

ROLE OF THE KIDNEYS IN THE REGULATION OF OSMOTIC PRESSURE

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S. A. Borisova

Department of Normal Physiology (Head, Docent Ya. D. Finkinshtein),
Novosibirsk Medical Institute

(Presented by Active Member AMN SSSR V. V. Parin)

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Besides their role as the chief effector organ in the maintenance of water-salt homeostasis [2, 3, 6], the kidneys evidently are also an important source of information for the mechanisms of osmotic regulation [1, 4]. The object of the present investigation was to study the osmotic regulatory reflex from the kidneys.

EXPERIMENTAL METHOD

Experiments were conducted on 31 dogs in which both ureters were exteriorized separately onto the skin of the abdominal wall. Hypertonic solutions of sodium chloride (1.5-5.0%), and isoosmotic solutions of glucose (18.3-30.5%) and urea (6-10%), in a volume of 5-6 ml, were injected into the blood flowing into the left kidney through a fine polyethylene catheter, preliminarily introduced into the renal artery by Barger's method [5] over a period of 35-45 sec. The right kidney was used as indicator for the reaction.

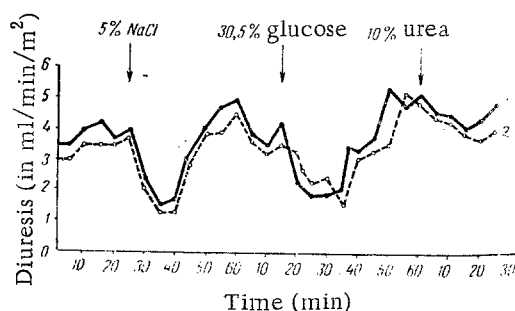


Fig. 1. Changes in diuresis after injection of hypertonic solutions into the blood flowing into the left kidney. 1) Diuresis of right kidney; 2) of left kidney. The arrows denote the times of injection of hypertonic solutions.

Diuresis amounted to 40-95% of its original value. No difference was observed between the reactions to the injection of sodium chloride and glucose. On the other hand, injection of solutions of urea—a substance which is osmotically inactive in the conditions appertaining to the body—did not produce any significant degree of inhibition of diuresis in any experiment (Fig. 1).

The experiments in which isoosmotic hypertonic solutions of different chemical nature were injected showed that, besides other types of receptors, the nervous apparatus of the kidney must also include osmoceptors, the adequate stimuli for which are changes in the osmotic pressure of the arterial blood. In order to discover the paths of

The reflex arc of the osmotic regulatory reflex was investigated in dogs with one denervated kidney and in hypophysectomized animals. In the first case, the hypertonic solutions were injected in succession into the blood flowing to the denervated and intact kidneys, and in the second case, as usual, into the artery of the left kidney. The observations were made by means of measurement of 5 min urine samples, followed by calculation of the results obtained per square meter of body surface. The diuresis of both kidneys was taken into account.

EXPERIMENTAL RESULTS

The effect of injection of hypertonic sodium chloride and glucose solutions was studied in 66 experiments conducted on 25 dogs. Injections of these hypertonic solutions were always accompanied by the development of an oliguric reaction, which developed simultaneously in both kidneys. Inhibition of diuresis developed 5 min, or, less often, 15-20 min, after injection of the solution and lasted 40-70 min. The magnitude of the fall in di-

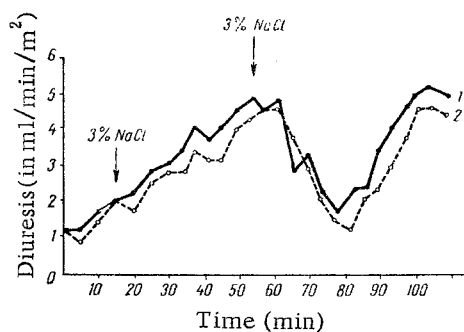


Fig. 2. Changes in diuresis in response to successive stimulation of the denervated and intact kidneys with hypertonic sodium chloride solution. Legend the same as in Fig. 1. First arrow—injection into artery of denervated kidney, second—into artery of intact kidney.

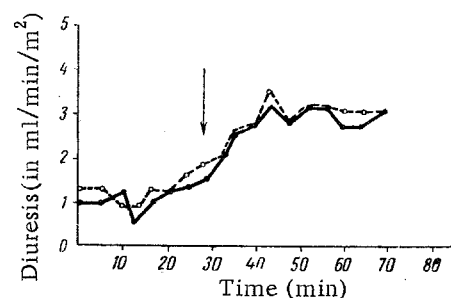


Fig. 3. Changes in diuresis after injection of hypertonic solution into blood flowing to left kidney of hypophysectomized animal. Legend the same as in Fig. 1.

renal artery produced an antidiuretic reflex, disappearing after denervation and hypophysectomy.

Injection of urea, a substance which is osmotically inactive in the organism, produced no effect. The experiments showed that the kidney plays a dual role in the system of the osmoregulation mechanism.

Since this organ is supplied with osmoceptors, apart from its excretory function it acts as an informant indicating the state of osmotic pressure in the local and general blood circulation.

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spread of the impulses of excitation arising in the osmoceptors, 27 experiments were conducted on 8 dogs with a denervated kidney. Injection of hypertonic solutions into the artery of the denervated kidney was hardly ever accompanied by the development of oliguria, whereas injection of the same solutions into the blood flowing to the intact kidney caused a reaction of inhibition of diuresis in both organs (Fig. 2).

It was concluded from these results that impulses arising in the osmoceptors of the kidney spread only along the nerves, and that the oliguric reaction observed in both the denervated and the intact kidney develops under the influence of a humoral factor, most probably vasopressin. In the last series of experiments the suggestion that vasopressin is concerned in the reaction was put to the test. Altogether 18 experiments were carried out on 3 hypophysectomized dogs, showing that removal of the pituitary leads consistently to disappearance of the antidiuretic reaction (Fig. 3).

Hence, the experiments showed that the kidneys are an osmoceptive field, the adequate stimulation of which sets in motion a typical osmotic regulatory reflex. Impulses arising in the receptors of the kidney evidently pass along nerve fibers leading to the subcortical centers of the antidiuretic system (the supraoptic and paraventricular nuclei of the hypothalamus), from which, after suitable processing, they are relayed to the posterior lobe of the pituitary, where they stimulate the secretion of vasopressin. Under the influence of the latter, the activity of the concentrating apparatus of the kidney is strengthened and its work is tuned to the osmotic situation appertaining to the internal milieu of the organism.

SUMMARY

The present paper analyzes the kidney's osmoregulation reflex. It was found in chronic experiments that injection of hypertonic sodium chloride and isosmotic glucose solutions into the