

REFLEXES FROM THE RECEPTORS OF A RABBIT'S EAR VESSELS EVOKED BY SODIUM NITRITE AND PLATYPHYLLINE AND THE MODE OF THEIR REALIZATION

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The interoceptive reactivity of the receptor apparatus of a rabbit's ear vessels to mechanical, thermal and, especially, chemical stimuli was discovered by S. A. Mirzoyan and S. V. Dovlatyan [6, 7, 8]. In experiments in which they perfused the vessels of a rabbit's ear isolated from the general circulation, but tied to the organism by intact nerves with acetylcholine and nicotine, they succeeded in showing that the ear vessels constitute a reflexogenic (primarily depressor) zone, capable of causing respiratory and blood pressure changes. This discovery led the authors to propose this zone as a model for use in analyzing the reflex effect of a number of pharmacological agents and in the study of certain questions concerning the mechanism of peripheral vessel interoception. The model developed has been used in research investigating the role of thiolic, cyanogen and fluorine compounds in the change of afferent impulsion from the receptors of a rabbit's ear vessels in response to acetylcholine and adrenalin [2, 3, 5]. A. I. Mironenko [9] and T. I. Baturenko [1] have studied the reflexes provoked by the action of certain medicinal agents. Rašcova [11] used the reflexogenic zone of the ear vessels to determine the nervous mechanism behind the formation of antibodies, while Lembeck [12] utilized this zone to establish the reflex nature of the effect of serotonin and preparation P.

In the experimental part of this work, we used the reflexogenic zone to demonstrate the reflex nature of the effect of sodium nitrite and platyphylline and to analyze the part played by different sections of the reflex arc in the realization of the chemoreflexes. These experiments were based directly on the investigations of M. P. Nikolaev [10], who first showed in experiments conducted in 1929 with a rabbit's ear isolated from general circulation, but with innervation intact, the part of the brain centers in the mechanism of the vasodilative effect of nitrites.

METHOD

Rabbits were anesthetized with urethan in a dose of 0.8-1 g/kg animal weight. The blood pressure in the common carotid artery was recorded with the aid of a mercury manometer. The neurovascular bundle of the ear was exposed through an incision 2-2.5 cm long; the auricular nerve was separated, ligated and kept moist with a warm physiological solution. A cannula through which the ear vessels were perfused with oxygenated Tyrode's solution (38°C in temperature) was inserted into the auricular artery. Scissors were slipped underneath the nerve to transect all the tissues so that only the neural connection of the ear with the organism was preserved. In order to determine the role of the different parts of the reflex arc in the realization of reflexes from the receptors of the rabbit's ear vessels, we excluded the cardioaortic and carotid sinus reflexogenic zones, desympathized the ear vessels and performed bilateral vagotomy and high transection of the spinal cord.

RESULTS

Analysis of experimental data concerned with the reflex effect of nitrites indicates that sodium nitrite introduced into the current of fluid perfusing the ear induces a reflex fall of blood pressure with certain typical characteristics. The mild fall of blood pressure observed in the majority of experiments was attended by the appearance of wave-like fluctuations in the blood pressure level.

As Fig. 1 shows, sodium nitrite perfusion of a rabbit's ear vessels induced a 20 mm mercury fall of arterial pressure after a brief 9-second latent period. This was attended by the appearance of clear, wave-like fluctuations in the blood pressure. The appearance of these waves was observed in almost all the experiments, even in those

where the blood pressure fall was slight. Conditions of experimental hypertension produced more marked results. Sodium nitrite supplied to the chemoreceptors through the vascular bed under these conditions induced a comparatively prolonged fall of blood pressure with marked wave-like fluctuations. All possible reflex reactions to sodium nitrite were excluded by preliminary novocainization of the receptor apparatus of the ear vessels.

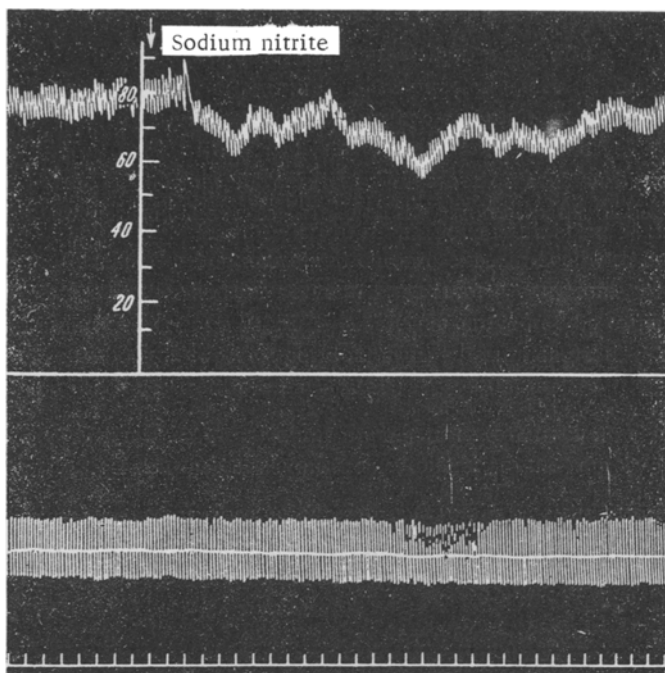


Fig. 1. Reflex changes in blood pressure and respiration induced by sodium nitrite perfused through the blood vessels of a rabbit's ear. Curves show (from top to bottom): blood pressure recorded with a mercury manometer; zero level of mercury manometer; respiration; time (in 3-second marks).

experiments in which the receptor formations were functionally excluded with the help of Novocain. Fig. 3 shows that a 2% Novocain solution perfused through the ear vessels totally precluded the possibility of reflex reaction to the action of platyphylline. Under conditions of experimental hypertension, platyphylline supplied to the vascular bed induced a greater and more prolonged fall of blood pressure, and a higher respiration rate.

Having discovered in our investigations a reflexogenic, primarily depressor zone capable of causing reflex change in the blood pressure and respiration under the influence of a number of stimuli, we decided to investigate the way in which the effects described are realized. For this purpose and to determine the part of the posterior root sensory nerve fibers (of the great auricular nerve) in transmission of the impulses, we undertook to analyze the role of the superior cervical sympathetic ganglion in this reaction, despite the fact that sympathetic innervation of the organ is known to belong to the efferent paths of the reflex arc.

We performed acute and chronic experiments with unilateral transection of the cervical sympathetic trunk and excision of the superior cervical sympathetic ganglion. The experimental results showed that the reflexes from the chemoreceptors of a rabbit's ear are not prevented by either transection of the sympathetic nerve to the neck or resection of the superior cervical sympathetic ganglion. Transection of the posterior roots totally excluded the chemoreflexes from the ear vessels.

Therefore, the afferent impulsation which develops in response to stimulation of the chemoreceptors of the ear vessels originates, as one would expect, in the sensory fibers of the posterior roots.

We then performed experiments to analyze the efferent paths of the depressor reflex on the blood pressure. Neither bilateral transection of the vagus nerve nor atropine sulfate blockade of the cholinergic systems in the effector organs prevented the reflex fall of blood pressure.

The alkaloid platyphylline, the pharmacological properties of which have been described in detail by G. S. Gvishiani [4], was investigated by the same experimental method. Comparatively low concentrations of platyphylline caused a slight reflex fall of blood pressure and respiratory acceleration, while high concentrations were found to produce a marked fall of blood pressure with a noticeable aftereffect, together with acceleration and deepening of the respiration.

Fig. 2 shows what happened when the ear vessels were perfused with platyphylline in a dilution of 1:600. A sharp fall of arterial pressure (40 mm of mercury) occurred almost immediately after the introduction of platyphylline. The blood pressure remained low for the whole duration of the perfusion and did not return to its original level until 40 seconds after perfusion ceased. A reflex acceleration and slight increase in the amplitude of the respiratory movements were observed at the same time. A more pronounced aftereffect, lasting 100-120 seconds, was observed in a number of experiments. The repeated use of platyphylline in the same concentration at specific time intervals notably reduced the depressor effect on the blood pressure and respiration.

To confirm the reflex nature of the effects described, we performed a series of control

The results of all these series of experiments showed where further investigation was required. It was necessary to determine the part played by the conduction paths of the spinal cord in the realization of reflexes from the chemoreceptors of the ear on the blood pressure.

The vasomotor centers of the medulla oblongata and spinal cord are known to have a substantial part in regulation of the blood pressure level. The transmission of nervous impulses to the vascular system in response to chemoreceptor stimulation should be eliminated by transection of the spinal cord and isolation of the higher sections of the central nervous system and the underlying formations.

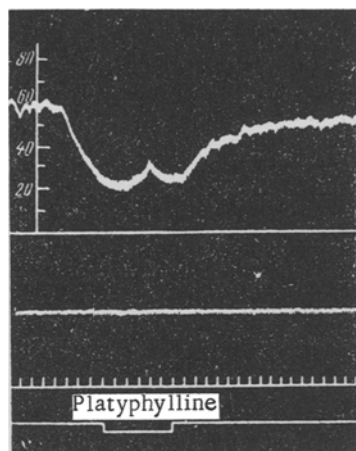


Fig. 2. Reflex changes in blood pressure and respiration effected by platyphylline perfused through the blood vessels of a rabbit's ear. Curves show (from top to bottom): blood pressure recorded by a mercury manometer; zero level of mercury manometer; respiration; time (in 3-second marks); indication of interoceptive stimulation.

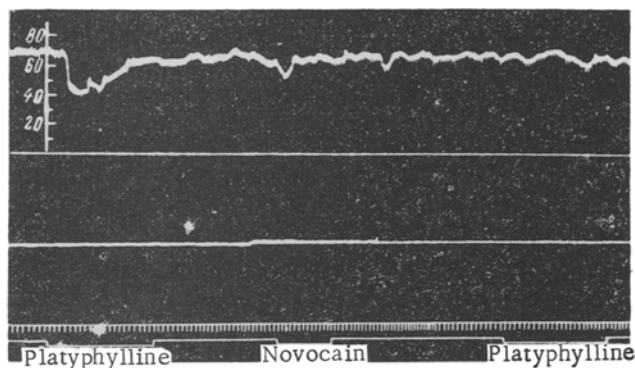


Fig. 3. Absence of reflex changes in blood pressure and respiration following novocainization. Curves show (from top to bottom): blood pressure recorded by mercury manometer; respiration; time (in 3-second marks); interoceptive stimulation and introduction of Novocain into perfusion current.

The experimental results were a clear confirmation of the accuracy of these hypotheses. The reflex reaction of the circulatory apparatus disappeared completely when the preparation was introduced into the current perfusing the ear under conditions of transection and considerable fall of blood pressure, while electrical stimulation of the vagus nerve produced the characteristic vagus-effect.

Since transection of the spinal cord inhibits many functions of the organism and is attended by a considerable fall of blood pressure, there was reason to doubt that any further fall of blood pressure could occur in response to perfusion of the ear vessels by a chemical stimulus. In order to explore this possibility, a series of experiments was performed under conditions of transection of the spinal cord, with the reflexes from the chemoreceptors of the ear vessels induced on a background of heightened blood pressure effected by the intravenous injection of adrenalin and ephedrine. No reflex changes in the blood pressure occurred in this case either.

The following conclusions can be drawn from the results of these experimental investigations.

Sodium nitrite and platyphylline are capable of producing a reflex effect on the circulation and respiration. The neuroreflex causality of the effect produced by sodium nitrite and platyphylline was confirmed in the experiments in which Novocain was used to obtain functional exclusion of the receptor formations of the afferent fibers of the ear vessels. The afferent impulsation which develops in response to stimulation of the chemoreceptors of the ear vessels is realized through the sensory fibers of the posterior roots. The efferent paths of the depressor reflex are located in the spinal cord, and impulses are transmitted (during stimulation of the receptors of the ear vessels) to the vascular system through the spinal conductor paths.

SUMMARY

The authors have demonstrated that blood vessels of a rabbit ear represent a reflexogenic, mainly depressor zone capable of changing the blood pressure and respiration level. This has made it possible to suggest this as a model for analyzing the reflex action of some pharmacological agents and for studying certain problems in the mechanisms of peripheral blood vessel interoception. Experimental investigations demonstrated that sodium nitrite and platyphilline were capable of producing a reflex effect on the circulation and respiration. The afferent impulsion occurring in the chemoreceptor stimulation is effected along the posterior root's sensory innervation. The efferent paths of the depressor reflex are located in the spinal cord and their impulses (during stimulation of the ear vessel receptors) are transmitted to the vascular system through the spinal conductive paths.

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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.
