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Effects of Interoceptive Stimulation on Glycemic Reactions in Brain Different Functional States under Physical Loading

Parvin Zulfugarova, Ali Aliyev, Fatemeh Aliyev and Bahram Abdi

Department of Physiology, Faculty of Biology, Baku State University, Azerbaijan

ABSTRACT

As it issues from the conducted studies, in intact animals and in the animals of different ages kept in light regime after epiphys-ectomy glucose levels in the blood at 8.00-9.00 A.M. is minimal, in the afternoon, at 1.00-2.00 P.M. it up-regulates significantly, while in the evening, at 6.00-8.00 it gets down. In the animals kept under darkness regime the blood glucose levels run down. It is revealed that after subjecting to short-term physical loading in the 30, 90, 180-day-old animals in the morning, afternoon and evening time of circadian rhythm up-regulation of glycemic reactions is observed, whereas long-term physical loading results in down-regulation of this index values. After keeping the animals under 7-day light and darkness regimes and subjecting them to olfactory-ectomy and interoceptive stimulation down regulation of the blood glucose level is observed, while after 14 days recovery in hypothalamo-hypophysal and other analysators systems takes place. On the grounds of the obtained data one can come to a conclusion that epiphysal hormone melatonin might be used for therapeutics purposes in the clinical practice.

KEYWORDS: Epiphys, Light, Darkness, Glycemic, Olfactory Nerve

1. INTRODUCTION

As it is known from the literature, information about external milieu and its changes comes to the brain through sensor apparatus engaged into regulation of functional and metabolic reactions, and sensor nerves and thereafter gets down to motor and secretor organs. Studies of dynamic interrelations between motor activity, tissue metabolism being under direct and indirect influences of rhythmic and sequential movements, homeostasis of internal milieu and distinct functional states from fundamental and applicable standpoints compose one of the most prominent physiological problems. Studies of changes in the form of blood glycemia in the organisms subjected to intensive physical loading always challenge tremendous interest. Particularly, physical loadings of different intensities in short time induce different magnitude changes of turnover indexes of blood carbohydrates, proteins and lipids [1, 2, 3, 4, 5, 6, 7 and 8].

Extra-sensor apparatus, mighty sensor pathways and centers of the brain have broad mutual relations with such important viscero-sensory and neuroendocrine structures as hypothalamus and hypophysis and effects-dependent endocrine activity of epiphysis which in relation to light (daytime) and dark (night) phases in rhythmic way tunes up on active and passive status of secretor activity in the form of hormone (melatonin) production. Circadian rhythm underlies fluctuations of glucose levels in healthy humans as well as in most mammals; on the other hand, in light-subjected mice glucose level in the blood increases, while in darkness its level goes down [9, 10, 11, 12]. At the same time these changes in epiphysis functioning in response to light and darkness conditions are reflected in dynamics of all listed above processes and functions and engage them into general chronometric and biorhythmic regulatory mechanisms of the organism fixed in phylogenesis and ontogenesis [13, 14].

2. MATERIAL AND METHODS

For this purpose we used effects of physical loading in our experiments. In order to subject the experimental animals to physical loading in experimental conditions most of researchers utilize rotating mechanical device having form of a drum with empty cavity. Velocity of drum rotation lies within limits of 40-50 rpm and rabbits this way are subjected both to forced running and vibration effects for 5 and 20 min.

The glucose level in the blood was measured with application of express method in glycometer (production of Bayer-Holding Company, USA and Canada). The experiments are carried out in the following series.

*__Corresponding Author:__ Bahram Abdi (Ph.D.). Department of Physiology, Faculty of Biology, Baku State University, Azerbaijan. E-mail: Abdi.bahram2@yahoo.com

- In the first series the effects of short-term (5 min) and long-term (20 min) physical loadings on dynamics of glycemic reactions in rabbits of different ages are studied.

- In the second series after olfactectomy the effects of short-term and long-term physical loadings on glucose levels in rabbits depending on animal's age are studied.

- In the third series the effects of light and darkness phases and interoceptive stimulus presentation under short-term and long-term physical loadings on glycemic reactions in rabbits of different ages are studied.

Experiments are carried out on 30, 90, 180-day-old and 12-month-old animals. Olfactectomy procedure is realized by the method of Progripkova in 1975 and experiments were launched 7 and 14 days after surgical operations. Blood samples are taken from the animals' ear edge vein at 8.00-9.00 AM, 1.00-2.00 PM, 6.00-8.00 PM and stimulation of interoreceptors of rectum is conducted by providing an air pressure of 90-100 mm of mercury column for 1-2 min on the 1st, 5th, 15th, 30th, 45th and 60th minutes throughout an hour.

Statistical analysis:

The results are analyzed statistically in Fisher and Student criteria and other methods with application of 7.0 version of computer EXSEL program.

3. RESULTS

The results of the experiments of the first series are presented in Table 1. As one can see from the table, in all studied ages (30, 90, 180-day-old and 12-month-old) relatively to the intact animals 5-minute physical loading of experimental rabbits results in up-regulation of glucose levels both in the morning, afternoon and evening. As it also issues from Table 1, after 20-minutes physical loading the level of glycemic reactions goes down relatively to the effects of 5-minute physical loading.

Table 1. Dynamics of glycemic reactions under short-term (5 min) and long-term (20 min) physical loadings in different time of a day in the animals of different ages (100 ml, mg%); M±m; n=24

Ages of the animals	After 5-minute physical loading					
	Morning		Afternoon		Evening	
	norm.	Ph.L.	norm.	Ph.L.	norm.	Ph.L.
30-day-old	76±2,57	88±0,62 p<0,001	88±1,08 p<0,001	101±0,88 p<0,001	70±1,67 p>0,01	84±1,15 p<0,02
90-day-old	85±1,33	104±0,53 p<0,001	92±0,62 p<0,001	108±0,91 p<0,001	80±0,93 p>0,01	95±0,67 p<0,001
180-day-old	114±0,90	136±0,80 p<0,001	126±0,99 p<0,001	144±1,05 p<0,001	110±0,62 p<0,01	124±1,13 p<0,001
365-day-old	127±2,13	152±1,07 p<0,001	135±0,80 p<0,01	156±1,34 p<0,001	118±2,20 p=0,05	136±1,11 p<0,01
After 20-minute physical loading						
30-day-old	76±2,57	66±1,12 p<0,01	88±1,08 p<0,001	74±1,11 p>0,5	70±1,67 p>0,01	61±0,88 p<0,001
90-day-old	85±1,33	67±0,82 p<0,001	92±0,62 p<0,001	74±0,80 p<0001	80±0,93 p<0,01	66±0,75 p<0,001
180-day-old	114±0,90	90±1,05 p<0,001	126±0,53 p<0,001	112±0,96 p>0,2	110±0,62 p<0,01	94±0,62 p<0,001
365-day-old	127±2,47	107±0,87 p<0,001	135±1,55 p<0,02	127±0,99 p>0,5	118±1,03 p<0,01	102±0,90 p<0,001

Table 2 presents the dynamics of levels of glycemic reactions after short-term and long-term physical loadings under stimulation of rectum with an air pressure of 90-100 mm of mercury column for 1-2 min on the 1st, 5th, 15th, 30th, 45th and 60th minutes throughout an hour. Data of table showed that, the normal levels of glucose in the blood in 30, 90, 189-day-old and 12-month-old animals are different, so due to this reason the observed glucose levels after physical loading are different in the animals of different ages. As can see from the data presented in Table 2, independently on animals' ages and original level of glucose in the blood, short-term (5 min) physical loading leads to up regulation of glucose in the blood – hyperglycemia, whereas long-term (20 min) physical loading results in down regulation of glucose in the blood – hypoglycemia. So, physical loadings having its effects on organism and possessing with certain effective power can provide different directional changes in blood glucose levels and circadian rhythm.

Table 2. Effects of stimulation (80-90 mm of mercury column) of the mechanoreceptors of the rectum on the blood glucose levels under short-term (5 min) and long-term (20 min) physical loadings in the animals of different ages (100 ml, mg%); M±m; n=24

Ages of the animals	Experi-mental conditions	Baseline	After interoceptive stimulation (min.)					
			1 min.	5 min.	15 min.	30 min.	45 min.	60 min.
30-day-old	norm.	76±1,17	74±1,00	78±0,75	80±1,08	84±0,62	80±1,53	74±1,12
	P *Value*		>0,2	>0,2	=0,05	<0,001	=0,05	>0,2
	5 min. Ph.L.	88±0,62	80±1,08	90±1,08	96±0,60	98±1,13	89±0,97	94±0,97
	P *Value*		<0,001	>0,2	<0,001	<0,001	>0,5	<0,001
	20 min. Ph.L.	66±0,73	70±0,78	71±0,55	77±0,90	73±0,83	68±0,53	65±0,65
	P *Value*		<0,01	<0,001	<0,001	<0,001	=0,05	>0,2
90-day-old	norm.	85±0,96	88±1,07	86±1,27	92±1,07	98±0,80	82±0,78	80±0,53
	P *Value*		=0,05	>0,5	<0,01	<0,001	<0,2	<0,001
	5 min. Ph.L.	104±1.42	106±3.89	110±3.24	116±4.65	120±3.94	110±2.94	106±2.32
	P *Value*		>0,5	>0,2	=0,05	<0,01	>0,2	>0,5
	20 min. Ph.L.	67±0.82	60±0.85	62±0.65	78±0.85	74±0.65	60±0.73	64±0.53
	P *Value*		<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
180-day-old	norm.	114±0,90	120±0,65	125±0,47	136±1,08	140±0,58	125±0,62	120±1,17
	P *Value*		<0,001	<0,001	<0,001	<0,001	<0,001	>0,2
	5 min. Ph.L.	136±0,80	140±1,17	146±1,39	150±1,07	155±1,08	140±0,83	138±0,99
	P *Value*		<0,2	<0,001	<0,001	<0,001	<0,001	>0,5
	20 min. Ph.L.	90±1,05	91±0,83	88±0,82	106±0,97	102±1,04	98±0,62	90±0,88
	P *Value*		>0,5	>0,2	<0,001	<0,001	<0,001	>0,5
365-day-old	norm.	127±1,19	125±0,62	132±0,85	150±0,85	154±0,85	130±0,83	118±0,93
	P *Value*		>0,2	<0,01	<0,001	<0,001	>0,2	<0,001
	5 min. Ph.L.	152±1,07	156±0,85	161±0,88	168±0,97	170±1,31	162±1,34	154±0,97
	P *Value*		<0,2	<0,001	<0,001	<0,001	<0,001	>0,2
	20 min. Ph.L.	107±0,87	101±0,73	98±1,20	114±1,03	120±0,90	110±1,18	104±0,99
	P *Value*		<0,001	<0,001	<0,001	<0,001	=0,05	=0,05

4. DISCUSSION

As it issues from the data presented in Table 2, in 30-day-old animals on background of short-term physical loading interoceptive stimulation does not lead to significant changes of the original blood glucose levels (owing to immature status of the regulatory neuroendocrine system). At the same time, in this age and 20-minute physical loading brings to downregulation of blood glucose, while interoceptive stimulation results in its slight upregulation. In 90, 180-day-old and 12-month-old animals on background of both 5-minute and 20-minute physical loadings interoceptive stimulation provides significant changes of glucose levels in the blood. The accomplished studies give grounds to make general conclusion that in relation to animals' ages and duration of physical loadings interoceptive stimulation can finalize in hyperglycemic and hypoglycemic reactions. Interoceptive stimulation can be considered as one of mighty physiological factors that strengthens effects of physical loading on glycemic reactions.

5. CONCLUSION

Presents the data on the olfactory-ectomized animals of 30, 90, 180-day and 12-month-old age under keeping in light and darkness regime and subjecting to physical loading and interoceptive stimulation. As it issues from the table, keeping animals in 7 and 14-day light and darkness regimes with interoceptive stimulation and 20-minute physical loading relatively to 5-minute physical loading effect leads to glycemic reaction with downregulation of blood glucose level.

So, basing on the obtained data it becomes clear that under effect of short-term and long-term physical work role of epiphysis in circadian rhythm depends on changing from night to day time. Particularly, as it issues from the abundant literature data, its hormone melatonin is synthesized much more in darkness than in light period. For this reason olfactory-ectomy and disturbances in normal changing of light and darkness periods in day rhythm in 30, 90, 180,365day and 12-monthold rabbits, laboratory rats and quails underlies changing in circadian rhythm and impairment of turnover processes.

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