mean systolic blood pressure readings in group I, were lower than in group II although the difference was statistically non-significant as depicted in Table No. 5.

The comparison of mean blood pressure (mmHg) in group I and group II was statistically non-significant (p=0.300) at the onset. At 5 minutes and 15 minutes after induction of anaesthesia, the Mean ± SD of mean blood pressure in group II was higher than in group I, with the difference being statistically significant as depicted by the p-values. At 10 minutes and 20 minutes after induction of anaesthesia, the mean blood pressure was higher in group II than in group I but the difference was statistically non-significant.(Table 6).

As depicted by table 7, in the preoperative period, among the signs and symptoms of hypoglycemia, excessive cry was observed in 17 out of 50 and pallor was observed in 3 out of 50 patients in study group I. In study Group II, 7 out of 50 patients had excessive cry. This difference was statistically significant. No other sign or symptom of hypoglycemia was found in any of the patients in both the study groups.

DISCUSSION

The present study "Effect of preoperative fasting duration on incidence of hypoglycemia and hemodynamic response in children" aims to investigate the incidence of hypoglycemia in routinely fasted children i.e. children fasted after midnight for morning surgery versus 3-4 hours fasting, and to study the hemodynamic response to the fasting status. For the 3-4 hours fasting group, 5% Dextrose was chosen as oral feed as in the earlier studies conducted by Graham [12] ,K Payne [13] and J.H. Vander Walt et al [14] .

The influence of preoperative starvation on blood glucose concentration in paediatric patients remains controversial. In the study by Thomas [15] , the risk of hypoglycemia (defined as blood glucose concentration less than 40mg/dl) was increased in children younger than 4 years of age having prolonged preoperative starvation . However, the other studies were unable to confirm that duration of starvation before operation had any influence on preoperative blood glucose concentrations (Bevan and Burn 1973 [16] ; Graham 1979 [12] ; Jenson, Wernberg, Anderson 1982 [17]). Further more, studies conducted by J.H. Vander Walt et al [14] , Nancy et at [18] on paediatric age group also failed to demonstrate hypoglycemia after preoperative fasting.

In our study none of the blood glucose determinations was found to be in the hypoglycemic range. Our observations are in accordance with the study conducted by Bevan et al [16] in which the mean values of blood glucose in each age group tended to be higher in the "fed" and in the "starved" group. The patients in Group I were exposed to overnight fasting with the fasting duration in these patients ranging from 10-16 hours. None of the patients in this group had blood sugar levels below 50mg/dl which was the hypoglycemic limit for the purpose of our study. The observation was in accordance to the studies conducted by J.H. Vanderwalt et al [14] , Graham et al [12] , Brain M. Schneider et al [19] , K. Nilsson et. Al [20] and Nancy Redfern et al [18] . Summary of these studies is given in table 8.

However, there have been studies conducted in the paediatric age groups in which incidence of hypoglycemia have been seen in contrary to our observation. The summary of such studies are given in table 9.

The fact that the earlier studies of perioperative blood glucose data showed variable results stimulated the present study. The observation of hyperglycemic response to the stress of surgery in our study is similar to the studies conducted by Dorothy J.O. et al [21] , K. Nelsson et al [20] and Watson et al [22] . Watson's study (25 with major and 55 with minor surgery) under relaxant technique showed a small but significant means rise of 8mg/100ml as a result of surgery in blood glucose. He found no relationship between the stressfulness of the operation and the rate of rise of blood glucose concentration. In another study Verhoevan et al [23] aimed to evaluate the time course of perioperative blood glucose levels of children undergoing cardiac surgery for congenital heart disease in relation endogenous stress hormones , inflammatory mediators, and exogenous factors such as caloric intake and glucocorticoid use. Hyperglycemia defined as glucose levels higher than 8.3 mmol/l (>150 mg/dl) was present in 52% of children at the end of surgery. During surgery ,glucocorticoids were administered to 65% of the children, and this was the main factor associated with hyperglycemia at the end of surgery (determined by univariate analysis of variance). In the study conducted by Dorothy et al [21] , all patients had minor operations and in them, mean blood sugar rise of 20 mg /100ml in the inhalational group and 23.3mg /100ml in the relaxant group were found following 15 minutes of surgery. Increases in blood glucose concentrations have been found during surgery in adults when both saline and 5% glucose solutions were infused during operation [24]. Several factors such as decrease in glucose tolerance, low peripheral utilization of glucose levels in the perioperative period in children have been postulated to explain this phenomenon [25]. In this study, the tendency was for glucose levels to rise postoperatively, but in the individual case, this was quite unreliable. Similar were the findings in our study also. This suggests that stress response raises the plasma glucose in paediatric age group as in adults, but to lesser degree.

The result of our study points out that prolonged fasting in the paediatric age group of 6 months to 6 years can lead to hypotension as compared to children who have had oral feed of clear fluid that is 5% Dextrose 3-4 hours before induction of anaesthesia. These results signify that paediatric patients in age group of 6 months to 6 years undergone surgery under general anaesthesia are more prone to hypotension under anaesthesia if they have experienced prolonged preoperative fasting which has been to the order of 10-16 hours in our study. Friesen et al [10] demonstrated that prolonged preoperative fasting is associated with a greater decrease in blood pressure in infants. Avoiding prolonged preoperative fasting has been assumed to prevent hypovolemia and hypotension during anaesthetic induction[6][26]. Diaz [26] believed that the incidence of hypotension was more frequent in infants who fasted for longer than 8 hours before surgery, but the difference in this retrospective study was not statistically significant. Cote [6] speculated that by offering clear glucose containing solutions 2 to 3 hours before surgery, "the incidence of severe hypotension during mask induction due to relative hypovolemia in fasting infants and small children may be reduced". The result of our study supports his statement.

None of the patients suffered complications like features of pulmonary aspiration, hypoglycemia and seizures. This was true for both to the overnight fasting group as well as 3-4 hours fasting group.

P. Gupta et al [5] concluded that clinical signs of hypoglycemia were found to be unreliable in diagnosing hypoglycemia (false positive rate=66.66%). For the purpose of present study, the parents and the concerned staff were explained in detail to observe in the paediatric patients for any signs of hypoglycemia i.e. sweating, lethargy, excessive cry and pallor. In overnight fasting group, 17 out of 50 patients had excessive cry and 3 out of 50 patients had pallor. In 3-4 hour fasting group, 7 out of 50 patients had excessive cry. Rest of the patients in both the groups had no signs or symptoms of hypoglycemia. However, in both the groups, none of the patients had biochemically demonstrable hypoglycemia i.e. blood sugar level less than 50 mg/dl. Since the excessive cry was more in the patients with overnight fasting but the blood glucose levels were normal in these patients, this could be attributable to decrease in patient comfort in the prolonged fasting age group. However, the utility of the hypoglycemic signs in detecting hypoglycemia in paediatric surgical patients in the age group of 6 months to 6 years cannot be commented upon on the basis of our study as there was no biochemically demonstrable hypoglycemia.

On the basis of our observations, we recommended that prolonged or overnight fasting in the healthy paediatric age group (ASA I and II) between the age of 6 months to 6 years is to be avoided and oral feed of 5% Dextrose 10ml per Kg of body weight can be given 3-4 hours before surgery as the patient comfort is increased without compromising on safety and these patients had a better hemodynamic response in the perioperative period.

TABLE –1 Comparison of blood glucose levels (mg/dl) prior to induction of anaesthesia with blood glucose levels 20 minutes after induction of anaesthesia in group I and group II

Group	Blood glucose (mg/dl) before induction (mean± SD)	Blood glucose (mg/dl/) 20 min. after induction (mean± SD)	t-value	p-value	Remarks
I	79.22± 11.22	85.52 ± 11.73	6.184	0.000	S
II	82.96± 6.02	93.28 ± 8.89	9.764	0.000	S

S - significant

TABLE–2 Comparison of blood glucose levels (mg/dl) before the induction of anaesthesia in group I and II

Group	Blood glucose (mg/dl) before induction (mean± SD)	t-value	p-value	Remarks
I	79.22 ± 11.22	1.970	0.056	NS
II	82.96 ± 6.02			

NS = Non – significant

TABLE–3Comparison of blood glucose levels (mg/dl) in group I and II 20 minutes after induction of anaesthesia

Group	Blood glucose (mg/dl) 20 minutes after induction (mean± SD)	t-value	p-value	Remarks
I	85.52 ± 11.73	1.970	0.001	S
II	93.28 ± 8.89			

S = Significant

TABLE–4 Comparison of pulse rates (beats per minute) in group I and II

Time in relation to induction of anaesthesia	Pulse rate in (beats/min.) group I (Mean ±SD)	Pulse rate in (beats/min.) group II (Mean ±SD)	t-value	p-value	Remarks
0 minutes	130.34 ±14.86	127.36±17.25	0.950	0.348	NS
5 minutes	119.92 ±15.,38	115.78±16.85	1.370	0.178	NS
10 minutes	114.96 ±15.59	113.50±15.49	0.500	0.625	NS
15 minutes	113.1 ±15.00	110.96±14.42	0.790	0.432	NS
20 minutes	111.82 ±13.90	109.34±14.16	1.02	0.325	NS

NS – Non-significant

TABLE–5 Comparison of systolic blood pressure (mmHg) in group I and II

Time interval in relation to induction of anesthesia	Systolic BP (mmHg) in group I (Mean ±SD)	Systolic BP (mmHg) in group II (Mean ±SD)	t-value	p-value	Remarks
0 minutes	105.62 ±9.39	107.60±8.93	1.125	0.266	NS
5 minutes	95.30 ±13.03	100.34±8.62	2.278	0.027	S
10 minutes	96.90 ±13.47	100.10±5.77	1.534	0.131	NS
15 minutes	100.32 ±11.13	103.58±7.52	1.790	0.080	NS

20 minutes	102.58 ±8.54	105.04±7.12	1.474	0.147	NS

NS – Non-significant, S = Significant

TABLE–6 Comparison of mean blood pressure (mmHg) in Group I and Group II

Time interval in relation to induction of anesthesia	Mean BP (mmHg) in group I (Mean ±SD)	Mean BP (mmHg) in group II (Mean ±SD)	t-value	p-value	Remarks
0 minutes	77.78 ±8.31	79.57±9.97	1.047	0.300	NS
5 minutes	68.88 ±9.84	73.30±9.04	2.295	0.026	S
10 minutes	70.68 ±8.36	74.23±8.29	1.980	0.052	NS
15 minutes	72.07 ±8.82	77.04±9.23	2.743	0.008	S
20 minutes	74.01 ±7.33	77.06±8.85	2.886	0.073	NS

NS – Non-significant, S = Significant

TABLE–7 Comparison of incidence of signs and symptoms of hypoglycaemia in Group I and Group II

	Signs and symptoms of hypoglycemia					X^2df	p-value	Remarks
	A	B	C	D	E			
Group I	0	0	17	3	32	8.744	0.013	S
Group II	0	0	7	0	43			

S = Significant
A = Sweating
B = Lethargy
C = Excessive Cry
D = Pallor
E = No signs

TABLE–8

S.No.	Author	No. of Study patients	Age (months)	Range of fasting time (Hours)	Incidence of hypoglycemia (%)
1.	Graham [12]	31	0-60	8	0
2.	Brain M Schneider [19]	50	0-72	4-13	0
3.	K. Nilsson [20]	70	0.5-22	4-14	0
4.	J.H. Vanderwalt[14]	123	0-12	2-14.8	0
5.	Nancy [18]	54	12-59	6.7-20.6	0

TABLE–9

S. No	Author	No. of Study cases	No. under 12 months of age	Age (months)	Range of fasting time (Hours)	Incidence of hypoglycemia (%)	Definition of hypoglycemia
1.	Watson [22]	80	0	22-180	9-12	10	40mg/dl
2.	Thomas [15]	62	0	19-166	4-10	29	60mg/dl
3.	Allison et al [4]	92	4	8-96	Overnight	11	60mg/dl
4.	Payne and Ireland [13]	100	52	0-60	4	12	55mg/dl

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