TISSUE LOCALIZATION OF THE OSMOCEPTORS

L. K. Velikanova, S. A. Borisova, and Ya. D. Finkinshtein

UDC 612.88.014.462.1 : 611-018.866

The osmoceptors are an information link in the osmoregulatory reflex maintaining the constancy of water and salt metabolism in the living organism.

Like the baroceptors and chemoceptors, they are widely distributed in the body, vary in their sensitivity to osmotic stimuli, and differ in their role in the over-all regulation of water and salt homeostasis [1, 9, 10, 14, 15].

Stimulation of the osmoceptors may also occur as a result of osmotic changes arising from ion-exchange reactions between the blood and the interstitial tissues associated with hypo- and hyperosmia in the capillaries [4,7,8].

The localization of the osmoceptors has received less study. The specific formations discovered by some authors [23-25] belong more correctly to the central part, and not the information part, of the osmoregulatory system of the body.

Investigations have revealed changes in the circulation and respiration following injection of hypertonic solutions of sodium chloride into blood vessels [2, 13, 18].

These results suggest the presence of receptors sensitive to osmotic changes of the blood in the walls of arteries and veins.

However, since in the investigations cited above, changes were observed in systems not directly connected with osmoregulation, there is reason to suppose that these changes owed their origin not to the osmoceptors, but to the angiochemoceptors, the presence of which within the blood vessels has been proved conclusively.

Indirect confirmation of the tissue localization of the osmoceptors has been obtained by the present authors in previously published investigations [3, 6, 20].

The object of the present investigation was to determine the localization of the osmoceptors by direct experiment.

EXPERIMENTAL METHOD

The technique of V. I. Grachev [11], by means of which test solutions can be injected directly into arteries, avoiding the capillaries, was used in this investigation. This property is achieved by creating a retrograde circulation in which the blood passes to an organ along the vein and flows from it along the arteries.

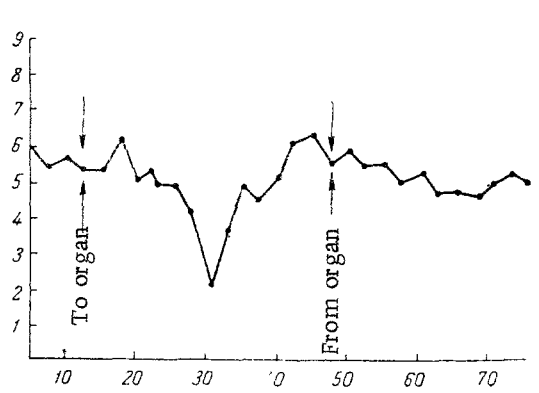
It is evident that if receptors are situated in the tissues, the reaction brought about by their stimulation will arise only when the solution passes through the capillaries. For this reason, introduction of the solution into the veins with a normal circulation and into the arteries with a retrograde circulation should not be accompanied by an effect.

Slight modifications were introduced into the method described so that a retrograde circulation could be created not in an isolated organ, but in the organism as a whole. The modification of the technique made it possible to carry out a series of acute and chronic experiments in conditions close to the normal state of the organism.

Dogs weighing from 10-15 kg, in which the ureters had been first exteriorized by the Pavlov–Orbeli method, were used in the experiment.

A cross-anastomosis was formed between the femoral artery and vein in one of the hind limbs of these animals. To form the arterio-venous anastomosis, under ether and morphine anesthesia, an incision was made in the thigh perpendicularly to Poupart's ligament, and the femoral vessels were mobilized for a distance of 5-7 cm from the underlying tissues and carefully freed from adventitia. The vessels were clamped, and by means of Gudov's

Department of Normal Physiology, Novosibirsk Medical Institute (Presented by Academician V. N. Chernigovskii). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 62, No. 12, pp. 13-15, December, 1966. Original article submitted December 31, 1964.



Injection of hypertonic saline (7 ml of 5% NaCl solution) into the vein "to the organ" (first arrow) and into the artery "from the organ" (second arrow). Along the axis of ordinates—diuresis (in ml/min/m^2); along the axis of abscissas—time (in min).

apparatus, they were sutured end-to-end so that the central end of the artery was joined to the peripheral end of the vein and the central end of the vein to the peripheral end of the artery. As a result, a retrograde circulation was created in the limb, in which arterial blood reached the tissues along the vein and venous blood returned from the organ along the arteries.

Thin catheters were introduced into the side branches of the artery and vein below the anastomosis, through which the test solutions were injected ("from the organ" and "to the organ").

The resumption of the blood flow in the limb vessels after the operation was detected by the appearance of pulsation in the saphenous vein and by the angioroentgenograms taken at different times during the investigation.

The films were taken after injection of 10-20 ml of 40% solution of methiodal sodium into the saphenous vein or the iliac artery.

The experiments began 2-3 days after the operation, in accordance with the following scheme. The dog was fixed to a frame, receivers were attached for collecting the urine, and a uniform diuresis was established (5-7 ml/min/m^2 body surface). Next, 5-7 ml of a 5% solution of sodium chloride was introduced, first into one, then into the other cannula. The effect of injection of the solution was determined from the change in diuresis recorded in time intervals of 5 min.

Besides the chronic experiments, a series of acute experiments was carried out. Their technique was practically the same as that of the chronic experiments. In this case chloralose anesthesia was used (100 mg/kg), and the diuresis was kept uniform by injecting warm physiological saline into the jugular vein.

Altogether ten chronic and six acute experiments were performed.

EXPERIMENTAL RESULTS

The injection of hypertonic sodium chloride solution into the vein, i.e., in the direction "to the organ," always led to the appearance of an antidiuretic reaction. The results of these experiments were so uniform that one of them can serve as an illustration for all (see figure). The figure shows that a 5% solution of sodium chloride, when injected "to the organ" (first arrow) produced inhibition of diuresis, which reached its lowest level at the 35th min, when it amounted to 42.6% of the initial level. In all 14 cases in which the hypertonic solution was injected "to the organ," the diuresis was 10-68% (mean 31.6±5.15%). The diuresis returned to its initial level after 50-70 min.

When the results of these experiments were compared with those of the authors' earlier investigations [5], in which hypertonic solutions (5-7 ml of 5% NaCl solution) were injected into the arterial blood flow while the normal circulation was maintained, they were found to be in full agreement.

Hence, irrespective of whether the solution entered the capillary system from the arteries or veins, its action was always the same, and took the form of the regular development of an oliguric reaction.

The second arrow on the figure indicates the time of injection of NaCl into the artery, i.e., "from the organ." In this case no regular change in diuresis was observed. The NaCl was injected "from the organ" 18 times, in 12 of which the diuresis increased on the average by 29±5.7%, in 2 it fell slightly, and in 2 cases it remained unchanged. The same result was obtained [6] when small volumes of a 5-7% NaCl solution were injected into veins in which the blood was flowing in the usual direction.

In order to prove conclusively that the absence of an antidiuretic reflex following injection of NaCl into the artery was not caused by thrombosis of the vascular anastomosis, angioroentgenography of the vascular system of the dog's thigh was performed. This showed that the blood moved freely through the arteriovenous anastomosis.

It was concluded from these results that the antidiuretic reaction following injection of hypertonic solutions into the blood stream arises only if the solutions enter the capillary system of the organ in the direction of the usual blood flow. It follows from this that the receptors which, when stimulated, give rise to this reaction are situated not in the arteries and veins, but in the capillary system.

Like the other types of tissue receptors described by V. N. Chernigovskii [21, 22], T. A. Grigor'eva [12], and others, the osmoceptors, a specialized first link in the osmoregulatory reflex, are most probably situated in the interstitial space.

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