CHANGES IN THE ACTION POTENTIALS OF THE CERVICAL SYMPATHETIC TRUNK AND SUPERIOR CERVICAL SYMPATHETIC GANGLION OF THE GUINEA PIG IN ONTOGENESIS

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Recent investig..tions [6-9, 12-15] have revealed the main characteristics of the action potentials (AP) arising in the sympathetic ganglia and preganglionic fibers during stimulation of the preganglionic trunk. These investigations were carried out on the superior cervical sympathetic ganglion of adult animals born while still immature (cats, rabbits). During the study of the AP of the preganglionic trunk and superior cervical sympathetic ganglion of these animals [1, 2, 10] considerable differences were found in the characteristics of the AP of such animals, immature at birth, in the process of ontogenesis.

The object of this investigation was to examine age changes in the conduction of excitation in the preganglionic trunk and ganglion of animals mature at birth—guinea pigs.

According to some reports the bioelectrical activity of the cerebral cortex [16-18] and its biochemical features [3-5] are identical in newborn and adult guinea pigs. It has also been found that the background bioelectrical activity of the superior cervical sympathetic ganglion of guinea pigs after the first days of life is very similar in its characteristics to that of adult animals [10, 11].

EXPERIMENTAL METHOD

Experiments were carried out on guinea pigs of different ages: 1-5 and 15-20 days, and adult animals.

Under light anesthesia with Nembutal the ganglion and preganglionic trunk were dissected. The preganglionic trunk was divided in its distal part and placed on stimulating electrodes. The recording electrodes were placed closer to the ganglion. Light, bipolar, hanging electrodes were placed on the ganglion. The preganglionic trunk was stimulated by rectangular pulses with a duration of 0.02-2 msec, a frequency of 1-100/sec, and a voltage starting with 0.1 V. The biopotentials of the preganglionic trunk and the superior cervical sympathetic ganglion were recorded after preliminary amplification on a cathode-ray oscillograph.

EXPERIMENTAL RESULTS

The AP in the cervical sympathetic trunk and the superior cervical sympathetic ganglion of the guinea pig could be recorded on the first day of the animal's life. As in the adults, in newborn guinea pigs maximal AP in the preganglionic trunk and ganglion appeared during stimulation of the preganglionic trunk with identical parameters (2-3 V, duration 0.2-0.5 msec; Fig. 1, A).

However, the latent period of the AP in the preganglionic trunk and ganglion of the guinea pigs varied with the age of the animals.

The dynamics of the changes in the latent period of excitation in guinea pigs with age are illustrated in Fig. 1, B and C.

The AP of the ganglion and, in particular, of the preganglionic trunk were similar in form in the newborn and adult animals. In guinea pigs of different ages, starting with newborn animals, the AP of the preganglionic trunk arising in response to supramaximal stimulation consisted of several negative components, demonstrating the nonhomogeneity of the fibers of the cervical sympathetic trunk as regards the velocity of their conduction of excitation (Fig. 2). The results of measurements of the velocity of conduction of excitation in the three principal groups of fibers distinguished in the preganglionic trunk by the

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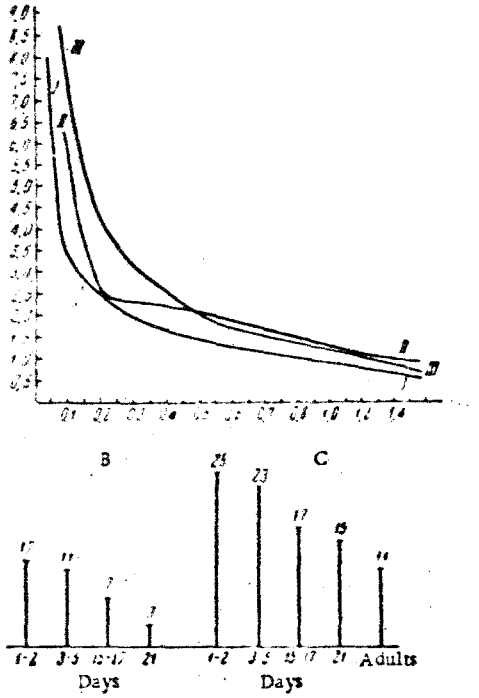

Fig. 1

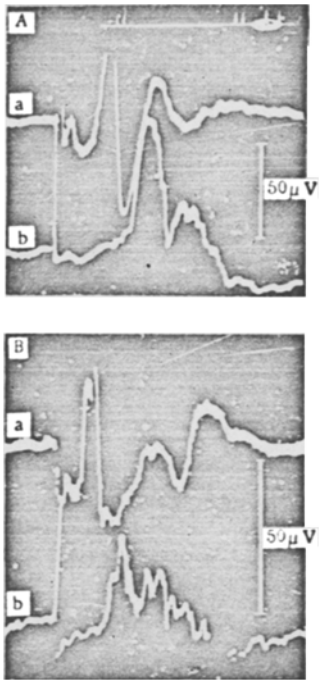

Fig. 2

Fig. 1. A) Strength-duration curves of action potentials of the superior cervical sympathetic ganglion of guinea pigs: I) adult; II) five days old; III) 1-2 days old. Along the axis of abscissas—time (in msec), along the axis of ordinates—voltage (in V); B) changes in duration of latent period of excitation (in msec) in the cervical sympathetic trunk of guinea pigs of different ages; C—the same in the superior cervical sympathetic ganglion.

Fig. 2. Action potentials of the cervical sympathetic trunk (a) and superior cervical sympathetic ganglion (b) of guinea pigs aged 2 days (A, and adults (B). Parameter of stimulation: duration of stimulus 0.5 msec, voltage 1 V. The position of the electrodes is shown schematically above.

number of separate components of the AP, showed that guinea pigs of different ages conduct excitation at different velocities. In the animals aged 1-3 days, for instance, it was 0.2 and 2.1 m/sec respectively for these groups, in guinea pigs aged 5-15 days 6, 2, and 0.3 m/sec, and in animals aged 20 days or adults, it was 10.5-10.6, and 1.0-0.5 m/sec.

The frequency of tetanic stimulation of the preganglionic trunk at which Wedensky inhibition began to appear in the conduction of impulses in both the preganglionic trunk and the ganglion also differed slightly in guinea pigs of different age groups (Fig. 3). In animals during the first three days of life a disturbance of synaptic transmission in the ganglion and of conduction of impulses along the preganglionic trunk appeared during stimulation at a frequency of 25-30 cps, while in guinea pigs aged 15-17 days, inhibition developed in response to a frequency of 50 cps, which in adult animals gave rise merely to an alternating rhythm of the AP.

It may be concluded from these experiments that in animals born mature (guinea pigs), as in animals born immature (rabbits, cats), the level of functional activity of the structures in the peripheral portion of the sympathetic nervous system is established in the early postnatal period. However, compared with animals born immature, in those born mature (guinea pigs) this period ends, according to the indices investigated in these experiments, mainly by the 15th-20th day of postnatal life, whereas in cats and rabbits it continued for a longer period.

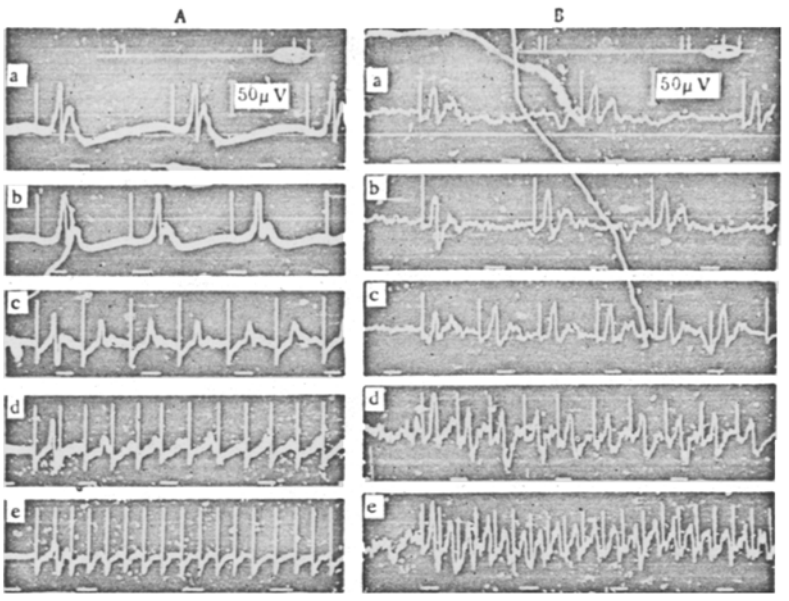

Fig. 3. Action potentials of the superior cervical sympathetic ganglion during stimulation of the preganglionic trunk with pulses of different frequency in a guinea pig aged 1 day (A) and in adult guinea pig (B). Parameters of stimulation: duration of stimulus 0.5 msec, voltage 3 V. a) Frequency of stimulation 5 cps; b) 10 cps; c) 20 cps; d) 30 cps; e) 50 cps. Time marker 0.1 sec.

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