ON THE MECHANISM OF COMPENSATORY DIURESIS FOLLOWING UNILATERAL NEPHRECTOMY IN DOGS

S. S. Polushkina

From the Department of Pathological Physiology (Head—Professor I. A. Oivin)
of Kubansk Medical Institute, Krasnodar
(Presented by Active Member Akad. Med. Nauk SSSR A. V. Lebedinskii)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 52, No. 12,
pp. 28-30, December, 1961
Original article submitted February 25, 1961

In the fields of biology and medicine, a great deal of attention is devoted to the problem of replacing parts of the body and substituting organ functions. It is of decided interest to study the compensatory reactions of the remaining kidney, following a nephrectomy. Although this latter problem has been treated in a number of experimental and clinical investigations, the compensatory mechanism, particularly directly after removal of one kidney, is still not sufficiently studied.

Earlier, in experiments on dogs, we established that the functioning of the remaining kidney is augmented immediately after a unilateral nephrectomy. Even in the first hours following the operation, there is a rise in the diuresis and an elevation in the total amount of urea and creatinine excreted. In this case, there is a rise in the filtration of the primary urine within the glomeruli [3, 4].

For further elucidation of the mechanisms by which the diuresis is augmented immediately after removal of a kidney, we felt it would be of interest to investigate the changes in the plasma antidiuretic properties in dogs.

METHOD

In short-term experiments, a unilateral nephrectomy was performed on dogs under morphine-hexenal narcosis. The kidney removal took 4-5 minutes, and usually involved a minimal blood loss. At the start, and at 1-2 hours after removal of the kidney, blood was drawn from the animals at the femoral artery; this blood was stabilized with heparin (2 units/ml) and centrifuged for 10 minutes at 2000 rpm, so as to obtain the plasma. To determine the antidiuretic properties of the dogs' plasma, we used a biological assay on rats [6, 8].

Rats, weighing 100-150 g, were placed in separate cages for 18 hours prior to the test and deprived of solid food, but were given as much water and milk as they wished. Immediately before the experiment, the rats were weighed and placed in glass funnels, attached to metal stands. An oval ampoule was inserted at the bottom of the funnel, blocking the entrance of fecal matter, but not impeding the flow of urine. The top of each funnel was covered with an inverted funnel. A water load was produced by the intraperitoneal injection of physiological saline (37.5°), under sterile conditions, using 6 ml per 100 g at the beginning, and at the end of the first hour, of urine collection. At the end of the second hour, the test plasma was injected into the caudal vein or the femoral cutaneous vein, in a dosage of 1 ml per 100 g. The animals were again individually placed in funnels for 2 hours, where their urine was collected and its volume measured. Trials were performed on rats with the plasma of each dog. Calculation of the injected plasma's diuretic effect was carried out according to the method described by J. H. Birnie [5]. We determined the amount of water excreted in the urine in the second 2 hours, in percent relationship to the loading water remaining in the rat's body at the time the test plasma was injected. In the control runs, we studied the diuresis in rats over a period of 4 hours, using the same water load.

In all, we studied the blood plasma of 13 dogs in the initial state and following unilateral nephrectomy.

RESULTS

The injection of the dog plasma into the rats, prior to the kidney removal, caused a statistically significant reduction in diuresis ($P < 0.01$). The average diuresis in the rats for the first 2 hours after the water loading was equal to 3.2 ml ($\sigma = \pm 2.09$, $m = \pm 0.4$; after the plasma injection—2 ml ($\sigma = \pm 1.18$, $m = \pm 0.23$).

The injection of plasma from these same dogs did not inhibit diuresis after the kidney removal. Thus, the average diuresis in the rats for the first 2 hours after the water loading equalled 3.6 ml ($\sigma = \pm 1.89$, $m = \pm 0.36$); after the injection of plasma from the nephrectomized dogs, for the same period—3.2 ml ($\sigma = \pm 2.12$, $m = \pm 0.4$).

As can be seen from the table, the amount of the loading water excreted by the rats who were injected with plasma from the nephrectomized dogs was considerably greater than in the case of the rats injected with plasma from the same dogs but prior to the kidney removal ($P < 0.02$).

These experiments showed a reduction in the antidiuretic activity of the dog plasma immediately after removal of a kidney.

Antidiuretic Activity of Plasma from Dogs (in Percent Excretion of the Loading Water)

Statistical index	Before nephrectomy	After nephrectomy
M	16.3	24.4
σ	±10.4	±14.8
m	±2.0	±2.7

In the control runs, with water loading, the water secretion in the urine of the rats proceeded uniformly: in the first 2 hours, the average diuresis was equal to 2.4 ml ($\sigma = \pm 1.26$, $m = \pm 0.56$); in the second 2 hours—2.9 ml ($\sigma = \pm 1.44$, $m = \pm 0.64$).

Dog plasma is heterogenic for rats; we thus tested the action of plasma from normal and nephrectomized rats, in experiments on rats. The results were analogous to the initial experiments: the average excretion of the loading water during the action of plasma from the nephrectomized rats was considerably greater (19.3%) than during the action of plasma from the normal rats (5.6%).

As shown by our experiments, prior to removal of a dog's kidneys its plasma inhibits diuresis in rats. Human blood plasma possesses the same activity [7]. Following nephrectomy, the antidiuretic activity of the dog plasma decreases, and the excretion of loading water in the rats increases.

It is known that, in the regulation of antidiuretic hormone secretion, an essential role belongs to the reflex actions of the osmoregulators in the vascular system and tissues [1, 2, 10], arising in connection with changes in the osmolarity of the blood and tissues. Lowering of the osmole concentration in the organism through the intake of water inhibits the secretion of antidiuretic hormone via the osmoreceptors, and this causes an elevation of the diuresis [9].

In previous investigations on dogs, we established that after unilateral nephrectomy there occurs an increase in the volume of the extracellular water at the expense of the cellular water. As a result of this, the osmolar concentration is lowered, and entrance of antidiuretic hormone into the blood is inhibited. It may be concluded that decrease in the antidiuretic activity of the blood following nephrectomy is one of the leading factors in the mechanism of the increased diuresis immediately following unilateral nephrectomy.

SUMMARY

The antidiuretic activity of blood plasma in dogs was studied (by means of tests on rats) prior to, and 1-2 hours after unilateral nephrectomy. The antidiuretic activity of dog plasma declines directly after the operation. The blood plasma obtained ffom dogs prior to the operation inhibits the excretion of the water load in the rats.

Changes in the antidiuretic activity of blood plasma are regarded as being the result of the reflex effects from the vascular and tissue osmoreceptors in connection with increased amounts of extracellular water, directly after nephrectomy. It is therefore concluded that reduction of the plasma antidiuretic activity is an important factor in the mechanism of diuresis compensation directly after unilateral nephrectomy.

LITERATURE CITED

1. L. K. Velikanova, Tissue Receptors in the Osmoregulatory Reflex. Cand. Diss. [in Russian] (Novosibirsk, 1955).
2. B. D. Kravchinskii, Contemporary Principles in Renal Physiology [in Russian] (Leningrad, 1958) p. 168.
3. S. S. Polushkina, in the book: Scientific Works of Kubansk Medical Institute [in Russian], 17, (30) (Krasnodar, 1959) p. 61.
4. S. S. Polushkina, Arkh. Pat., No. 3 (1959) p. 70.
5. J. H. Birnie, R. Jenkins, et al., Proc. Soc. Exp. Biol., 70 (New York, 1949) p. 83.
6. M. Ginsburg and H. Heller, J. Endocr., 9 (1953) p. 283.
7. J. Hankiss, I. Vajda, I. Massath, et al., Acta med. Acad. Sci. hung., 11(1958) p. 343.
8. H. Heller and K. E. Blackmore, J. Endocr., 8 (1952) p. 224.
9. H. Jahn, F. Stephan, J. Gruner, et al., C. R. Soc. Biol., 152 (1958) p. 1798.
10. E. B. Verney, Proc. Roy. Soc., B135 (1947) p. 25.