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Effect of Exercise-induced Fatigue on the Electrical Activity of the External Globus Pallidus Neurons in rats

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Objective The motor cortex (MC) stimulation-induced unitary responses of globus pallidus external segment (GPe) neurons in control and exercise induced-fatigue rats were recorded in vivo to examine the role of cortical-striatum-external globus pallidus pathway in the mechanism of central fatigue.

Methods 32 Clean healthy male Wistar rats (260~300g), were randomly divided into 4 groups: control group (Control), 1-day fatigue group (1FG), 3-day fatigue group (3FG) and 7-day fatigue group (7FG). Rats were subjected to a 5-day adaptive treadmill training. Modified Bedford treadmill exercise with progressively increasing load was used to create the exercise fatigue model. (3 levels: 8.2 m/min, 15 min; 15m/min, 15 min; 20 m/min, lasting till exhaustion) The spontaneous unit activity and responses to MC stimulation of GPe neurons were recorded by the electrophysiological technique of extracellular recording of glass microelectrodes.

Results The results showed that the firing frequency of high-frequency firing with pause (HFP) and low frequency firing with burst (LFB) in the GPe of 1FG was comparable with that of control group ($P>0.05$). However in 3FG and 7FG, the percentage of HFP neuron was significantly decreased ($P<0.05$), while the proportion of LFB was significantly increased ($P<0.05$), and the average firing rate of LFB was higher and inter spike intervals (ISI) was significantly lower than that of the control group. With 200 μ A electrical stimulation, the explosive discharge of GPe neurons was attenuated after fatigue in rats. The response of GPe neurons to variable frequency stimulation in exhausted model groups was stronger than that of the control group. MC-stimulation typically induced a triphasic response composed of early excitation, inhibition, and late excitation in GPe neurons. The population of neurons showing a short inhibition slightly increased in 3FG and 7FG.

Conclusions 1. The results confirmed that GPe is an important nucleus of basal ganglia involved in the regulation of exercise-induced fatigue by the change of spontaneous activity.
2. Electrical stimulation on the cortex can alter response patterns of GPe neurons in exercise-induced fatigue rats, the results confirmed that the Ctx-Str-GPe neural pathway is involved in the regulation of exercise fatigue, and the indirect pathway is over-activated.