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The Effect of Stress on the Body of Animals

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Annotation: To date, it has been shown that stress disrupts the function of almost all organs and systems of living organisms. Individual metabolic characteristics of neuromotor function disorders under experimental stress and the search for ways to correct them. Physiological indicators characterizing the functional state of the CNS in stress-resistant and non-stress-resistant animals under normal conditions and under immobilization stress. The effect of a complex preparation containing zinc and glycine on the physiological and biochemical parameters of stress-resistant and non-stress-resistant animals was revealed.

Keywords: stress, metabolic characteristics, stress-resistant animals, stress-resistant.

Stress (from the English stress - load, pressure, tension) is a non-specific (general) reaction of the body to an influence (physical or psychological) that violates its homeostasis, as well as the corresponding state of the nervous system of the body (or the body as a whole [1,3,15].

Thus, this definition reflects the fact that the organism reacts to each requirement of the environment with a special tension. Stress is perceived as happening and occurs at the moment of the strongest reaction that gets out of control. The problem of stress lies in the fact that such a manifestation can be expressed in an extraordinary way, with restraint or not at all. At the same time, stress is one of the most common causes of trouble, suffering and failure of any person, because the modern lifestyle is a constant rush, nerves, emotions[4,8].

The idea of stress is very popular in the scientific world. The term "stress" is widely used in biology, establishing a connection between physiological and psychological phenomena. In psychology, this concept includes the concepts of anxiety, conflict, emotional distress, threat to one's own "I", frustration, stress, etc. From the middle of the 20th century to the present day, theories and models of stress have been intensively developing, each explaining in its own way views and attitudes on the essence of stress, the causes of its development, mechanisms of regulation, and features of manifestation[11,21]..

However, in cases of major depression or drug addiction, the critical exposure to oxidative stress may occur during adolescence or adulthood. Thus, the pathological significance of oxidative stress in adulthood should be fully explored in both preclinical and clinical studies[7,23].

Stress can be both shaking and tremors on the roads, as well as crowding, poor ventilation, changes in temperature and humidity, etc. The intensification of animal husbandry carried out in the world today leads not only to an increase in stress factors, but also to the fact that many modern technologies for growing and keeping farm animals come into conflict with the peculiarities of their physiology, which arose and took shape in animals in evolutionary process[12,24].

The studies carried out by various authors on the protective physiological functions of the body under normal and pathological conditions contain data that reflect, as a rule, the dominant role of the nervous and humoral systems. At the same time, quite a lot of evidence has now accumulated that the genetic apparatus also actively participates in all responses of the body to a stressful stimulus[13].

The relevance of our study is also due to the fact that the study of the influence of the same stress factors on animals of the same genus, but of different species and lines, contributes to the elucidation of the mechanism of participation of the genotype in reactions to stress, and, thereby, a deeper study of the mechanisms of long-term consequences stress[26].

In response to these influences, the body responds with standard activation of the nervous and endocrine systems. The stress response, being a necessary link in adaptation, is aimed at restoring and maintaining homeostasis. Short-term exposure to physical and/or emotional stressors accompanied by the mobilization of the functions of organs and systems, the switching of energy resources to these organs, as well as a change in the activity of the immune system[2,10].

Prolonged and constant exposure to stress leads to overstrain, exhaustion of physiological mechanisms and their transformation into a pathogenic factor. As a result, prerequisites are created for hormonal disorders, violations of the visceral functions of organs, the morphological composition of "white blood", a decrease in immunity, autoimmune processes, etc[29].

According to the authors' ideas, the primary reaction to stressors of various origins are changes in the function of the central nervous system, especially in the emotiogenic structures of the brain with the formation of "stagnant" stationary excitation, and all somatovegetative manifestations are realized secondarily, as a result of the "exit" of excitation to the periphery []. Thus, in the modern sense, Selye's concept of stress is transformed into the problem of neurogenic (emotional) stress[5,19].

Emotional stress from the standpoint of the general theory of functional systems is formed in "conflict" situations in which the subject is long-term limited in the ability to satisfy his biological and social needs []. It is in these cases that negative emotions through the activation of the somatic, autonomic nervous system and the hormonal hypothalamic-pituitary mechanism determine systemic stress reactions[22,28].

Currently, a study on the effect of stress on experimental animals is being carried out using various experimental models that differ in the nature of the irritating agent, the strength and duration of exposure. The model of prolonged intermittent immobilization is most often used to simulate emotional stress in experiments [16].

Numerous studies indicate that under the influence of chronic immobilization stress, irreversible changes occur in the composition of the blood, the structure and function of internal organs. At the same time, the work of the endocrine, immune, cardiovascular, reproductive and other systems is disrupted.

Corticotropin-releasing factor (CRF) is involved in the regulation of adaptive responses to stress. In addition to activating the hypothalamic-pituitary-adrenal axis and the autonomic nervous system, CRF also modulates behavioral responses to a wide range of stressful stimuli, for a recent review. In experimental animals, the administration of CRF leads to behavioral changes resembling the effects of stress. Inhibition of CRF neurotransmission can normalize a number of stress-induced behavioral changes. Increased activity of the brain's CRF system has been hypothesized to play a role in stress-related psychopathology, including affective disorders and substance abuse[14].

The stress-realizing system, under the influence of external and / or internal stimuli, provides mobilization, modification of functional systems and coordinates adaptive processes. However, under conditions of strong stress, excessive operation of the system can lead to adverse side effects, stress-induced damage [18].

Along with the activation of the stress-realizing system, there is a dynamic increase in the activity of the stress-limiting system, which limits the pathological manifestations of stress-reactions at the central and peripheral levels of regulation [5]. The main central stress-limiting systems include the systems of GABA neurons, the opioidergic, nitric oxide and dopamine systems of the “substance nigra-striatum” complex. In organs and tissues, the effects of stress are limited by prostaglandins, nitric oxide, opioid peptides, antioxidants, and adenosine [6]. The ratio of the activity of stress-realizing and stress-limiting systems determines the body's resistance to environmental conditions.

Reactivity to stress, stress resistance is the main criterion for adaptability and viability in extreme situations. This is true for both animals and humans. Stress resistance is formed on the basis of the genetic characteristics of the organism, and its phenotypic variability in the course of ontogenetic development [17].

Researchers have noticed that the same type of experimental conditions in different organisms can cause different manifestations and consequences: in some animals, significant violations of physiological functions are observed, while in others such changes do not occur. Some animals are sensitive and predisposed to stress loads, while others are resistant [20].

Different individual resistance to emotional stress is determined by the structural, morphological and biochemical characteristics of brain formations [25]. Animals with an initial elevated level of opioid peptides, norepinephrine, substance P, delta sleep peptide in the limbic-reticular structures of the brain show greater resistance to emotional stress compared to animals in which the content of these substances is reduced [9].

Zinc is an indispensable biologically active mineral and is necessary for the performance of important physiological functions of the body.

In the last two decades, data have been obtained that shed light on the participation of zinc ions in many molecular and cellular processes. This trace element is present in most organs and tissues. It contains approximately 2-3 grams in the human body, while the daily requirement is 10-20 mg. Zinc is released from food during digestion as free ions, which are absorbed into the bloodstream, bind to plasma albumin and are carried throughout the body[9,15].

However, under pathological conditions, such as ischemia, central nervous system trauma, dementia, and seizure activity, significant amounts of zinc accumulate in the brain, which causes toxic damage and neuronal death []. The origin of zinc, which affects neuronal excitability and causes cell death, is not known. One possibility is that it is released from zinc-containing terminals into the extracellular space during enhanced neurotransmission and enters postsynaptic neurons. Another possibility for the accumulation of free zinc in the soma of neurons is the release of ions from proteins containing zinc and the release from intracellular organelles that store zinc ions [25].

The obtained results indicate that zinc ions regulate many processes in the brain, from neurogenesis and development to neurodegeneration and disease pathogenesis. Using histochemical and gene-transcriptional methods, special glucinergic neurons containing two different pools of zinc ions, free and bound to metallothiones, were found. The homeostasis of this trace element underlies the normal functioning of nerve cells and functional networks.

To determine the individual stress resistance of an animal, the “open field” test method proposed by E.V. Koplik et al. [6]. In this test, the severity of the manifestation of the stress reaction directly is proportional to the duration of the latent period of the first movement and exit to the center of the experimental animal, and inversely proportional to the value of its orienting activity, the number of stands and the duration of stay in the center of the "open field".

Rats that exhibit high motor activity on the periphery and in the center and have a short latent period of the first movement and exit to the center are resistant animals. Rats with low behavioral activity, a long latent period of the first movement and exit to the center, as well as those with a high autonomic balance (number of grooming's and boluses) belong to the group of animals predisposed to emotional stress[21,29].

Predicting individual stress resistance to conflict situations is of decisive importance for diagnosing and correcting possible disorders in biological objects predisposed to them.

In the works of many authors, it has been shown that stress-resistant rats selected in the "open field" test are characterized by a lower content of adrenaline and corticosterone compared to stress-resistant animals. was lower than that of stress-unstable. The authors explain the results obtained by the fact that during emotional stress in resistant animals, parasympathetic influences predominate, which prevent an increase in the content of catecholamine's, stress-unstable animals - sympathetic influences[14,24].

According to some authors, the hormonal profile in animals with different prognostic resistance to stress. When studying the features of thyroid homeostasis in stress-reactive and stress-resistant rats, it was found that under stress conditions, the content of triiodothyronine decreases in all experimental animals, but the lowest level of the hormone was noted in stress-resistant individuals.

In the experiments of many researchers, it has been shown that 30-hour immobilization in cramped houses in one group of resistant rats does not cause changes in blood pressure and heart rate, while in a group of rats predisposed to stress, under the same conditions, there is an increase and decrease in blood pressure, accompanied by fluctuations in heart rate. Some of the experimental rats died at different times against the background of a sharp decompensation of hemodynamic parameters, while at autopsy they showed thymus involution and hypertrophy of the adrenal glands, indicating the development of stress[21].

The dependence of changes in the parameters of phospholipid metabolism (lung surfactant) in rats on their prognostic resistance to stress was proven by researchers []. The authors showed that the greatest degree of stress disorders is manifested in stress-unstable animals.

The most vulnerable to environmental stressors is the reproductive system [3]. Under stress, it, taking a passive position, temporarily reduces or suspends its function, yielding blood flow and energy supply to vital systems.

Numerous studies [8] have established that the chronic course of dyshormonal changes in the reproductive system can lead to structural changes in the organs of the genital tract, as well as increase the risk of developing hormone-dependent tumor pathology.

Under stress, the cytotoxic activity of natural killers and macrophages decreases, and the ability of the cells themselves to produce α-, β- and γ-interferons is suppressed, against the background of an increase in the production of certain cytokines (IL-1β, TNF-α).

With stress-induced immunodeficiency in animals, activation of latent viral infections is observed, and the development of a specific immune response during vaccination is suppressed [9].

Chronic stress in rats is most often caused by an improper diet, a number of metabolic diseases, such as diabetes. Long-term or chronic stresses have the most severe impact on animal health [14]. The ideas of the Great Russian physiologist I.P. Pavlova in experiments on dogs caused a breakdown in their nervous activity, as a result of which premature physiological aging occurred in experimental animals.

Prolonged and strong effects of stress factors suppress the immune system, increase the risk of developing infectious and oncological diseases, dramatically change brain metabolism, and lead to the development of neurosis [25].

Most scientists around the world dealing with the problem of stress note that up to 90% of all diseases depend on stress, that is, they are caused or aggravated by stress factors. Frequent and prolonged stresses are considered the main risk factors for the manifestation and exacerbation of cardiovascular diseases and diseases of the gastrointestinal tract [12].

When stress occurs, the release of stored glucose from the muscles and liver, this leads to a quick, but short-term burst of energy, after which the stressed body enters a state of prolonged fatigue. That's why stress is considered an "energy waster". However, despite the many negative effects of stress on the body, it would be wrong to perceive it only as a necessary evil. Constant stressful effects are training for the body. A long-term absence of stressful influences can lead to a negative effect, as when growing animals - gnotobiotes in a sterile environment, in the body of which pathological changes can occur when they are transferred to normal conditions [28]. But recent studies have shown that stress causes immunomodulation rather than immunosuppression in animals, since a number of immunological indicators (playing an important protective role) are stimulated under stress, but there are, of course, exceptions, the researchers note in their work [18].

In any case, getting rid of stress completely is impossible, you can only adapt to it. Consequently, adaptation is a natural function of any living organism that undergoes fine adjustment to constantly changing environmental conditions. The environment is indeed replete with a wide variety of stress factors, the complete elimination of which only brings death to a living organism [15].

Thus, studying the complex relationship between general and local reactions in the development of pathological processes associated with the impact of stress factors, it is also necessary to consider them from the standpoint of the theory of adaptive reactions. In order to further develop tactics for managing these processes, since the data obtained can open up good prospects for managing the state of the body and overcoming pathological processes that are not only general, but also local in nature.

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