INVESTIGATION OF THE FUNCTION OF A SINGLE AORTIC BARORECEPTOR

D. I. Miminoshvili

Physiologic Laboratory (Chief – Active Member of the Academy of Medical Sciences USSR P. K. Anokhin), the A. V. Vishnevsky Institute of Surgery (Director – Active Member of the Academy of Medical Sciences USSR A. A. Vishnevsky), Academy of Medical Sciences of the USSR, Moscow

(Received January 20, 1956. Presented by Active Member of the Academy of Medical Sciences USSR Professor P. K. Anokhin)

The afferent activity of the aortic nerve was studied electrophysiologically by Alvarets-Buya [1], P. K. Anokhin and A. I. Shumilina [3]. The oscillogram of the action potentials of the whole aortic nerve presents a picture of the summated activity of many nerve fibers and baroreceptors associated with them. In order to study certain questions concerning the functioning of baroreceptors of the aortic arch it is essential to have a single nerve fiber preparation, associated with a single baroreceptor.

The present author is aware of only one work, by D. W. Bronk [7], devoted to investigation of a single aortic baroreceptor. The usual method of obtaining a single nerve fiber preparation consists of dissecting it from the nerve trunk. This method is rarely successful, especially in the case of warm-blooded animals.

Completely satisfactory preparations of a single baroreceptor with the corresponding single nerve fiber were obtained by the present author on rabbits using the heterogeneous nerve anastomosis method as described by P. K. Anokhin [2].

The central end of the phrenic nerve was sutured to the peripheral end of the sectioned aortic nerve. It is known that the phrenic nerve contains, in addition to the main mass of motor fibers, a small number of sensory fibers which are predominantly proprioceptive [5, 6, 9]. After suturing, the nerve fibers of the phrenic nerve grow into the sheaths of the fibers in the peripheral portion of the aortic nerve. At the periphery fully functional connections with receptors are formed only by sensory fibers. This was shown on other models by V. F. Lashkov [4] and P. Weiss [10].

EXPERIMENTAL METHODS AND RESULTS

Experiments were performed on 6 rabbits. 3-4 weeks after operation the nerves regenerated and preparations of a single nerve fiber or of several nerve fibers were obtained; in the latter case the number of fibers

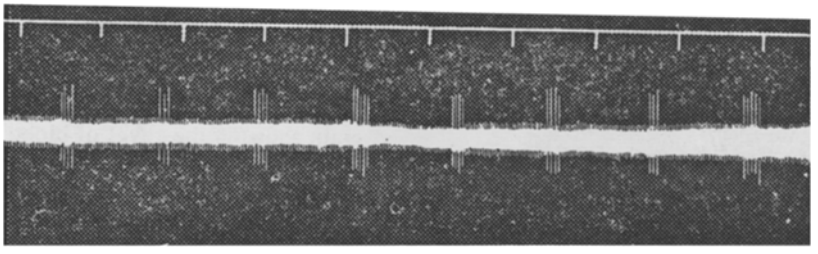
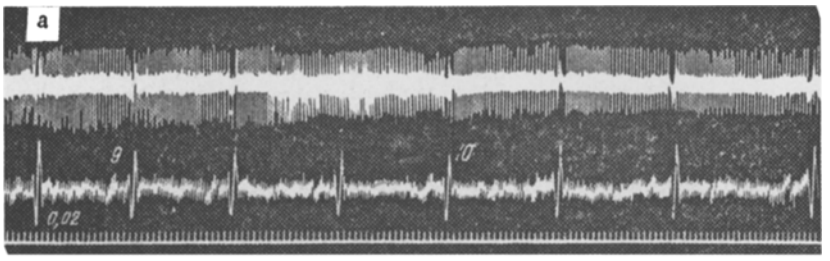


Figure 1. Action potentials of a single fiber of the aortic nerve with normal blood pressure. Time marker (0.2 seconds).

could be readily reduced to one by fractional damage under oscillographic control. When a burst of action potentials appeared below the anastomosis after each systole and the individual oscillations constituting the burst were of equal amplitude the biocurrents were considered to emanate from a single nerve fiber. The action potentials were recorded by means of an A. C. amplifier and oscillograph. Biocurrents characteristic of a single nerve fiber (of equal amplitude) were obtained in all 6 cases of anastomosis.

Figure 1 shows the oscillogram of single nerve fiber action potentials with normal blood pressure. The bursts consist of oscillations equal in amplitude which appear 0.04 seconds after a systole. Each burst contains



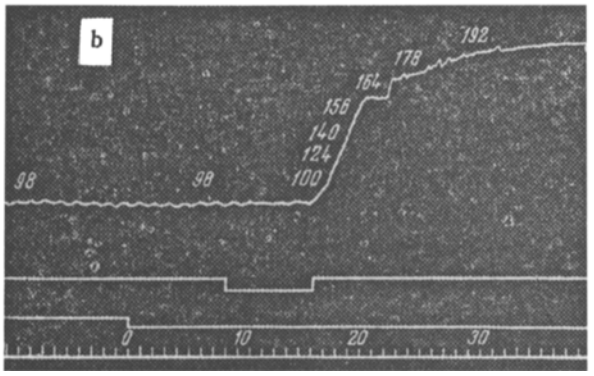


Figure 2. Changes in single nerve fiber action potential discharges in the aortic nerve on raising the blood pressure. Records from above down: a) aortic nerve action potentials; electrocardiogram; time marker (0.02 seconds) b) kymogram of blood pressure; mark denoting injection of adrenaline; mark denoting beginning of action potential recording; time marker (1 second).

1-5 action potentials. The following alternation of the number of discharges in a burst has been noted: 3 – 4 – 4 – 5 – 4 – 3. This evidently reflects respiratory undulations, since the period of the cycle equals the duration of the respiratory undulation on the blood pressure curve, i. e, 1.5 second.

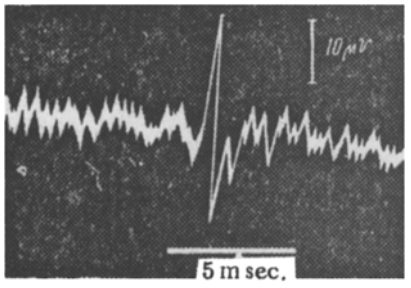


Figure 3. Action potential of a single aortic nerve fiber in the rabbit.

Figure 2 shows the oscillogram of the same nerve fiber 10-12 seconds after intravenous injection of 1.2 mg adrenaline. Below that is given the kymogram showing the level of blood pressure. 4 $^{1}/_{2}$ seconds after injection of adrenaline the minimal number of impulses in a discharge increased from 3 to 5 and oscillations at the end of diastole appeared corresponding to the dicrotic wave.

As the blood pressure rose the burst became

more extended, the frequency of the oscillations constituting the burst became higher, and the burst eventually occupied the whole diastolic interval. The latent period of the burst diminished from 0.04 to 0.02 seconds with the rise of blood pressure. At the beginning of the burst the oscillations had a frequency of 150 cps, reaching a maximum of 250 cps after 60 milliseconds and dropping to 50 cps at the end of the burst.

Characteristically, the amplitude of the action potentials decreased at times by half as compared with the initial amplitude as the rhythm increased (Fig. 3).

The oscillogram of a single action potential of the preparation under investigation as recorded with high speed makes it possible to characterize the single aortic nerve fiber biocurrent in more detail (Fig. 3). The sharpness of the first phase of the wave must be noted, as it is generally characteristic for single nerve fiber action potentials [8]. The duration of the action potential of both phases is 1 millisecond. The amplitude of the action potential is about 30 μv.

The method employed allows more single and adequate conditions for the investigation of the functioning of a single aortic baroreceptor under conditions of natural stimulation.

SUMMARY

An original method of obtaining preparations of isolated aortic nerve fibres by anastomosing the phrenic and aortic nerves is described. Discharge of impulses from the isolated aortic nerve fibre consist of biopotentials of an alternating rhythm. At the beginning of the discharge the frequency of impulsation is high, later it falls down to zero. In case of persistent hypertension impulsations of succeeding bursts blend together forming an unbroken line, with increasing frequency in rhythm of every newly-appearing burst.

LITERATURE CITED

[1] R. Alvarez-Buya, Thesis, Physiologic Analysis of Afferent Impulses in a Depressor Nerve, * Moscow, 1946.

[2] P. K. Anokhin, The Problem of Center and Periphery in the Physiology of Nervous Activity, * Moscow, 1935.

[3] P. K. Anokhin, A. I. Shumilina, Fiziol. Zhurn. SSSR, 33, No. 3, pp. 275-288, 1947.

[4] V. F. Lashkov, Byull. Vses. In-ta Eksptl. Med., No. 1, pp. 21-23, 1935.

[5] B. A. Favorsky. In book: Trudy Voenno-Morsk. Med. Akad., * Leningrad, 1946, Vol. 5, Part 2, pp. 56-64.

[6] S. Baglioni. Zbl. Physiol., 1902, Bd. 16, S. 649-652.

[7] D. W. Bronk, Proc. Soc. Exper. Biol. a. Med., 1931, v. 28, p. 1014.

[8] H. Hertz, Action Potential and Diameter of Isolated Nerve Fibers Under Various Conditions, Kopenhagen, 1947.

[9] M. G. Little, B. A. McSwiney, J. Physiol., 1938, v. 94, pp. 2-3.

[10] P. Weiss, M. V. Edds, J. Neurophysiol., 1945, v. 8, N. 3, pp. 173-193.

* In Russian