Peculiarities of Modulation of Afferent Reactions for Stimulation of Intraosseous Receptors

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The effects of interaction of competitive afferent flows have been discussed in detail in numerous studies, where the main conclusion was of a primary inhibiting influence of conditioning stimuli, causing long-term presynaptic depression of the test reactions [1-3]. The phenomenon of suppression of the afferent flows occuring for electrical stimulation of somatic and autonomic nerves under conditions of competitive stimulation of the skin and subcutaneous and periosteal tissues is one of the fundamental phenomena to consider when discussing mechanisms of reflexotherapy (acu- and electropuncture, transdermal electrostimulation, osteoreflexotherapy). The role of osteoreception in the mechanisms of afferent reaction moducations is practically unknown. Meanwhile, crucial experience with methods of manipulating the intraosseous receptors in diverse neuralgias, and, specifically, osteochondrous syndromes makes it possible to assume that there are some fundamental peculiarities in the mechanisms of the therapeutic effects in comparison with other modes of treatment (paraventricular blocks, methods of reflexotherapy).

The purpose of this study was to elucidate the interaction of afferent reactions elicited by electrical stimulation of the sciatic nerve for conditioning stimulation of intraosseous receptors.

MATERIALS AND METHODS

Acute experiments carried out on sexually mature male cats (15 animals) under chloralose anesthesia and myorelaxation revealed evoced potentials (EP) in the first sensorimotor area of the cerebral cortex (CC) and medial center of the thalamus (MCT) for discrete electrical stimulation of the contralateral sciatic nerve (pulse duration 0.3 msec, frequency 0.1 Hz, force 3-10 μA).

Conditioning stimuli were applied to the spongy substance of the ilium by means of needle electrodes insulated all along their length except for the ends (pulse duration 0.3 msec, frequency 0.1 Hz, force 3-10 μA). Moreover, during the experiment the animals received intraosseous injections through needle electrodes of physiological saline in a volume of 10-20 ml at a pressure of 200-300 mm Hg. EP were registered with the use of stereotaxis with MULTI-BASIS (OTE Biomed) apparatus for 10 signal presentations. The amplitude fluctuations of the summated EP phases were subjected to statistical processing (from peak to peak): phases 1-2, 2-3, and 3-4.

RESULTS

In the recording of the test EP the strength of sciatic nerve stimulation was selected at a level of threshold intensity sufficient for forming stably repeated responses for summated phase amplitude in CC: phases 1-2 from 18 to 158; phases 2-3 from 23 to 125; phases 3-4 from 50 to 120 mV. In MCT: 1-2, from 7 to 100; 2-3 from 7 to 84; 3-4 from 10 to 66 mV.

Due to the substantial scatter of the values of the amplitudes of the detected EP phases (for a minimal intensity of sciatic nerve stimulation), the variation of the indexex obtained for conditioning stimulations was estimated in percentages, taking the initial data as 100%.Conditioning stimuli of the

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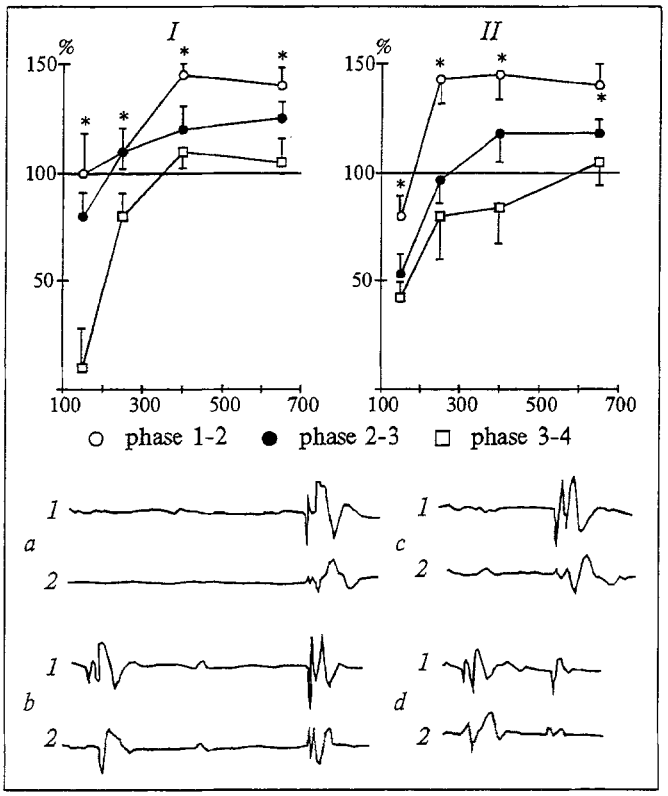

Fig. 1. Variation of summated amplitude of EP phases occurring in CC and MCT for test stimulations sciatic nerve and with conditioning stimulation of intraosseous receptors. *I*) Variation of EP in CC (in % relative to 100% initial, as in graph *II*). *II*) changes in EP in MCT. Oscillograms *I* are registered in CC, II in CT. *a* and *e*) without conditioning stimulation; *b* and *d*) with conditioning stimulation of osteoreceptors. Calibration: 100 msec, 50 μV. Asterisk: reliable variations of phase amplitude of test EP developing under conditioning stimulation ($p<0.01$).

spongy substance of the ilium preceded the test pulses by 100-1000 msec. The intensity of stimulation did not exceed the threshold values of 50-100% of the intensity of sciatic nerve stimulation.

The conditioning stimulations of the spongy tissue markedly affected the amplitude of the test EP, while the degree and nature of the influence were determined by the duration of the interval between stimuli. For example, in CC within the interval from 100 to 200 msec, the summated ammplitude of phases 3-4 decreased by 70% in comparison with the initial, whereas the decrease for phases 2-3 was 30%. The amplitude of phases 1-2 changed slightly (Fig. 1). When the interpulse interval was increased from 200 to 300 msec, there was a tendency toward restoration of the amplitude of phases 1-2 and 2-3 up to the initial one, for maintainance of a reliable drop of the amplitude of phases 3-4 (77% of the initial interval). With an interval duration of 300-800 msec between the test and conditioning pulses there was a stable reliable increase of amplitude of all EP phases with this tendency preserved to 800-1000 msec: phases 1-2, 143; 2-3, 124; and 3-4, 112% in comparison with the data obtained without conditioning stimulation of the intraosseous receptors. A further increase of the interpulse interval led to a gradual loss of the faciliating influences of the conditioning stimulation. Similar relations have been traced for the variation dynamics of EP recorded in MCT. Thus, for an interpulse interval from 100 to 200 msec there was a phase depression in EP: phases 1-2, 78; 2-3, 63; 3-4, 57% against the initial. With an interval from 200 to 300 msec: 1-2, 144; 2-3, 93; 3-4, 78% as compared with the data obtained without conditioning stimulation. For an increase of the interval between pulses from 300 to 800 msec the summated amplitude of phases 1-2 was 146, of 2-3, 114, and of 3-4, 82% of the initial extension of the interval for more than 800 msec caused a decline of the effects of conditioning stimulation of the intraosseous receptors.

During reproduction of the experiment using the method of paired stimuli, physiological saline was forced into the spongy tissue. The intraosseous pressure increase also caused a rise of the summated amplitude of all the phases of the test EP arising in both CC and MCT: in CC phases 1-2 increased to 145; 2-3 to 136, and 3-4 to 120%; in MCT phases 1-2 increased to 149, 2-3 to 140, and 3-4 to 125%. These changes were reliable in comparison with the baseline, whereas the facilitation effect persisted for 1-3 min after intraosseous perfusion of the solution was terminated.

It is especially worth mentioning that destruction of the outer insulation of the stimulating electrodes resulted in the disappearance of the facilitation effect of the test reactions or, conversely, the suppression of recorded EP. It seems that these phenomena are associated with the fact that the excitation process involves not only the intraosseous receptors, but also perceptory apparatus of the periosteum and periosteal tissues. We believed that the principle of the observed effects lies in anatomicofunctional peculiarities in the organization of the intraosseous receptor system and, primary, in the prevalence of slow conducting afferent fibers in comparison with the periosteum and periosteal tissues [5]. Afferentation facilitation for activation of the portion of slow conducting fibers is postulated by the theory of input control of pain [6]. Hence, the results obtained make it possible to view the peculiarities of neuralgia genesis in a new way, particularly in the case of spinal column osteochondrosis, and shed new light on the therapeutic effects of intraosseous blocks in root pain syndrome. For instance, intraosseous injection of trimecaine into the wing of the ilium results in a stable painkilling effect for those suffer-

ing from lumbosacral osteochondrosis pain accompanied by ischialgia, although the anesthetic does not reach the pertinent sections of the spinal column or roots. It may be assumed that in these cases the therapeutic effect has to do with disengagement of the intraosseous receptors and, consequently, with limitation of afferent influences, alleviating the excitation process which is associated with root compression, muscle spasms, etc. Osteochondrous root syndromes are accompamied by changes of the bone tissue regional hemodynamics and an increase of the intraosseous pressure [4], which, as has been shown in this study, may promote a drop of the afferent reaction threshold for stimulation of nerve trunks and hence intensification of the pain syndrome.

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Cardiac Output and Regional Blood Flow Changes in Alert Rats with Acute Streptozotocin-Induced Diabetes

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Microangiopathy is known to be the main cause of death and disability among patients suffering from diabetes mellitus. In the eighties several groups of investigators put forward the hypothesis that the trigger factor causing microcirculatory disturbances in diabetes might be changes in the regional blood flow [9,12,15]. According to this hypothesis, the early increase in blood flow and capillary pressure in some vascular regions results in the development of microvascular sclerosis followed by a decrease in blood flow and weakened autoregulation.

It should be noted that the early changes in blood flow observed in experimental diabetes mellitus are likely to be related to a rise in the blood sugar level, since the injection of insulin to rats 40 to 50 hours after streptozotocin (STZ) injection normalized the blood sugar level and hemodynamic indexes [10].

Streptozotocine injection to rats was previuosly shown by us to result in marked changes in the systemic blood flow as early as 24 hours post-injection: the total peripheral resistance dropped and the cardiac index rose [1]

The aim of this study was to investigate the regional blood flow changes in alert rats 24 hours after STZ injection. The diabetic syndrome, manifested in a blood sugar level rise 24 hours following STZ injection, was referred to as acute streptozotocine-induced diabetes.

MATERIALS AND METHODS

The experiments were carried out on male Wistar rats weighing 300 to 400 g. Cardiac output and blood flow in 10 organs were determined by the

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