Adaptations of proprioceptive input from muscle spindles to motoneurons in response to strength and endurance training

The spinal cord contains specialized neurons (motoneurons), whose axons reach the muscles through the nerves and transmit electrical impulses from the nervous system to the muscle fibers, resulting in a contraction. Motoneuron excitability and firing characteristics directly determine the recruitment of motor units to contractile activity and influence generated muscle force, and together with afferent connections from muscle receptors are crucial for spinal reflexes. The neuromuscular system has the lifelong ability to reorganize structure and function of neurons and/or muscle fibers to the altered level of motor activity. Strength and endurance exercises have opposing goals and in many aspects induce opposite neuromuscular adaptations. The strength training leads to an increase in the muscle force, and causes morphological, histochemical and biochemical changes in the muscle fibers. On the other hand, the effects of endurance training are considered to be the most important for improvement of physical capacity and exercise tolerance.

While exercise-induced adaptive responses of motoneurons and motor units are basically known, it is still unknown whether physical training affects afferent synaptic transmission to motoneurons. Muscle spindles are receptors reacting primarily to muscle stretching, but are also activated during voluntary contractions of muscles. They are the source of direct (monosynaptic) proprioceptive input to spinal motoneurons. The results of the planned study will be innovative, as for the first time will demonstrate the influence of chronic alterations of motor activity (during strength or endurance training) on effectiveness of synaptic excitation of motoneurons from afferent fibers, conveying sensory information from the muscles.

The research will be carried out on an animal model - adult male rats, under the same experimental conditions, in homogeneous age groups, and from the same breeding. Rats will be randomly assigned to the untrained control and the trained groups. Considering the 3R principle, experiments on 60 animals are planned – the procedures will be authorized by the Local Ethics Committee. The acute electrophysiological experiments will be conducted under general anesthesia, in fully controlled conditions (artificial ventilation, monitoring of the body temperature, ECG, and end-tidal CO_2).

The project consists of two major research tasks. In task 1 the effects of a 5-week strength training (weight-lifting) on monosynaptic potentials evoked in motoneurons from muscle afferents will be evaluated. We will know whether proprioceptive input from muscle spindles on motoneurons can be modified by repeated resistance exercises during the strength training. In task 2 the effects of a 5-week endurance training (treadmill running) on monosynaptic potentials evoked in motoneurons from muscle afferents will be tested. We will know whether proprioceptive input from primary muscle afferents on motoneurons can be modified by repeated running during the endurance training.

The results will be published in peer-reviewed scientific journals indexed in the international databases. The effects of the project will broaden the knowledge in the field of neurophysiology, kinesiology and rehabilitation, and will contribute to understanding the basics for the sport training.