REPRESENTATION OF AFFERENT NERVES OF THE CONCHA AURICULAE IN THE CAUDAL TRIGEMINAL NUCLEUS

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KEY WORDS: Caudal trigeminal nucleus; evoked potential; auricular branch of the trigeminal nerve.

The concha auriculae has an extremely rich innervation and is supplied with somatic and autonomic afferent fibers. Results of experimental and clinical investigations [3, 6, 9] indicate that an effect of analgesia and reflex changes in various functions of the internal organs can be induced (auriculotherapy) by stimulation of individual points of the concha auriculae.

In the investigation described below the distribution of evoked potentials (EP) in the caudal trigeminal nucleus and adjacent structures of the brain stem was investigated for the first time during stimulation of the auricular branch of the trigeminal nerve (AN).

Experiments were carried out on 18 adult cats. Each animal in the experiment was kept lightly anesthetized with pentobarbital sodium, which was injected intraperitoneally (initial dose 30 mg/kg body weight) regularly. The animals were immobilized by intravenous injection of listhenon and were artificially ventilated. Throughout the experiment a 5% solution of glucose was injected by intravenous drip.

The auricular branch of the auriculotemporal nerve was dissected under an operating microscope, after which silver electrodes were applied to the nerve for stimulation and nonpolar derivation of the electrical activity of the nerve. The recording electrode was applied to the point of bifurcation of the nerve into auricular and temporal branches, the stimulating electrode to the base of the ear. AN was stimulated by square pulses 0.05-0.1 msec in duration and with an amplitude of 0.5-25 V. EP were derived by means of insulated stainless steel macroelectrodes with a tip 50-70 μ in diameter. To locate the electrode tip, Berman's stereotaxic atlas [2] was used. Evoked electrical activity was amplified and displayed on an oscilloscope screen for observation and photographic recording.

To verify the location of the tip of the recording electrode morphologically it was tagged by electrical coagulation by means of a direct current of 0.8 mA for 30 sec. After fixation of the brain in 10% formalin solution for 3-4 days, sections 30-60 μ thick through the layers of the brain were cut on a freezing microtome and subsequently photographed.

EXPERIMENTAL RESULTS

The results were obtained by analysis of 83 electrode insertions into the brain stem. The region of the brain stem investigated was between 1 mm rostrally and 4 mm caudally to the obex.

Evoked responses of AN to electrical stimuli of varied intensity are illustrated in Fig. 1. The maximal conduction velocity for the first high-amplitude wave, according to calculations, did not exceed 25-30 m/sec and for the second wave 5-8 m/sec. Calculation of the conduction velocity of the fibers of AN on the basis of the results of the present investigation indicates that AN consists mainly of fibers of the A-delta group.

The dynamics of changes in the evoked response with an increase in the intensity of stimulation suggests that the appearance of the late component of the negative wave in activity of AN corresponds to activation of group A-delta fibers with the highest thresholds.

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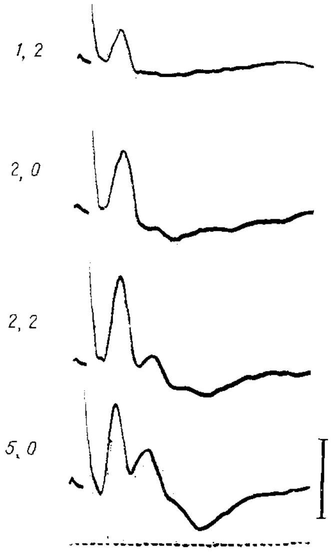

Fig. 1

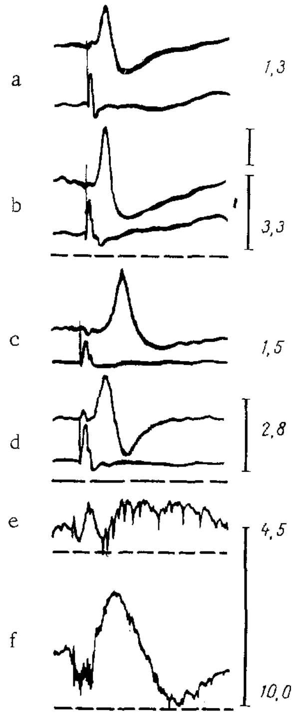

Fig. 2

Fig. 1. Activity of AN evoked by electrical stimulation of that nerve. Amplitude of stimuli relative to threshold value given in numbers. Time marker 1 msec, amplitude marker 100 μV.

Fig. 2. EP of brain stem (top beam) and AN (bottom beam). Amplitude of stimuli relative to threshold values given in numbers; a and b) EP of first group, c) and d) EP of second group; e and f) EP of third group. Time marker 20 msec, amplitude 250 μV.

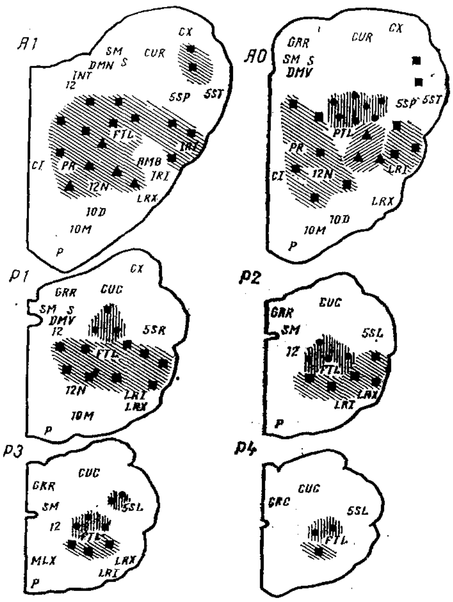

Fig. 3. Distribution of regions where different groups of EP were recorded in the brain stem. Circles show region of recording EP of first group, square of second group, and triangles of third group. Names of morphological structures taken from Berman's atlas [2].

TABLE 1. Electrophysiological Characteristics of Evoked Responses

Region of recording	Latent period, msec	Amplitude of response, μV	Range of amplitude of effective stimuli relative to threshold values
Nerve	1,6–1,8	50–100	1,0–7,0
Spinal trigeminal tract	3–4	100–300	1,0–7,0
5SP	4–6	150–500	1,0–2,0
LRX, LRI	6–10	100–300	1,0–7,0
PR	6–10	50–200	1,3–6,0
Rostral part of FTL	10–20	50–200	2,5–10,0

This is confirmed by the appearance of a late wave of positive polarity, reflecting hyperpolarization phenomena in afferent fibers (Fig. 1). Primary afferent hyperpolarization arises during activation of fibers of small diameter in response to an injuring stimulus [1, 7, 8]. It can accordingly be concluded that electrical stimuli exceeding in strength the threshold of activation of the nerve by 2.1-2.2 times, applied to AN, are equivalent as regards the composition of activated fibers to stimuli injuring the body tissues of the animal.

EP of the brain stem were divided into three groups on the basis of latent period, amplitude, and duration of the negative and positive phases. The first group consisted of EP arising to stimuli of near-threshold intensity for the appearance of an afferent wave of activity in AN. With an increase in stimulus intensity, EP of the first group changed only within the limits of values not causing the appearance of later waves in the response of AN activity. A further increase in the strength of stimulation did not change EP significantly (Fig. 2a, b). The second group consisted of EP which changed over a wide range of intensities of stimulation. EP of the second group, which appeared in response to stimuli of threshold values of AN, changed when the intensity of stimulation was increased above the level necessary for excitation of late waves for AN activity (Fig. 2c, d). The third group included EP recorded only to stimulation of intensity more than enough to cause the appearance of late waves of AN activity (Fig. 2e, f). Neuronal units whose activity was reflected in EP of different groups thus corresponded to the physiological significance of stimulation.

A study of the distribution of EP in this part of the brain showed that regions in which definite types of EP were recorded were spatially delimited (Fig. 3). The physiological characteristics of EP of the first group that were discovered enabled neurons located in the region of recording of these EP to be identified as follows. The region of low-threshold EP of the first group, located dorsally above FTL, corresponded to ascending fibers of the dorsal trigeminal tract. At the level of the obex a region of high-amplitude EP of the first group, corresponding in functional characteristics to activity of descending fibers of the ventral trigeminal tract [5], could be distinguished medially, adjacent to the caudal trigeminal nucleus. EP derived within the dorsomedial part of the caudal trigeminal nucleus at a level 3 mm caudally to the obex enabled a region of primary projections of AN to be distinguished in the caudal nucleus, where it coincided with the region of representation of the mandibular branch of the trigeminal nerve [4].

The electrophysiological characteristics of evoked responses derived from different regions in the present investigation are given in Table 1. They show that the range of amplitude of effective stimuli for the rostral part of FTL exceeds that for the region of the spinal trigeminal tract, which includes fibers of AN. The reason for this disparity is that AN along its length to its point of emergence on the auricular surface converges with the other afferent nerves with higher threshold.

CONCLUSIONS

1. AN consists of afferent fibers belonging to the A-delta group.

2. Electrical stimulation of AN fibers, with an intensity equivalent to non-noxious stimulation, is sufficient to activate fibers of the dorsal and ventral trigeminal tracts and also neurons of the caudal trigeminal nucleus at a level 3 mm caudally to the obex.

3. Neuronal units of the paramedian and lateral reticular nuclei can be excited by electrical stimulation of AN fibers equivalent in intensity to both noxious and non-noxious stimulation.

LITERATURE CITED

1. Yu. P. Limanskii, Structure and Functions of the Trigeminal Nerve System [in Russian], Kiev (1976), pp. 91-98.
2. A. N. Berman, The Brain-Stem of the Cat. A Cytoarchitectonic Atlas with Stereotaxic Coordinates, Madison, Wisconsin (1968), p. 55.
3. J. Darian-Smith et al., J. Physiol. (London), 168, 147 (1963).
4. H. Mogami et al., in: Oral-Facial Sensory and Motor Mechanisms, New York (1971), pp. 205-228.
5. P. Nogier, Treatise of Auriculotheraphy, Maisonneuve (1972), p. 321.
6. R. F. Young and R. B. King, J. Neurophysiol., 35, 87 (1972).
7. R. F. Young et al., Exp. Neurol., 38, 64 (1973).
8. D. M. Tabeeva and L. M. Klimenko, Auricular Acupuncture [in Russian], Kazan' (1976), pp. 57-65.

AGE DIFFERENCES IN FUNCTIONAL PROPERTIES OF VASCULAR SMOOTH-MUSCLE CELLS

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An important role in the formation of vascular tone is played by the state of the smooth-muscle cells (SMC) of the blood-vessel wall. Consequently, to understand mechanisms of age changes in vascular tone, it is essential to study the basic properties of SMC of the vascular wall at different stages of individual development. Considerable progress has been made in the study of the function of vascular SMC of adult animals [2, 7, 11, 12], but as yet age differences in the physiological properties of these effector formations have received little study.

The object of the present investigation was to study the electrical and contractile properties of vascular SMC in animals of different ages.

EXPERIMENTAL METHOD

Experiments were carried out on isolated segments of the portal vein of rats of three age groups: 3-4 weeks (young), 6-8 months (adult), 26-28 months (old). The level of the membrane potential (MP) and the spontaneous electrical activity possessed by the SMC of this vessel were recorded by intracellular microelectrodes. Spontaneous contractile activity was studied by means of a mechanical to electrical transducer. The levels of MP and electrical

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