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CHANGES IN THE ACTIVITY OF HEMOCOAGULATION FACTORS IN DIFFERENT LIGHTING CONDITIONS

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Abstract

In this work, we investigated the effect of epiphysectomy in inhibiting and activating the melatonin-forming function on hemocoagulation factors. When the melatonin-producing function of the pineal gland is activated in the dark phase, the blood clotting time is shortened more sharply than in animals in a state of inhibition of the melatonin-producing function of the pineal gland. The reasons for this phenomenon are revealed in the following: when the melatonin-forming function of the pineal gland is inhibited in the light phase, a hypercoagulable shift is observed in almost all hemocoagulation factors - blood clotting time is shortened (by 38%), the number of platelets increases (by 3.1%), the amount of fibrinogen increases (by 25%), fibrinolytic activity decreases (by 32%). In the dark phase, hypocoagulative changes develop, the number of platelets decreases by 2.7%, the amount of fibrinogen increases by 45%, fibrinolytic activity increases by 60%.

The effect of light on the endocrine apparatus is mediated by two special organs: photoreceptors and neuroendocrine transducers. Moreover, the only photoreceptor in adult mammals is the retina. When light acts on the retina, nerve impulses enter not only the brain, but also through the spinal cord into the neuroendocrine transducers-epiphysis. Under the influence of light in rats, the size of pinealocytes decreases, the number of nucleoli in cells decreases, and the cytoplasm becomes less basophilic.

The above makes it possible to conclude that with prolonged inhibition of the pineal gland by the light factor, hypercoagulation develops. With prolonged activation of the melatonin-producing function of the pineal gland, a paradoxical phenomenon is observed: the blood clotting time is sharply shortened (by 62%) than in animals with an inhibited melatonin-producing function of the pineal gland and epiphysectomized animals.

Keywords: melatonin-forming, pineal gland, hemocoagulation.

1. Introduction

During the evolution of humans and animals, adaptability to a certain rhythm of life developed, associated with the periodicity of the Earth's movement and with the energy dynamics of metabolic processes occurring in a vicious circle. Structural and functional biological processes in living organisms were formed both in space and in time. Temporal orientation is based on periodic changes in the physiological reactions of the body during the day. In animals this phenomenon is only of a biological nature, but in humans it is characterized by the participation of not only primary signal information, but also social changes.

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The vital functions of any biological objects exhibit periodic fluctuations, which are called biological rhythms. These rhythms are a form of movement of living matter in time. Their period can be calculated in seconds, hours, days, seasons, years, decades. The whole variety of biological rhythms is studied by the science of “Biorhythmology”. The rhythm of physiological processes is studied by chronophysiology.

The scientific and practical significance of studying the circadian (circadian) rhythm of physiological processes is determined by the possibility of developing the foundations of chronopathology and chronopharmacology.

Ordered cyclic oscillations can be detected at the molecular, cellular, organ levels and at the level of the entire organism. At the same time, numerous functions of the body are combined into one common oscillatory system based on a circadian rhythm, the period of which is approximately 24 hours.

If you place the body in constant (aperiodical) conditions, it exhibits rhythms with a free period that differs from the daily one (210-28 hours).

The strict order of physiological processes in time is developed by natural selection and is one of the expressions of the biological expediency of organisms.

In the manifestation of biological rhythms, the role of the central nervous system is especially important, in which time is counted; the “measure of time” is a complex and precise “clock device” - a wave-like rhythmic change in the processes of excitation and inhibition.

More than 40 different physiological functions have been identified, which are characterized by daily rhythm.

The main biological rhythm that ensures the normal functioning of all body systems is the rhythm of sleep and wakefulness [1].

Changing a daytime lifestyle to a nighttime one is not indifferent to the body, since the restructuring of biological processes requires not only time, but also a lot of brain work.

In the first few days of a changed lifestyle, the human body seems to physiologically split into a waking brain and a sleeping body, and vice versa.

Periodicity in work is also characteristic of the endocrine glands. It has been established that in humans the maximum adrenaline in the blood is observed at 9 o’clock, and the minimum at 18 o’clock. Adrenaline accumulates in the blood before the period of physical activity begins, as if preparing the body for it.

The daily rhythm of physiological processes in higher vertebrates is regulated by the pineal gland. During the daytime, the activity of hydroxyindole-O-methyltransferase (HIOMT) is inhibited 10 times and melatonin synthesis almost stops. At night, the activity of this enzyme, which synthesizes melatonin from serotonin, increases 10 times [2].

Melatonin with the flowing blood from the pineal gland enters the circulatory network of the hypothalamus, hypothalamic nuclei and from there through the portal vein enters the pituitary gland.

Melatonin is an inhibitor of the formation of tropic releasing factors in the hypothalamic nuclei and tropic hormone formation in the pituitary gland. Therefore, in many endocrine glands, hormonal function is suppressed at night, as well as in our laboratory.

It has been established that metabolic-vegetative functions and its circadian rhythm are regulated by the pineal gland.

2. Materials and Methods

The inhibition and activation of the melatonin-forming function of the pineal gland was studied under different lighting conditions, which sheds light on the chronophysiology of the regulation of the aggregative state of the blood. The studies focused on the circadian rhythm of sleep and wakefulness, the functional state of the central nervous system and environmental factors - light and darkness.

The influence of the pineal gland on the functional system of hemostasis and fibrinolysis was carried out in animals (adult rats), in the amount of 100, by removing the pineal gland using the Kitau method as modified by D.M. Aulov, prolonged inhibition and activation of the melatonin-forming function of the pineal gland (keeping animals in different lighting conditions for 10 days).

3. Results and discussion

Based on the above, the task was set to study the effect of inhibition and activation of the functional state of the pineal gland under different lighting conditions on hemocoagulation.

Table. Changes in blood clotting time, content
and activity of hemocoagulation factors in different lighting conditions

n100 P<0,001

Factors/phases	intact	Light mode	Dark mode
Blood clotting time (sec.)	101,0±3,2	62,0±3,3	38,0±1,3
Platelet count (thousands)	226,0±4,6	233,0±17,8	220,0±19,0
Amount of fibrinogen (mg%)	48,8±1,7	61,0±5,5	71,0±10,7
Fibrinolytic activity (%)	50,0±0,0	66,0±3,0	80,0±8,1

In control animals, blood clotting time was 101.0±3.2 seconds, platelet count was 226.0±4.6 thousand, fibrinogen was 48.8±1.7 mg%, fibrinolytic activity was 50.0%.

In control animals, animals kept in the light phase, the blood clotting time was 62.0±3.3 seconds. (61.38%), platelet count 233.0±17.8 thousand (103.1%), fibrinogen 61.0±5.5 mg% (125%), fibrinolytic activity 66.0±3.0% (132%).

In animals kept in the dark phase, the blood clotting time was 38.0±1.3 seconds (37.62%), platelet count 220.0±19.0 thousand (97.3%), fibrinogen 71.0±10.7 mg% (145.49%), fibrinolytic activity increased in relation to control data and amounted to 80.0±8.1% (160%).

When animals are kept in the inhibition phase (light phase) of the melatonin-forming function of the pineal gland, the hypercoagulable potential of the blood increases, the blood clotting time is shortened, which is due to an increase in the number of platelets, an increase in the amount of fibrinogen and an increase in fibrinolytic activity [3].

With prolonged activation of the melatonin-producing function of the pineal gland (for 10 days, dark phase), the amount of fibrinogen increases, fibrinolytic activity increases, resulting in a sharp increase in hypercoagulation.

As noted above, the pineal gland is the main internal oscillator of the daily rhythm of the vegetative functions of the body in higher vertebrates and humans. Chronophysiological changes in the body cannot be indifferent to the regulation of hemostasis. In this experiment, paradoxical phenomena are observed: when the melatonin-forming function of the pineal gland is inhibited in the light phase, the blood coagulation system changes identically with the results of epiphysectomized animals, the hypercoagulability potential of the blood increases and the blood clotting time is sharply shortened.

When the melatonin-producing function of the pineal gland is activated in the dark phase, the blood clotting time is sharply shortened than in animals in a state of inhibition of the melatonin-producing function of the pineal gland [2].

In the dark phase, the amount of fibrinogen increases, fibrinolytic activity also increases, the number of platelets decreases, and therefore hypercoagulation is observed.

The effect of light on the endocrine apparatus is mediated by two special organs: photoreceptors and neuroendocrine transducers. Moreover, the only photoreceptor in adult mammals is the retina. When light acts on the retina, nerve impulses enter not only the brain, but also through the spinal cord into neuroendocrine transducers - the pineal gland.

4. Conclusions

1. The pineal gland is one of the important factors in the neurohormonal regulation of the hemostatic potential of the blood.
2. The pineal gland is actively involved in the chronophysiological reactions of the hemocoagulation system.
3. With prolonged inhibition of the melatonin-forming function of the pineal gland, the procoagulant potential of the blood increases and hypercoagulation develops.

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