SERUM FREE FATTY ACID AND BLOOD SUGAR LEVELS IN CHILDREN UNDER HALOTHANE, THIOPENTONE AND KETAMINE ANAESTHESIA (Comparative Study)

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OVER THE LAST TWENTY YEARS, several anaesthetic agents have been introduced to everyday anaesthetic practice. Some of them, like thiopentene sodium and halothane have proven themselves to be successful drugs. Nevertheless, even they remain under clinical and experimental investigation and controversies exist among investigators regarding some of their effects.¹⁻⁶

Ketamine hydrochloride is the newest of the induction agents and because of its special pharmacological properties has become a very important drug, especially in paediatric anaesthesia. Knowledge of the effects of ketamine upon body metabolism are very limited and we have found only one study of its effects on serum free fatty acid and blood sugar levels.⁷

In the present study we have attempted to investigate the effects of halothane, thiopentone and ketamine anaesthesia upon these two serum constituents in children and to compare the results in each group of patients in relation to the given drug.

MATERIAL AND METHOD

Thirty healthy children were selected for our study. They had been admitted to hospital for minor surgical problems such as inguinal hernia and hydrocele. Special attention was directed towards the selection of our patients, including only those who were free of hereditary disease such as haemolytic anaemia, syphilis or endocrinological abnormalities involving thyroid, pancreas or adrenal glands. Children with acute or chronic cardiovascular and respiratory disease were also excluded from the study. The average weight of the patients was 37 kilograms and they were from 10 to 12 years of age. Premedication was the same for all patients, consisting of atropine 0.4 mg and promethazine 1 mg/kg body weight, 30 minutes before the start of the operation. After transfer to the anaesthesia room and after routine preparation, an intravenous infusion of normal saline was commenced. The thirty children were divided into three groups of ten each. The first group was anaesthetized with halothane 0.5 per cent to 1.5 per cent, supplemented by nitrous oxide and oxygen 5:3, v/v. The second group were given thiopentone, 3 to 5 mg/kg body weight supplemented also by nitrous oxide: oxygen, 5:3, v/v. The third group received ketamine 2 mg/kg body weight supplemented by nitrous oxide:oxygen as in the other groups.

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TABLE I
MEAN SERUM FFA AND BLOOD SUGAR VALUES AFTER HALOTHANE

A/A	0'		10'		20'		30'	
	FFA	Glu	FFA	Glu	FFA	Glu	FFA	Glu
1	900	80	1100	87	1600	92	1980	125
2	670	78	810	84	990	107	1450	152
3	570	65	680	72	920	84	1530	97
4	860	91	1120	102	1560	108	1810	127
5	580	59	850	72	1210	79	1620	85
6	630	63	980	72	1120	95	1530	141
7	850	62	900	121	970	135	1320	161
8	810	71	870	97	930	125	1220	157
9	730	73	850	77	940	101	1300	118
10	660	53	720	106	840	123	870	150
$\bar{X}$	726	70	888	89	1108	105	1463	131
Percentage	%	%	22.3%	27.1%	52.6%	50%	101.5%	87.1%
SD	121	13	144	15	271	18	312	26
SE	38	4.1	46	4.7	86	5.7	99	8.2
t value	—	—	2.75	3.06	4.06	5.00	6.95	6.63
Statistic Evaluation	—	—	p < 0.05	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01

In all the patients, blood specimens were taken for free fatty acid and blood sugar determinations prior to induction as control, and then after induction and at 10, 20 and 30 minutes during the surgical procedure. The duration of anaesthesia exceeded one hour.

There was no incident in the course of anaesthesia of hypoxia, vomiting, bronchospasm, laryngospasm, or any other abnormality that could have affected results by increasing the P_{aCO_2} or by disturbing autonomic balance. Blood gas determinations were not done due to technical reasons. Serum free fatty acid determinations were done by means of Duncomb's and Howorth's colorimetric technique.^{8,9} Blood sugar determinations followed Werner and Wielinger's GOD/POD technique.¹⁰

TABLE II
MEAN SERUM FFA AND BLOOD SUGAR VALUES AFTER THIOPENTONE

A/A	0'			10'			20'			30'		
	FFA	Glu		FFA	Glu		FFA	Glu		FFA	Glu	
1	570	52		540	68		720	97		830	128	
2	830	62		800	81		970	94		700	147	
3	700	61		920	75		1130	92		1250	135	
4	920	65		1125	80		1450	127		1510	132	
5	850	72		920	121		1100	135		1260	161	
6	790	81		900	100		980	120		1430	160	
7	430	80		500	91		520	132		780	157	
8	510	57		620	85		670	99		920	135	
9	490	45		570	65		650	117		810	140	
$\bar{X}$	677	64		766	85		910	113		1054	128	
Percentage	%	%		13.1%	32.7%		34.4%	76.5%		55.7%	100%	
SD	180	12		217	17		295	21		308	49	
SE	60	4		72	6		98	7		103	16	
t-Value	—	—		0.95	3.8		2.10	6.13		3.17	3.76	
Statistic Evaluation	—	—		p > 0.1	p < 0.01		0.1 > p > > 0.05	p < 0.01		p < 0.01	p < 0.01	

TABLE III
MEAN SERUM FFA AND BLOOD SUGAR VALUES AFTER KETAMINE

A/A	0'			10'			20'			30'		
	FFA	Glu		FFA	Glu		FFA	Glu		FFA	Glu	
1	600	67		642	70		670	72		699	77	
2	570	52		560	59		540	62		540	70	
3	640	55		600	61		560	61		500	64	
4	880	62		760	70		700	77		680	80	
5	790	72		710	75		680	80		590	84	
6	810	80		720	82		660	85		550	87	
7	800	80		800	80		680	79		560	85	
8	730	68		650	74		600	81		540	96	
9	690	72		600	77		610	95		560	98	
10	580	64		600	66		650	86		700	97	
11	930	63		810	68		620	79		550	99	
$\bar{X}$	729	67		677	71		634	77		588	85	
Percentage	%	%		-7.13%	5.97%		-13.06%	10.5%		-19.5%	20.7%	
SD	123	9		87	7		52	9		71	16	
SE	37	2.7		26	2.1		16	2.7		21	4.8	
t-value	—	—		1.16	1.18		2.32	2.63		3.36	3.27	
Statistic	—	—		—	—		—	—		—	—	
Evaluation	—	—		p > 0.1	p > 0.1		p < 0.05	p < 0.05		p < 0.01	p < 0.01

Fig. 4

BLOOD SUGAR CHANGES AFTER DIFFERENT ANAESTHETIC AGENTS

Fig. 5

RESULTS

Group 1 (Halothane)

Free fatty acid and blood sugar levels were elevated 10, 20 and 30 minutes after induction (Table I and Figure 1). The mean values are statistically significant ($p < 0.01$) for both at the 30-minute reading.

Group 2 (Thiopentone Sodium)

Again serum free fatty acid increased but to a lesser extent than in Group 1 halothane anaesthesia. There was also a remarkable increase of blood glucose levels and these were much higher than those observed under halothane anaesthesia. These values are also statistically significant ($p < 0.01$), for both at the 30-minute period (Table II and Figure 2).

Group 3 (Ketamine-HCl)

As shown in Table III, there are important observations. In this case, serum free fatty acids were decreased below control values while blood sugar was slightly increased but much less than in the halothane series and much lower than in the thiopentone group. Statistically, both values are significant ($p < 0.05$) at 30 minutes (Table III and Figure 3). The mean values of serum free fatty acids and blood glucose for each group as percentage from control are shown in Figures 4 and 5.

DISCUSSION

The above data demonstrate a hyperglycaemic effect of the three drugs used in our study. This was expected for halothane and thiopentone anaesthesia and confirms the reports of other investigators.^{11,12,5} It is remarkable, however, that ketamine also produces hyperglycaemia, albeit less marked than the two other drugs. The significance of this observation must be considered to be favourable from a practical point of view. Thus, if it is accepted as fact that halothane and thiopentone affect the sympathetic system, then ketamine would appear not to exert sympathetic metabolic action.⁷ Therefore, ketamine does not seriously impair peripheral glucose uptake. By the same token it can be said that ketamine might have less effect on basal metabolism as compared to the other drugs. The glucose assimilation coefficients with ketamine could be higher than with the other drugs, which means that cellular metabolism and especially biological oxidation is impaired less seriously.

As far as the effects on serum free fatty acid levels is concerned, it must be underlined that surgical stress might represent one of the main causes at least for the halothane and thiopentone groups, through activation of the sympathetic system,⁵ which in turn might increase the lipolysis, although this is not proven and would not explain the decreased free fatty acid levels in ketamine anaesthesia. This decrease might be attributed either to an increase of liposynthesis or to a decrease of lipolysis or both. It could be postulated also that either disturbance of the body basal metabolic state¹³⁻¹⁵ or a mechanism involving tissue cells is

involved, but any attempt to explain the lowering effects of ketamine on free fatty acids is very difficult and the problem remains speculative for the time being, requiring further study on a biochemical level.

SUMMARY

Serum free fatty acid and blood glucose levels were determined in 30 children under halothane, thiopentone and ketamine anaesthesia. Blood sugar is increased above baseline values by halothane 54.75 per cent (+++), thiopentone 71.7 per cent (++++), and ketamine 12.2 per cent (+) anaesthesia. Serum free fatty acid was increased during halothane 58.7 per cent (+++) and thiopentone 34.4 per cent (++) anaesthesia, but was decreased with ketamine anaesthesia 13.4 per cent (-).

It is assumed that several factors contribute to these changes and are related either to the sympathetic nervous system or basal metabolism and to the specific actions of each drug.

RÉSUMÉ

Chez 30 enfants anesthésiés à l'halothane, au thiopentone et à la kétamine, on a mesuré le taux d'acide gras circulant et la glycémie. Ces trois agents augmentent la glycémie à des degrés divers: halothane 54.75 pour cent, thiopentone 71.7 pour cent et kétamine 12.2 pour cent. Le taux d'acide gras circulant augmente durant l'anesthésie à l'halothane (58.7 pour cent) et au thiopentone (34.4 pour cent) mais diminue durant l'anesthésie à la kétamine (-13.4 pour cent).

Plusieurs facteurs contribuent à ces changements qui sont attribuables ou bien l'activité du système nerveux sympathique sur le métabolisme basal ou à l'action spécifique de chaque agent.

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