# EFFECT OF AURICULAR ELECTROACUPUNCTURE ON MOTOR MANIFESTATIONS OF NOCICEPTIVE RESPONSES

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During research into electroacupuncture (EAP) anesthesia allowance must be made not only for the degree of the analgesic effects, but also the intensity of nociceptive motor responses arising during EAP. Better results with EAP anesthesia are obtained by the use of low-frequency electrical stimulation (1-3 Hz) [2].

In the investigation described below the effect of low-frequency EAP accordingly was studied on the intensity of the motor responses evoked by nociceptive stimulation.

## EXPERIMENTAL METHOD

Experiments were carried out on 22 adult cats. Nociceptive stimulation consisted of electrical stimulation of the pulp of the lower canine tooth by square pulses 50 $\mu$sec in duration and up to 50 mA in amplitude, for the dental pulp is innervated by high-threshold A$\Delta$- and C-fibers [3, 11]. The frequency of the stimulating pulses did not exceed 0.1 Hz. The intensity of the nociceptive motor responses was assessed from the latent period and amplitude of electromyographic responses (EMGR) of the anterior belly of the digastric muscle, evoked by stimulation of the dental pulp, averaged for five presentations. This particular muscle was chosen because motoneurons of the trigeminal motor nucleus, whose axons innervate this muscle, are activated by A$\Delta$-fibers of the trigeminal nerve [7]. EMGR were recorded by means of two needle electrodes inserted into the dissected muscle.

To obtain EAP-analgesia in the region of the mouth in clinical practice, according to data in the literature, points located in the region of the lobe of the ear are used. Accordingly, in the present investigation EAP was induced by means of three needles inserted in the region of the lobe of the ear. A pulsed electric current with the following parameters was used to stimulate the points on the lobe of the ear for 30-50 min: duration of square pulse 1.2 msec, amplitude 2-8 mA, pulse following frequency 1 Hz.

## EXPERIMENTAL RESULTS

After insertion of the needles, the amplitude and latent period of EMGR evoked by stimulation of the dental pulp were unchanged if no electric current was passed through the needles. During EAP the amplitude of EMGR was higher than in the control. The amplitude of EMGR was directly dependent on the intensity of EAP (Fig. 1). The results agree with clinical data indicating an increase in muscular activity in the course of EAP analgesia [9] and during successful treatment by means of EAP of diseases associated with a decrease in tone of individual muscle groups [8].

As investigations by Granit et al. [5] showed, tonic activation of muscles from different afferent inputs and, in particular, from afferents of the concha auriculae, takes place through a common interneuron. During excitation of afferents of the concha auriculae effective activation of various muscles can be obtained, and in this case the fusimotor component is well marked and precedes activation of $\alpha$-motoneurons [4]. The increase in EMGR during EAP, obtained in this investigation, may thus be explained by tonic activation of the $\gamma$-motoneurons of the anterior belly of the digastric muscle, which are excited by afferent impulses in sensory auricular fibers. The transmission of activity from sensory auricular fibers excited during EAP to $\gamma$-

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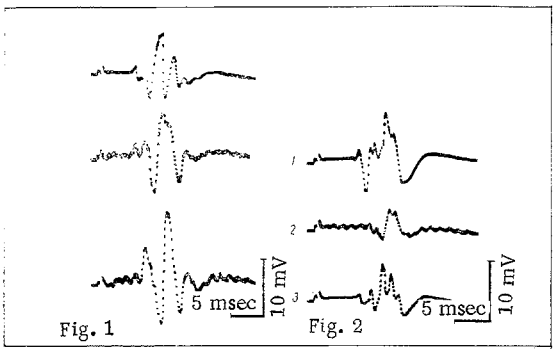


Fig. 1. Changes in amplitude of EMGR of anterior belly of digastric muscle induced by stimulation of pulp of canine tooth by stimuli of equal strengths, during auricular electroacupuncture (EAP) of varied intensity. 1) Control; 2) EAP with current of 2 mA; 3) EAP with current of 6 mA.

Fig. 2. Effect of intravenous injection of a small dose of pentobarbital on changes in amplitude of EMGR of anterior belly of digastric muscle induced by application of stimuli of equal strengths to pulp of canine tooth. 1) Control; 2) 10 mg/kg pentobarbital during EAP with current of 4 mA; 3) 10 mg/kg pentobarbital.

motoneurons takes place through interneurons participating in different motor responses, and there are no specific features of the action of EAP in this mechanism.

However, despite equal amplitude of EMGR, the latent period of EMGR during intensive EAP (strength of current 6-8 mA) was greater than in the control. This difference could be due to inhibition arising during EAP in the afferent part of the nociceptive motor reflex.

The suggestion that EAP has an inhibitory effect on the afferent part of the nociceptive motor reflex and an activating effect on its efferent part was tested on the following model. When activation of $\gamma$-motoneurons was blocked, the amplitude of EMGR evoked by stimulation of the dental pulp ought to be less during EAP than in the control, on account of inhibition in the afferent part of the nociceptive motor reflex. Activation of $\gamma$-motoneurons was blocked by intravenous injection of small doses of pentobarbital.

According to data in the literature, injection of small doses of barbiturates (3-15 mg/kg) has an inhibitory effect mainly on activity of secondary endings, which is determined by $\gamma$-motoneuron activity [6, 10]. Motoneurons of the digastric muscle are activated by sensory fibers of the inferior alveolar nerve, containing afferents from the teeth of the lower jaw, through a disynaptic pathway [1]. Injection of small doses of barbiturates evidently could not significantly affect the afferent part of the nociceptive motor reflex studied.

Changes in the latent period and amplitude of EMGR after intravenous injection of pentobarbital (10-15 mg/kg) without EAP and the same time interval after injection of the same dose of pentobarbital during EAP were analyzed. The greatest decrease in the amplitude of EMGR was observed in fact during EAP (Fig. 2), which confirms the suggestion put forward.

The rule governing changes in the latent period and amplitude of EMGR after injection of pentobarbital, it will be noted, was the same as the rule governing their change in response to weakening of stimulation of the dental pulp in the control (Fig. 3, 1). During EAP this rule when nembutal was used was the same as curve 2 (Fig. 3) obtained during EAP without pentobarbital. Comparison of these results indicates that lengthening of the latent period of EMGR during EAP was due to the effect of EAP on the afferent part of the reflex arc.

The mechanisms of the increase in the latent period of EMGR in response to stimulation of equal

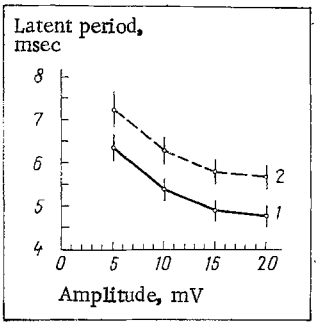


Fig. 3. Change in latent period as a function of amplitude of EMGR of anterior belly of digastric muscle evoked by stimulation of pulp of canine tooth by stimuli of different strengths, in control (1) and during auricular electroacupuncture with a current of 6 mA (2).

strength compared with the control, observed during the combination of EAP and injection of pentobarbital, differed. The increase in the latent period of EMGR when pentobarbital was injected was most probably due to a decrease in the rate of rise of the EPSP in the neurons. Constancy of the increase in the latent period of EMGR during EAP (on average 0.9 msec) despite differences in the amplitude of EMGR compared with the control is evidence that EAP lengthens the pathway of transmission of excitation to motoneurons by one or two synaptic relays, and that this increase during EAP takes place on account of inhibition of shorter pathways of transmission of excitation in the afferent part of the nociceptive motor reflex.

The following conclusions can be drawn from the results of this investigation.

1. Enhancement of nociceptive motor responses during EAP is due to tonic activation of $\gamma$-motoneurons, the degree of which is directly proportional to the intensity of EAP.

2. EAP lengthens the pathways of transmission of excitation during the nociceptive motor reflex by one or two synaptic relays on account of inhibition of shorter pathways in the afferent part of the reflex arc.

3. The use of small doses of barbiturates may not only increase the degree of EAP analgesia, but may also block activation of $\gamma$-motoneurons evoked by EAP.

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