THE EFFECT OF MAXIMUM PHYSICAL EXERTION ON PERIPHERAL NERVES IN AN EXPERIMENT

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Abstract: The article describes an experiment in which rats were subjected to maximum physical exertion through swimming in water, and neurohistological changes in peripheral nerves were observed. The obtained materials were processed using general cytological methods (hematoxylin-eosin and Weigert-Pal staining) and neurohistological methods (Nissl method and silver impregnation according to Rasskazova). Starting from the 30th day of the recovery period, a significant reduction in reactive and destructive changes was noted in the nerve fibers of the sheaths of the sciatic nerve, its muscular branch, and the subcutaneous nerve. By the 60th day after cessation of the exertion, these changes practically approached the physiological reactivity background of the control group animals.

Keywords: experiment, rat, physical exertion, sciatic nerve, hematoxylin-eosin method, Nissl method, neurohistological changes.

ВЛИЯНИЕ МАКСИМАЛЬНОЙ ФИЗИЧЕСКОЙ НАГРУЗКИ НА ПЕРИФЕРИЧЕСКИЕ НЕРВЫ В ЭКСПЕРИМЕНТЕ

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Резюме: В статье в экспериментальных условиях на крысах максимальная физическая нагрузка осуществлялась путём плавания в воде, при этом наблюдались нейрогистологические изменения в периферических нервах. Полученные материалы обрабатывались общецитологическими методами — гематоксилин-эозином и Вейгертом–Палем, нейрогистологическими — методом Ниссля и импрегнацией по Рассказовой. Начиная с 30-х суток восстановительного периода в нервных волокнах оболочек седалищного

нерва, его мышечной ветви и в подкожном нерве отмечается значительное снижение реактивных и деструктивных изменений; эти изменения к 60-м суткам после прекращения нагрузки практически приближаются к фону физиологической реактивности животных контрольной группы.
Ключевые слова: эксперимент, крыса, физическая нагрузка, седалищный нерв, метод гематоксилин-эозин, метод Нисcля, нейрогистологические изменения.
Introduction. In modern sports, to achieve high results and maintain athletic form over a prolonged period, athletes perform a large volume and high intensity of physical work [6]. At the same time, irrational use of increased physical loads leads to significant morphological and functional changes in the body, primarily in the vascular, muscular, and nervous systems [1,2,3]. In this regard, the study of the morphological state of various systems under increased physical loads acquires particular relevance in sports medicine. The results of studying the vascular and muscular systems under physical loads are reflected quite extensively in the literature, and there are also individual works reflecting the state of peripheral nerves in this context [4,5]. The state of the nervous apparatus of the sheaths of peripheral nerves under hyperkinesia is devoted to works of other authors; there is no other information on this issue in the literature. The present article presents data that continue the study of the state of the nervous apparatus of the sheaths and conductors in non-organ functionally different nerves of the rat after maximum physical load and during the recovery period.
Aim of the study. To investigate the influence of maximum physical load on peripheral nerves in the experiment.
Materials and methods. The experiment was conducted on 30 white outbred rats of both sexes, of the same age, five of which served as controls. For morphological examination, the following objects were taken: 1) the trunk of the rat sciatic nerve (mixed nerve), 2) the muscular branch of the sciatic nerve to the semimembranosus muscle (motor nerve), 3) the subcutaneous nerve of the thigh (sensory). Maximum physical load was created by swimming the animals in water at a temperature of

38°C until complete exhaustion. The animals were euthanized 1 hour, 1, 3, 7, 15, 30, and 60 days after the experiment. The material was processed according to Weigert-Pal, Nissl, stained with hematoxylin-eosin, and impregnated according to Rasskazova. To assess the morphological state of the investigated nerves, variational-statistical processing and methods of information analysis were used.

Results. Examination of preparations from control animals showed that the rat sciatic nerve has predominantly a single-bundle structure. Occasionally, 4–6 nerve bundles with interconnections were encountered. The trunk of the sciatic nerve mainly consists of myelinated nerve fibers with diameters from 1 to 11 μm. The muscular branch of the sciatic nerve to the semimembranosus muscle consists of two bundles, which usually divide into 5–6 before entering the muscle. The subcutaneous nerve has one bundle, as a rule, with a spiral course of nerve fibers. In the neural sheaths, there is an intrinsic nervous apparatus represented by nerve bundles, single nerve fibers, forming together with vessels neurovascular plexuses, bush-like receptors, and microganglia. In the nerves of control animals, reactive changes in nerve structures were revealed in the form of alternation of thickenings and thinnings of axial cylinders, unevenness of their contours, neuroplasm overflows, dyschromia, constituting the physiological background of reactivity (protective-compensatory and age-related rearrangements of nerves). The physiological background of reactivity was 8 ± 1.5%. Thirty-day maximum physical load leads to a significant decrease in the functional capabilities of the musculoskeletal apparatus, accompanied by significant morphological changes in nerve elements. In the study of the nervous apparatus of the sheaths of the rat sciatic nerve after swimming to complete exhaustion for a month, an increase in reactive changes in axial cylinders to 29.2 ± 1.2% was revealed. Expansion of perineural and periaxonal sheaths, swelling of nuclei and accumulation of cytoplasm at the ends of internodal segments, more often in thick myelinated fibers, is observed. In rare cases, destructive changes are encountered in the form of granular and crumbly disintegration of axial cylinders. Destructive changes constitute 3.5 ± 0.5%. In the conductive component of the sciatic nerve, there is a redistribution of myelinated nerve fibers by groups toward an increase in thick myelinated fibers to 56.0 ± 1.4% (norm 43.2%); the number of thin myelinated fibers was 19.8 ± 1.2% and medium ones — 23.2 ± 1.7% (norm 33.6%). In the sheaths of the muscular branch and subcutaneous nerve, similar reactive changes are also observed: thick fibers were respectively 14 ± 1.2% (norm 5%) and 19.6 ± 1.7% (norm 10%). Destructive changes in axial cylinders in the muscular branch constitute 5.2 ± 1.5%, and in the subcutaneous nerve — 8.0 ± 1.2%. In the conductive component of the muscular branch of the sciatic nerve after 30-day maximum physical load, an increase in the number of medium myelinated fibers to 30.8% (norm 18.2%) is observed; in the subcutaneous nerve, the content of thick conductors increases to 27.2 ± 1.8% (norm 17.8%). At 1, 3, 7, and 15 days after cessation of physical load exposure, a statistically insignificant decrease in reactivity of nerve structures occurs in the nervous apparatus of the sheaths of all three functionally different nerves. At the same time, in the conductive component of the rat sciatic nerve trunk, the increase in the number of thick myelinated fibers continues; by the 15th day of the recovery period, it reaches 62.2 ± 2.1%, and in the muscular branch at these times, a slight decrease in the number of these fibers is revealed, which, however, is statistically insignificant (46.2 ± 1.9%). In the subcutaneous nerve, the content of thick conductors remains at the previous level (31.8 ± 2.0%). Starting from the 30th day of the recovery period, in the nervous apparatus of the sheaths of the sciatic nerve trunk, its muscular branch, and the subcutaneous nerve, a significant decrease in reactive and destructive changes is noted, which by the 60th day after cessation of the load practically approach the physiological background of reactivity of intact animals. The conductive component of the investigated nerves also approaches in composition the nerves of control rats; in the sciatic nerve trunk, thick fibers predominate, in the subcutaneous nerve — medium ones. The conducted study indicates that maximum physical loads, following one after another for a month, do not allow the untrained organism to restore performance, as a result of which significant morphological rearrangements occur in the nerve conductors of functionally different nerves.

Thus, 30-day maximum physical load leads to a decrease in the compensatory-protective capabilities of the peripheral nervous system and to the appearance of reactive and destructive changes in the nervous apparatus of the sheaths and in the conductors of nerve trunks.

Conclusion. The main stages of recovery of the morphological state of nerve structures in the sheaths and conductors of the rat sciatic nerve, its muscular branch, and the subcutaneous nerve of the thigh begin from the 30th day after cessation of physical load. Relative normalization of the morphological picture occurs by the 60th day of the recovery period.

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