

ELECTROACUPUNCTURE INHIBITION OF NOCICEPTIVE RESPONSES IN THE CAUDAL TRIGEMINAL NUCLEUS

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Acute experiments on cats showed that electroacupuncture applied to the concha auriculae leads to marked inhibition of evoked potentials (EP) arising in the caudal trigeminal nucleus in response to single stimulation of the dental pulp. The duration of inhibition of EP is 60–80 min. It is followed by gradual (in the course of 30–40 min) recovery of EP. Acupuncture stimulation very slightly reduces the amplitude of EP during stimulation of the mucous membrane of the mouth. This fact is evidence that electroacupuncture depresses nociceptive responses but does not affect conduction of impulses of other modalities. To obtain an analgesic effect from auricular electroacupuncture, the classical scheme of arrangement of the acupuncture points need not necessarily be complied with.

KEY WORDS: auricular electroacupuncture; evoked potentials; analgesia.

Clinical [1, 3, 7, 8] and experimental [9, 10, 12] investigations have shown that electrical stimulation of certain parts of the peripheral nervous system (acupuncture points) by surface or deep electrodes induces an analgesic effect. However, the results of these investigations often do not agree, for different criteria were used to assess the degree and duration of the analgesia. Some workers have used objective electrophysiological indices in order to study this phenomenon.

In this investigation the analgesic effect of electrical stimulation of various parts of the auricle of the ear (auricular electroacupuncture, AEP) was assessed by changes in the amplitude of evoked potentials (EP) in the caudal trigeminal nucleus (CTN).

EXPERIMENTAL METHOD

Experiments were carried out on 23 adult cats previously anesthetized with pentobarbital (30 mg/kg, intraperitoneally), immobilized with listhenon, and artificially ventilated. To obtain nociceptive responses the pulp of the upper canine tooth was stimulated with square pulses (1 msec, strength up to 50 mA) through bipolar electrodes fixed into holes drilled in the dentine by means of acrylic glue. The mucous membrane of the mouth was stimulated through bipolar needle electrodes with similar pulses with a strength of up to 20 mA. The experiments began 6 h after injection of pentobarbital. AEP was applied by square pulses 1.2 msec in duration, with a strength of 12 mA and frequency of 1 Hz, through acupuncture needles. Three points of the ear were stimulated in the course of 15 min. EP in the ipsilateral CTN were derived by a monopolar stainless steel electrode with a tip 50 μ in diameter, inserted in accordance with stereotaxic coordinates [5]. The character of EP was assessed after averaging of 39 presentations on a special purpose computer. At the end of the experiments the location of the recording electrode was verified histologically.

EXPERIMENTAL RESULTS

In the experiments of series I the effect of AEP on the amplitude of EP arising in CTN in response to stimulation of the dental pulp with stimuli of different strengths was investigated (Fig. 1A). The amplitude of the responses depended directly on stimulus intensity. In response to threshold stimulation EP consisted of a positive wave of low amplitude. In response to a stimulus of twice the threshold strength, a marked increase in amplitude of EP and a steeper rise of the positive wave were observed. A maximal response was observed

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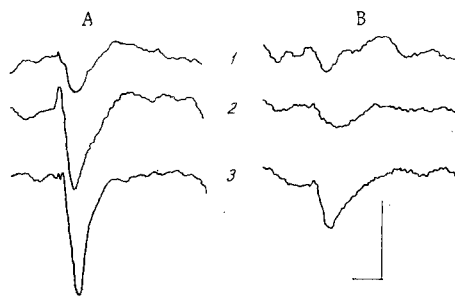


Fig. 1

Fig. 1. Effect of auricular electroacupuncture stimulation on amplitude of EP and CTN during stimulation of dental pulp. A) Before electroacupuncture; B) 3 min after end of electroacupuncture. 1, 2, 3) Stimulus strength in thresholds. Calibration: amplitude $50 \mu V$, time 50 msec.

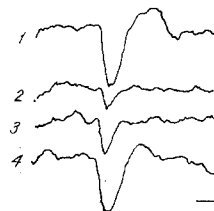


Fig. 2

Fig. 2. Restoration of EP in CTN in response to stimulation of dental pulp after electroacupuncture. 1) Before electroacupuncture; 2, 3) 3 and 60 min respectively after end of electroacupuncture; 4) restoration of EP after 80 min. Calibration: amplitude $50 \mu V$, time 50 msec.

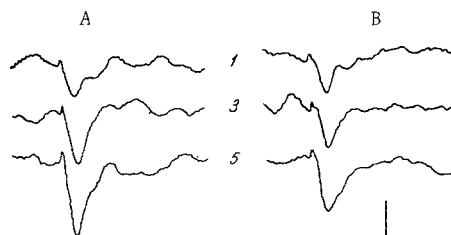


Fig. 3. Effect of electroacupuncture on amplitude of EP and CTN in response to stimulation of mucous membrane of mouth. Legend as in Fig. 1.

to stimulation at three times the threshold strength. A further increase in stimulus intensity caused no further increase in amplitude of the responses. The latent period of EP was 6-10 msec and depended on stimulus intensity.

After AEP considerable inhibition of EP took place in CTN (Fig. 1B). Depression of amplitude of EP was observed in the course of 60-80 min, after which they gradually (in 30-40 min) recovered their initial level (Fig. 2).

It must be emphasized in particular that the location of the stimulation points was unimportant as regards the degree of depression of EP. With any uniform distribution of points on the surface of the auricle the analgesic effect was the same.

In the experiments of series II the action of AEP was studied on EP in CTN in response to stimulation of the mucous membrane of the mouth. These responses were considerably higher in amplitude than EP in response to stimulation of the pulp. The threshold intensity of stimulation of the mucous membrane was considerably lower than the threshold strength of stimulation of the pulp (less than one-tenth).

The maximal amplitude of responses to stimulation of the mucous membrane was reached when the strength of stimulation was increased to five times the threshold (Fig. 3A).

AEP had much less effect on EP in response to stimulation of the mucous membrane than on EP to stimulation of the pulp. It will be clear from Fig. 3B that the amplitude of the response to stimulation of the mucous membrane at threshold intensity was unchanged after AEP compared with the control. There was only a very small decrease in the potentials evoked by stimulation at 3-5 times the threshold strength.

A similar effect also was observed when the duration of AEP was increased to 30 min.

According to many clinical and experimental investigations the dental pulp is innervated by high-threshold A δ - and C-fibers, activation of which is accompanied by painful sensations [2, 4, 13]. Clinical investigations have shown that the degree of electrical activity in CTN correlates closely with the intensity of painful sensations in the region of the face [11].

Consequently, the depression of EP arising in CTN in response to stimulation of the dental pulp after AEP is evidence of inhibition of nociceptive impulses at the level of this primary sensory relay.

Acupuncture and electroacupuncture are known to induce an analgesic effect but to have no effect on other sensory modalities [1, 3, 6]. This is in good agreement with the fact that stimulation of the external ear has no effect on EP in response to threshold stimulation of the mucous membrane of the mouth. Only a very small decrease in amplitude of EP was observed in response to stimuli of 3-5 times threshold strength. However, during stimulation with this intensity not only tactile and low-threshold fibers but also high-threshold afferents are excited. The fall in the amplitude of EP, reflecting activity of both low- and high-threshold fibers, is due to inhibition of the high-threshold (i.e., nociceptive) component.

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