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PHYSIOLOGY

Morphological Study of Myelinated Fibers of the Sciatic Nerve in Mice after Space Flight and Readaptation to the Conditions of Earth Gravity

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Abstract—We revealed a decrease in the thickness of the myelin sheath and myelin delamination in the tibial nerve of C57BL/6N mice after a 30-day flight aboard the biosatellite *Bion-M1*. The processes of myelin degeneration continued for seven days after return of the animals to Earth and adaptation to the conditions of natural gravity. Our data add to hypothesis on the role of neurogenic component in pathogenesis of hypogravity motor syndrome.

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Under the conditions of space flight, skeletal muscles undergo specific modifications leading to the development of hypogravity motor syndrome (HMS). HMS is characterized by atrophy of muscle fibers (MFs), shift of the ratio of MFs, and impairments of electrophysiological properties of the membrane of MF that result in the disturbances of functional activity of the skeletal muscle [1]. These pathognomic signs appear in the skeletal muscle after damage to the peripheral nerve. Our previous data [2] indicate a role of spinal cord neurons in the development of HMS; specifically, substantial changes in axonal myelin sheaths were observed.

Under the conditions of hypogravity, the impairments underlying HMS develop as soon as the first day. Postural muscles which are innervated by muscle branches of the tibial nerve, a branch of the sciatic nerve, are mainly involved in this process. It is known that about 13 600 nerve fibers compose the rat tibial nerve, of which 7% are myelinated axons of motor neurons, 26 and 40% are sensory myelinated and nonmyelinated fibers, respectively, and 27% are nonmyelinated processes of sympathetic neurons [3].

It is known that the negative effect of hypogravity on the human body develops during staying in space; however, pathological changes become more expressed after return of cosmonauts to the conditions of ordinary gravity.

This study was performed in the framework of the *Bion-M1* project, which included studies on the effect of a 30-day orbital space flight followed by a seven-day after-flight readaptation on Earth on the mouse body [4]. The aim of the study was to examine morphological properties of myelinated axons of the tibial branch of the sciatic nerve in mice after the 30-day flight on a board of the biosatellite *Bion-M1* followed by a seven-day readaptation. We took into account that axons of motor neurons compose one tenth part of total number of nerve fibers of the tibial nerve.

The experiments were performed in mature male C57BL/6N mice (Pushchino Laboratory Animal Farm) weighing 25.1 ± 3.2 g. The experimental animals were divided into three groups: "Flight," the mice subjected to 30-day orbital space flight on a board of the biosatellite *Bion-M1*; "Readaptation," the mice subjected to 30-day space flight followed by a seven-day readaptation on Earth; "Control," the mice housed in a biosatellite under the natural gravity on Earth. The animals were withdrawn from the experiment by the cervical translocation method according to the Rules of the Physiological Section of the Russian Committee on Bioethics under the Commission of the Russian Federation for UNESCO and in accordance with the Bioethical Rules for Studies in Humans and Animals (Supplement 1b) [15].

For morphological studies, a fragment of the sciatic nerve containing the tibial branch was fixed in glutaric aldehyde, postfixed in osmium tetraoxide, dehydrated, and embedded into Epon 812 resin. Half-thin

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