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Structure of Neuronal Impulse Trains of the Rat Inferior Olive under Conditions of Long-Lasting Vibrational Influence

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Abstract

In acute experiments on albino rats anesthetized with Nembutal (40 mg/kg, i.p.), we recorded the background impulse activity (BIA) generated by neurons of the inferior olive in the norm and after 5-, 10-, and 15-daylong vibrational influence (60 Hz, 2 h, daily). We characterized the distributions of neurons according to the regularity of impulse successions, their dynamics, and pattern of histograms of interspike intervals (ISIs); we also calculated the mean frequency of impulsation and the coefficient of variation of ISIs. It was demonstrated that the most significant shifts of the characteristics of BIA generated by neurons of the inferior olive were formed within the first 10 days of the vibrational influence. These shifts were observed mainly in the mean discharge frequency (increased within the initial period) and, to a lesser extent, in the intrinsic structure of impulse trains. Such shifts in the background activity of the inferior olive caused by long-lasting vibrational influence result, perhaps, from intensification of the influences of excitatory cerebellar/mesodiencephalic inputs to olivary neurons within the early periods of action of the above factor and prevalence of GABAergic influences within the later periods. It seems possible that, under such conditions, the characteristics of electrical synapses of the olivary neurons are also subjected to modification.

Keywords inferior olive - background impulse activity - structure of impulse trains - vibration

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Keywords: inferior olive, background impulse activity, structure of impulse trains, vibration.

INTRODUCTION

In modern studies of the biological effects of negative factors of the industrial environment, special attention has been paid to detection of shifts developing in the organism at different levels of integration. Adaptation to variable conditions of the human environment causes complex rearrangements in the controlling systems of the organism. Long-lasting influences of different negative industrial factors can initiate stable pathological disorders in the organism. In particular, the general influence of mechanical vibration frequently results in the so-called pneumatic hammer disease [1]. This disease can be classified as a form of "movement diseases," which often cause complete loss of the professional capacity for work.

Our preliminary studies were devoted to examination of functional activity of neurons of the cerebellar nuclei upon long-lasting vibrational influence [2, 3]. As is known, the cerebellum is the most important center of sensorimotor integration and is involved in reflex modulation of not only motor but also autonomic functions of the organism. This is confirmed by the data obtained in studies of afferent and efferent cerebellar projections, proof of its close connections with the systems of supraspinal control, and findings of the involvement of the cerebellum in the mechanisms underlying the control of postural activity [4].

Interpretation of complex physiological mechanisms of the functioning of the cerebellum is impossible without the analysis of interactions between this structure and other brainstem structures; among the latter structures, the inferior olive plays an important role. Morphological and functional characteristics of synapses formed by climbing fibers on cerebellar Purkinje cells have now been studied in detail. In a few studies, the pattern of olivo-cerebellar interactions was examined [4-8]. As is known, there are electrical synapses (gap junctions) on olivary neurons; their functioning underlies the olivo-cerebellar system-induced synchronized activity (complex peaks) of Purkinje cells [9-11]. It is significant to note

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