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# Impulses in Cardiac Sympathetic Nerves.*

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A better understanding of the mechanism of the reflex regulation of heart rate and blood pressure is to be gained from a study of the afferent nerve impulses from the circulatory system and of the efferent impulses to the heart and blood vessels. Previous communications have described the nature of the nervous discharge from the arch of the aorta and from the carotid sinus,[1, 2] and its relation to blood pressure. On the efferent side, sympathetic impulses concerned in maintaining the tone of the blood vessels have been recorded.[3] The present report is concerned with the activity of the sympathetic fibers to the heart.

One of the small nerve twigs running to the heart from the stellate or inferior cervical ganglion in a cat under urethane anesthesia was freed from the surrounding tissue and cut close to the heart, all other cardiac sympathetic fibers remaining intact. The nerve was then slung onto electrodes and the action potentials, after amplification, were recorded by means of an oscillograph. Figure 1A shows a typical discharge. It will be observed that the impulses tend to come in bursts but in general we have not been able to identify the frequency of these volleys with the heart rate or respiratory rhythm, although it has been shown[3] that in the case of sympathetic nerves carrying fibers to the blood vessels, there is usually a grouping that is synchronous with either the respiratory or cardiac rhythm. The records further show that under the conditions of these experiments there is normally a "tonic" sympathetic discharge to the heart.

The relation of the discharge in the cardiac sympathetic fibers to the heart rate is shown by a comparison of Figures 1A and B. In A, the frequency of the heart beat was 132 per min. Adrenalin was then injected intravenously, resulting in a complete cessation

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2 Bronk, D. W., and Stella, G., *J. Cell and Comp. Physiol.*, 1932, **1**, 113.

3 Adrian, E. D., Bronk, D. W., and Phillips, G., *J. Physiol.*, 1932, **74**, 115.

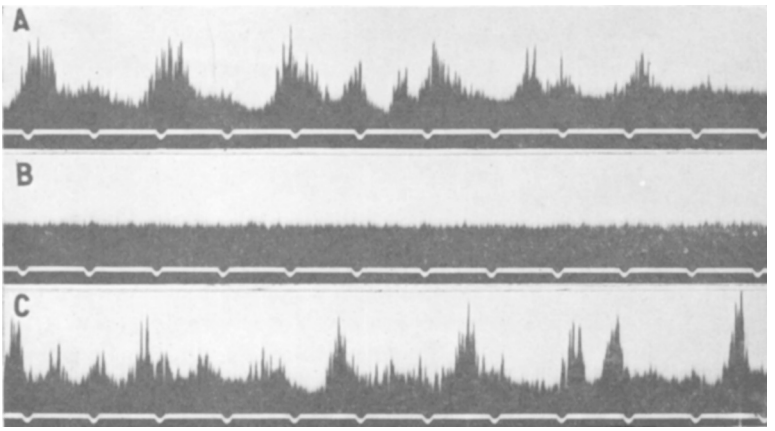


FIG. 1.

Action potentials in a cardiac branch of the sympathetic. A. Heart rate 132 per min. B. Following intravenous injection of adrenalin. Impulse discharge abolished. Heart rate 80 per min. C. Later. Blood pressure down to normal. Heart rate 130 per min. White marker gives time in 1/5 sec.

of the sympathetic impulses as shown in B. Associated with this abolition of impulses there was a decrease in the heart rate to 80 per min. Some minutes later, the sympathetic discharge had returned as in C and the frequency of the heart beat was again about 130 per min. Inhalation of amyl nitrite on the other hand increased the activity of these sympathetic fibers and was associated with cardiac acceleration. There is then a definite relation between the number of sympathetic impulses in the cardiac fibers and the heart rate. In general, any agent producing an increase in blood pressure causes a decrease in the discharge in cardiac sympathetic fibers, whereas a decrease in blood pressure is followed by an increase in the discharge provided the afferent nerves from the carotid sinus and aorta are still functional. These results are analogous to those obtained by Adrian, Bronk and Phillips[3] on sympathetic fibers to the blood vessels. The direct action of various chemical agents on the centers is being investigated.

Records of action potentials in practically any of the cardiac branches of the vagus have shown a similar type of nervous discharge and a similar relation to heart rate. Subsequent section of the ascending branches of the stellate ganglion have, however, abolished the impulses. It may be concluded, therefore, that vagal branches going to the heart carry a considerable number of sympathetic fibers which conduct impulses that are concerned with cardiac acceleration. The nature of the discharge in vagal fibers associated with cardiac inhibition will be discussed in a subsequent paper.