# ALTERATIONS IN ELECTRIC ACTIVITY OF THE AFFERENT AND EFFERENT NERVES OF THE TONGUE WHICH RESULT FROM EXPERIMENTAL REFLEX HYPERTENSION

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The aim of the present study was an investigation of the electrical activity in the efferent fibers of the cervical sympathetic trunk and in the afferent fibers of one of the organs innervated by this same sympathetic nerve, at a time when urinary bladder interoceptors were being stimulated so that a reflex hypertension was induced.

As the afferent nerve we chose the lingual nerve because basically it is a sensory nerve into whose composition enter fibers from tissue vessel receptors. In some experiments, instead of registering electric activity in the cervical sympathetic nerve, the activity was recorded in the central end of the sublingual nerve, composed basically of the post-ganglionic sympathetic fibers directed to the tongue [1, 3].

## EXPERIMENTAL METHODS

The experiments were conducted upon cats weighing 1.5-3 kg under ether-urethane narcosis. The electrical activity of the nerves was recorded by means of a double cathode oscillograph (OB-2 of the experimental instrument factory Acad. Med. Sci. USSR) with an amplification from $10^5$-$10^6$ times. The action potentials were taken off by means of silver bipolar electrical conductors. The thickness of the wire was 0.5 mm and the distance between the poles was 3-5 mm. The filters permitted passage of wave frequencies from 30-2000 cps. The sound level did not exceed 5 $\mu$v.

The cervical sympathetic nerve was dissected from the vagus and depressor nerves at the level of the middle third of the neck. The lingual and sublingual nerves were separated from the mandible. The experiments were conducted upon tracheotomized animals. The interoceptors were stimulated by air distension of the urinary bladder under a pressure of 50-100 mm mercury.

## EXPERIMENTAL RESULTS

According to the findings of Zotterman [7], Pfaffman [6] and I. I. Laptev [2] the lingual nerve, even in the absence of any special stimuli, may register slow impulses of low amplitude associated with constant stimulation of the thermal receptors of the tongue. We were successful in recording two types of spontaneous activity in the lingual nerve: slow impulses of low amplitude and, in some experiments, rapid single phase impulses of high amplitude. Also in the cervical sympathetic as well as the sublingual nerve, we recorded slow double phase impulses which grouped themselves in rhythm with the pulse and respiration (Fig. 1, A and 2, A).

Fig. 1, A shows the results of one of these experiments.

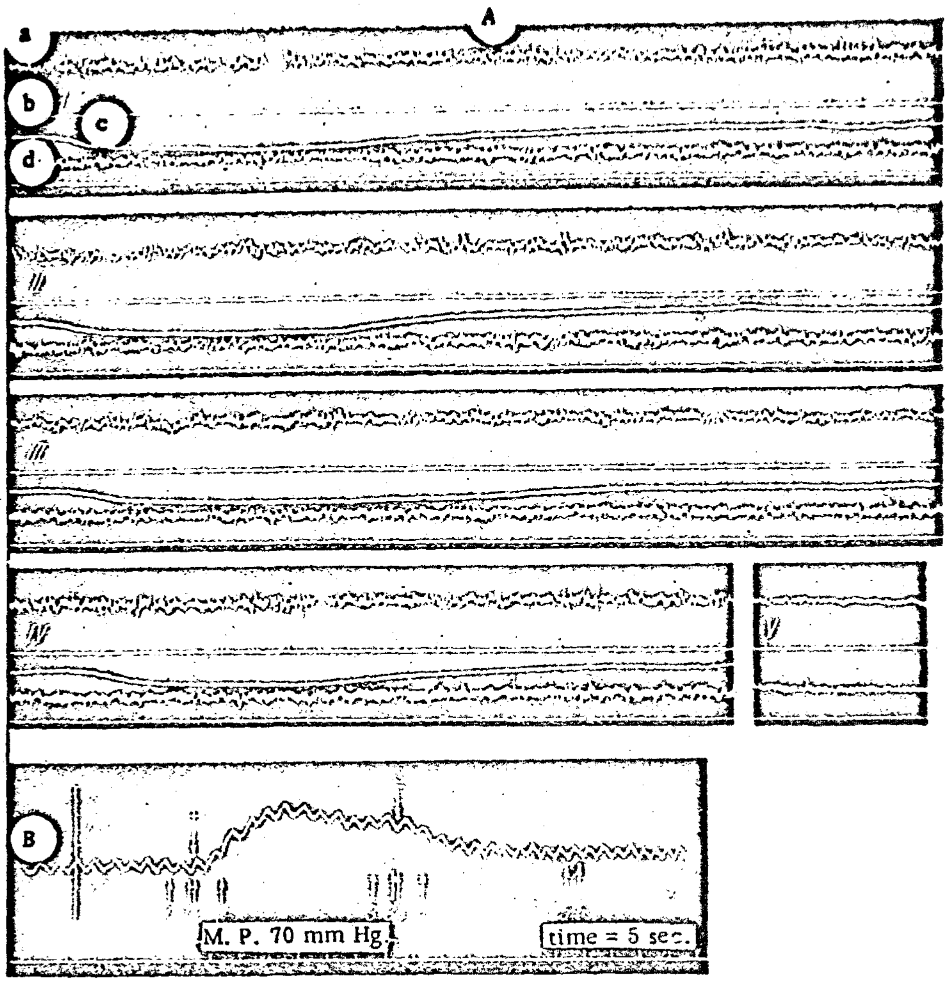
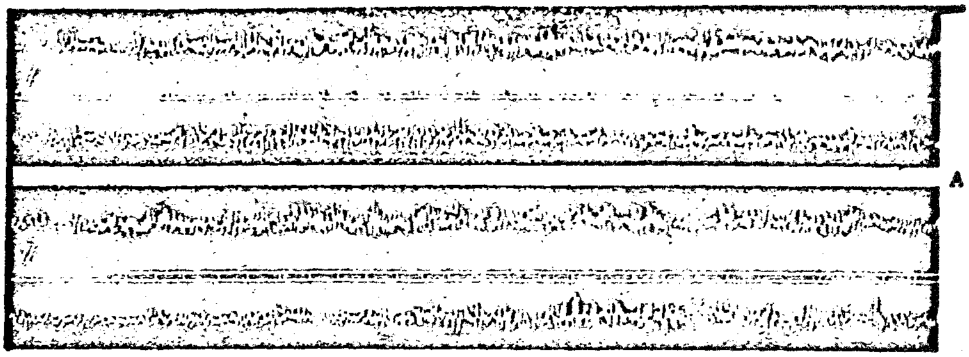



Fig. 1. Electrical activity in the sublingual and lingual nerves during hypertension produced by bladder distension.
A) Oscillograms. On each piece from above down there is indicated: a) electric activity in the sublingual nerve; b) time marker in 0.1 sec.; c) registration of respiration (curve rises with inspiration); d) electrical activity in the lingual nerve. Oscillogram portions: I) electrical activity in the nerves before urinary bladder distension (corresponds to portion 1—1 on Fig. 1, B); II) activity at the beginning of urinary bladder distension; distension 0.9 seconds from the start of this oscillogram portion (see Fig. 1, B, 2—2); III) activity 30 seconds after distension (see Fig. 1, B, 3—3); IV) activity 30 seconds after releasing the air from the urinary bladder (see Fig. 1, B, 5—5); V) control: severed pieces of the same nerves on the electrodes. B) Kymograms, plus and minus indicate the beginning and the end of urinary bladder distension; the blood pressure in the femoral artery is recorded; M.P.) period of urinary bladder distension with air pressure of 70 mm mercury; time marker (5 seconds).

The basal electrical activity of the lingual nerve as shown on oscillogram d, portion I indicates impulses of 2 kinds; slow, of low amplitude (8-10 μv) and fast, single and double phase, of high amplitude (25-30 μv). After the beginning of the distension of the urinary bladder within 0.4 second there began a marked increase in the number of both types of impulses, especially the fast (see Fig. 1, A, portion II). The increase in the impulses could be observed even before there were any indications of alteration in the arterial pressure. The arterial pressure was seen to rise only 3 seconds after the interoceptors began to be stimulated. The period of increased stimuli lasted for 6 seconds, after which the frequency of increased impulses diminished gradually.

Within 30 seconds from the beginning of the distension of the urinary bladder (see Fig. 1, A, Part III) the electrical activity fell below basal. This moment corresponded to the beginning of the gradual decrease in the arterial pressure as the action of the stimulation was continued.



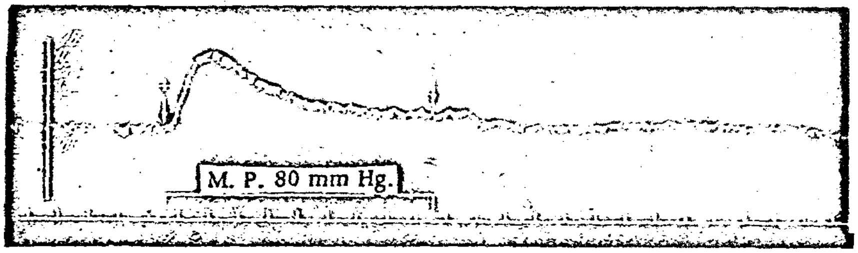



Fig. 2. Electrical activity in the cervical sympathetic and lingual nerves during hypertension induced by urinary bladder distension.
A) Each piece from the oscillogram has: a) electrical activity in the cervical sympathetic nerve; b) time marker in 0.1 sec.; c) electrical activity in the lingual nerve; d) period of the beginning of the urinary bladder distension shown on portion II by the horizontal line near the time marker. Oscillogram portions: I) basic electrical activity; II) at the beginning of bladder distension. B) Kymogram. Marked as in Fig. 1, B.

The sublingual nerve showed good electrical activity (see Fig. 1, A, oscillogram, a, portion I). The respiratory groupings are readily seen: at the time of expiration there is seen a large number of double phase, fast impulses of high amplitude. At inspiration are seen many single phase impulses of a lower amplitude. Distention of the urinary bladder (see Fig. I, A, portion II) produced a gradual lowering and even a disappearance of the fast impulses seen during inspiration. The double phase impulses of high amplitude grouped during expiration remained.

When comparing the alterations in the electrical activity of the lingual and sublingual nerves, it can be observed that at the beginning of stimulation the electrical activity of the lingual nerve increased markedly while that of the sublingual nerve decreased. However these reciprocal relationships in the electrical activity of these two nerves were not maintained constantly during the period of urinary bladder distension. 6 seconds from the beginning of the distension the electrical activity in the lingual nerve fell below basal (see Fig. I, A, portion II and III), while the sublingual nerve failed to show increased activity.

After letting the air out of the urinary bladder the electrical activity in both nerves returned to the basal value and the initial arterial pressure was restored (see Fig. I, A, portion IV and 1, B, kymogram). What then causes the increased electrical activity in the lingual nerve?

It is necessary to consider the conditions under which we observed the alterations in the impulses. Experiments have shown that when the impulsation of the lingual nerve becomes more pronounced, the rise in arterial pressure becomes more pronounced, resulting in higher levels of pressure. The impulses increased only during the period of rising arterial pressure but, when this pressure reached its maximum, not infrequently the impulses would decrease to initial levels.

These findings seem to indicate that the impulses in the afferent, that is the lingual, nerve are associated (when strengthened) with a rise in the arterial pressure.

A detailed comparison of the changes in the electrical activity of the cervical sympathetic nerve with the changes in the electrical activity of the lingual nerve which occur at the very beginning of the stimulation of the receptors of the urinary bladder shows the definite phases of these alterations (Fig. 2). Portion I shows the initial electrical activity of the lingual nerve in the form of slow impulses of low amplitude (oscillogram c), while the cervical sympathetic nerve records a larger number of double phase slow impulses, grouped within the rhythm of the pulse (oscillogram a).

Within 0.4 seconds after distending the urinary bladder, there could be observed an increase in the impulses within the sympathetic nerve, while the lingual nerve at this time did not show any alterations as yet. The increase in the impulses within the lingual nerve began only 0.9 seconds after the beginning of the stimulation. 0.5 seconds later the electrical activity within the cervical sympathetic nerve fell below intitial levels while the lingual nerve showed a strengthening of the impulses, for still another 0.5 seconds, after which it also reflected a decrease. Thus, the alterations in the impulses within the sympathetic nerve preceded the alterations to be seen in the lingual nerve. As the increased activity within the cervical sympathetic nerve could increase the tonus of the arteries and arterioles within the tongue, it might be assumed that the stimulant of the receptors within the vessels of the tongue is the changing tonus of the vessel walls which is produced by stimulation of the sympathetic nervous system. This is similar to the mechanism described for the receptors of the carotid sinus by C. Heymans [4] and by S. Landgren [5].

Another reason for the stimulation of the vessel receptors might possibly be the secondary increase in the pressure within the vessels of the tongue as a result of the general rise in arterial pressure. Comparison of the initial alterations of the afferent and efferent impulses within the lingual and sympathetic nerves serves as a basis for the belief that these changes might have reciprocal relationships.

The physiological significance of the afferent impulses reaching the central nervous system from the receptors within the vessels of various organs during the course of arterial pressure alterations is to be the object of our further studies.

## SUMMARY

The electric activity of the afferent (lingual) nerve and efferent (cervical sympathetic) nerve (preganglionic fibers) or sublingual (postganglionic sympathetic fibers) was studied during stimulation of interoceptors of the urinary bladder. The latter resulted in increase of arterial pressure. It was shown that the greater the afferent impulsation of the lingual nerve, the more pronounced is the rise of the arterial pressure.

Impulsation increase took place only during the rise of the level of the arterial pressure. When the pressure reached its maximum, the impulsation was frequently decreased to the initial level.

After interruption of the stimulation of the urinary bladder, reestablishment of the character of impulsation took place almost at the same time when the arterial pressure returned to normal. Comparison of the initial changes of the afferent impulsation (in the lingual nerve) and efferent (in the cervical sympathetic nerve) points to the possible interrelationship of changes in the afferent and efferent impulsation. The increase of the efferent impulsation takes place at first in the cervical sympathetic nerve and later the afferent impulsation is increased in the lingual nerve. After that a significant decrease in the impulsation takes place in the cervical sympathetic nerve. Increased electrical activity is retained in the afferent nerve for 0.5 seconds.

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