CHARACTERISTICS OF SYNAPTIC DELAY IN THE NEUROMUSCULAR APPARATUS OF DOGS OF VARIOUS AGES

(UDC 612.816:612.66]-08)

T. A. Adzhimolaev

Institute of Normal and Pathological Physiology,
Academy of Medical Sciences of USSR, Moscow
Presented by Academician V. V. Parin
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 59, No. 5,
pp. 12-14, May, 1965
Original article submitted February 14, 1964

Investigations carried out in this laboratory have shown that there are no physiological indices of the functioning of the myoneural synapse in very young puppies [2-7].

Morphological studies have also shown that there is gradual maturation of the myoneural synapse, and that acquisition of the adult characteristics is relatively late.

On this evidence it was postulated that synaptic delay might vary in duration with age.

The length of synaptic delay was now studied in dogs of different ages.

METHOD

The method described by A. F. Samoilov [10] was employed. One recording electrode was placed on the distal part of a nerve (tibial nerve) at the point where the latter enters the gastrocnemius, and another on the tendon of the muscle. The recording arrangement was thus similar to that used for the recording of electrocardiograms, when one electrode is on the atrium and a second on the ventricle. The stimulating electrodes (inter-pole distance 2 mm) were placed on the tibial nerve (which had been picked up on a ligature) 2-3 cm away from the recording electrode. The nerve was stimulated with rectangular pulses (0.1 msec) from an electronic stimulator. These conditions resulted in the recording, first, of a stimulation artefact, then the action potential of the nerve (of small amplitude) and finally, the action potential of the muscle. The interval between the artefact and the commencement of the action potential of the nerve represented the time required for spread of the excitation in the nerve, and the interval between the beginning of the action potential of the nerve and the beginning of the action potential of ther muscle represented the synaptic delay time. The action potentials were recorded oscillographically, after amplification, from a myograph. The investigations, in the form of acute experiments, were carried out on 49 dogs ranging in age from a few days to the adult state. The determinations were repeated several times on each dog to ensure that the characteristics recorded were correct and reproducible.

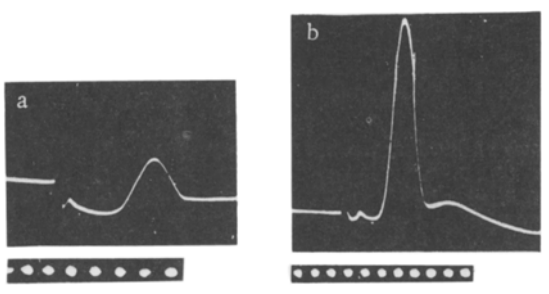

Fig. 1. Oscillograms of nerve-muscle action potentials for determination of time required for passage of excitation from nerve to muscle in 2 day old (a) and 16 day old (b) puppies. Time scale (in all figures) - 2 msec.

RESULTS

The results indicated that the dogs could be divided into 3 groups, namely puppies up to the age of 16 or 18 days, puppies between the ages of 18 days and $2^1/_2$-3 months, and dogs more than 3 months old. Synaptic delay lasted 3-4.5 msec in the animals of the 1st group (21 puppies) (Fig. 1). Within this group, the duration of synaptic delay was 4.4 or 4.5 msec between 10 and 14 days, and 3 msec in puppies of 16 days.

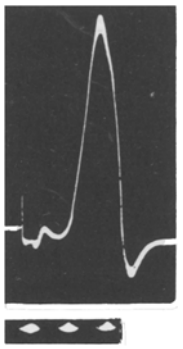

Fig. 2. Oscillogram of nerve-muscle potential in a 2 month old puppy.

Synaptic delay ranged from 2.2 msec to 1.5 msec in the 19 puppies of the 2nd group (Fig. 2). The value was 2.2 msec for puppies of 18-20 days, and thereafter it became progressively shorter, to reach 1.3 msec at the age of $2^1/_2$-3 months.

Synaptic delay lasted 1.3-0.7 msec in the 9 animals of the 3rd group. It was 1.3 msec at the age of 3 after which it fell steadily to the adult value of 0.7 msec (Fig. 3a). The differences in the length of synaptic delay at different ages are illustrated by the potentials recorded myographically in puppies of 3 months (b) and 3 days (c). A difference in the rate of excitation conduction along the nerve can also be observed, in addition to the obvious difference in the length of synaptic delay. The rate of spread of excitation in the nerve of the young puppy was only a 3rd or less of the rate in the adult animal. The pronounced shortening of synaptic delay (by more than half) which occurs about the age of 16-18 days develops at a time when the hind limbs begin to be brought into action to produce the standing position, and when the first signs of an exaltation phase, of after-hyperpolarization in post-tetanic activity and of the power to develop inhibition.

When at the age of $2^1/_2$ months, these characteristics are firmly established, synaptic delay was reduced to less than a third of its original value, and in the adult animal the duration of synaptic delay was less than one-sixth of the duration recorded in very young puppies.

The amplitude of the action potential of the muscle had increased considerably by the 16th day.

Work in this laboratory has shown that polarization in skeletal muscle, as indicated by increase of impedance and of demarcation potential, has increased considerably by the age of 16-18 days [1, 6, 9].

The present investigation has established that synaptic delay is reduced, and not increased, as might have been expected, with the gradual maturation of the myoneural synapse in the course of postnatal development.

Investigations by Ginetsinskii and Shamarina [8] have established that, in the early postnatal period, cholinergic substance is widely distributed over the entire extent of the muscle fiber and that concentration in the region of the myoneural synapse develops later. It is still impossible to say just how these facts can be used to explain the differences in the duration of synaptic delay in relation to age. Nevertheless, these results together with the results of other investigations carried out in this laboratory suggest that the gradual structural and functional maturation of the myoneural synapse in the course of postnatal development is associated with a speeding-up of the conduction of excitation from nerve to muscle and, again, with the creation of a special mechanism for the production of inhibition.

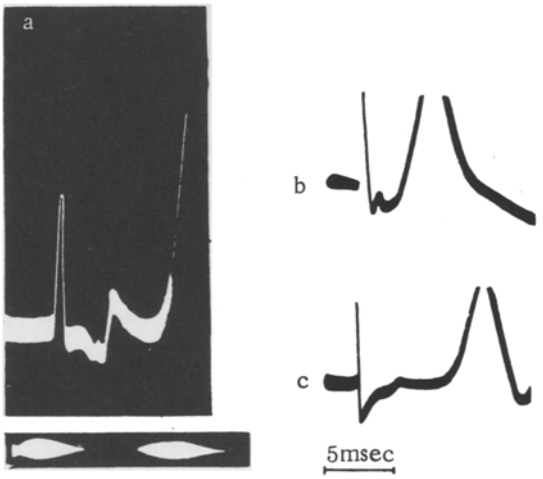

Fig. 3. Oscillograms of nerve-muscle potentials in adult dog (a), 3 month (b) and 3 day old (c) puppies.

LITERATURE CITED

1. T. A. Adzhimolaev and V. V. Gavrilov, Dokl. Akad. Nauk SSSR, Vol. 147, No. 4, (1962), p. 981.
2. T. A. Adzhimolaev, Proceedings of Fifth Scientific Conference on Age Morphology, Physiology and Biochemistry, Moscow (1962), p. 190.
3. T. A. Adzhimolaev, Byull. Éksp. Biol. i Med., No. 2 (1963), p. 3.
4. T. A. Adzhimolaev, Byull. Éksp. Biol. i Med. No. 3 (1963), p. 11.
5. I. A. Arshavskii, Vestn. Akad. Med. Nauk SSSR, No. 8 (1960), p. 41.
6. I. A. Arshavskii, In: Problems of Age Physiology and Biochemistry. Kharkov (1962), p. 184.
7. I. A. Arshavskii, In: Problems of Lability, Parabiosis and Inhibition, Moscow (1962), p. 9.
8. A. G. Ginetsinskii and N. M. Shamarina, Usp. Sovr. Biol. Vol. 15, No. 3 (1942), p. 283.
9. I. I. Gokhblit and I. A. Korinenko, Byull. Éksp. Biol. i Med. No. 2, (1960), p. 26.
10. A. F. Samoilov, In: Collection Commemorating 75th Birthday of I. P. Pavlov, Leningrad (1924), p. 75.

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
