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Scientists study nervous system adaptation to ischemic damage

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Lobachevsky University researchers are working to explore the mechanisms of adaptation of the nervous system to ischemic damage. Scientists say that under certain conditions, the brain's protective response can be activated, even in some severe cases.

According to Maria Vedunova, director of the Institute of Biology and Biomedicine at Lobachevsky University, a large number of stressors affect the body by depleting its internal reserves and, as a consequence, lead to a number of diseases. "The effect of stress on the nervous system and the brain is especially damaging. Everything that we associate with the personality, self-consciousness, all our feelings and thoughts, decisions and experiences—all this is the result of brain function. Therefore, scientists and medical practitioners face a global challenge—to find an effective way to protect nervous system cells and restore lost brain function after damage. By solving this problem, it will be possible to change the quality of life of those who have suffered a stroke, severe trauma or surgery," notes Maria Vedunova.

UNN scientists are currently involved in the study of the role of internal adaptation systems of the central nervous system.

"We are developing ways to repair brain damage. To understand the mechanisms of ischemia and effectively combat this disease, each of its key links has to be examined separately. For this purpose, scientists created special model conditions to study the primary cultures of the cells from different brain sections (the "brain in vitro") rather than the whole brain. Thus, one can trace the processes taking place at the neural network level. Why is it so important? In fact, the brain functions are performed not by single neurons, but by their groups, neural networks. It is at the level of the neural network (the minimal structural and functional unit of the nervous system) that information is transferred, processed and stored, and complex cognitive reactions occur. In a cell culture, one can see how the neural network is formed, how an electrical impulse is generated, and how it is distributed and transmitted over the network, how the entire functional ensemble reacts to ischemic damage. Researchers around the world hope that the understanding of the way neural networks function in the normal state and under the effect of stressors will open up prospects for the development of effective therapeutic strategies.

It is practically impossible to study the operation of a neural network in the whole (intact) brain, because signals of a single network cannot be isolated. Besides, the brain is very well protected by the skull bones, and it is not so easy to get access to it: there are too many cells and signals. In culture, this can be done by using special techniques and complex mathematical calculations," says Maria Vedunova.

UNN scientists have developed methods for modeling different phases of ischemia and studied the features of neural network operation under such effects. When modeling ischemic damage, very large numbers of neurons die, but their death does not occur simultaneously. Ischemic factors trigger pathological reactions within active neurons that lead to cell death within three to six days after an episode of ischemia.

Something similar occurs in the brain. Most neurons die within the first week after exposure rather than at the moment of actual damage. The signal that a cell receives when there is a lack of oxygen and glucose or when the free radical oxidation is activated leads to the activation of the processes of cell death by the cell itself. It means that there is a period of time during which treatment could change the neuron's program and keep it alive.

These studies are of great fundamental importance. In the near future, the study of the nervous system's adaptive and regenerative properties will allow the development of a new therapeutic strategy for protecting the brain from traumatic and ischemic damage, thus contributing to the improvement of life quality and reducing the risk of severe disability among the working-age population.

More information: Tatiana V. Shishkina et al, Glial cell line-derived neurotrophic factor (GDNF) counteracts hypoxic damage to hippocampal neural network function in vitro, *Brain Research* (2017). DOI: 10.1016/j.brainres.2017.10.023

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