# THE EFFECT OF SPINAL CORD TRANSECTION ON RENAL WATER EXCRETION

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(Received March 4, 1957. Presented by Academician L. A. Orbeli)

In contrast to the views held by Verney [4] concerning strictly local distribution of osmoreceptors along the course of the internal carotid artery in the hypothalamic area, we suggest that osmoreceptors, sensitive to osmotic changes, are widely represented in the body, as has been shown by V. N. Chernigovsky [3] for baro – and chemoreceptors. It can be expected, on the strength of this suggestion, that substantial changes in the rate of excretion of water supplied in excess would accompany transection of the spinal cord isolating to a considerable degree the tissue osmoreceptors from the hypothalamic centers. The present work is devoted to the experimental verification of this suggestion.

## EXPERIMENTAL METHODS

The experiments were performed on dogs with exteriorized ureters and on rats with urinary bladder fistulas.

Hydration of the animals was calculated on the basis of 5% of body weight.

In a number of experiments renal filtration was determined by the inulin clearance method and concentration of solid substances in the blood plasma by refractometric methods.

## EXPERIMENTAL RESULTS

When control dogs were given 50 ml water per 1 kg body weight there was considerable increase in diuresis. The diuresis sometimes reached 8-10 ml per minute per 1 $m^2$ surface area. As a rule the animals excreted the water almost completely in 2-3 hours.

Following transection of the spinal cord at the level T4-T5 no water diuresis developed at all. As can be seen from a typical experiment (Fig. 1), only 19.5% of the administered fluid was excreted in 175 minutes.

Such a sharp drop in the rate of water excretion may be determined by various factors.

First of all slowing of absorption from the intestine may be postulated. This suggestion is, however, excluded, by investigation of changes in the concentration of blood plasma solids following hydration.

In intact animals the maximal drop in plasma solids following hydration developed after 60 minutes and did not exceed 7-12%. The refractometric index of the plasma returned to normal by the end of three hours.

Data of the control experiments corresponded entirely to the results obtained by L. I. Kurdyban [2] and V. I. Inchina [1].

The refractometric index of the plasma in operated animals decreased more rapidly and remained low for a longer time. In their case hydremia reached a maximum after 30 minutes, the index fell by 24-26% of the original value and showed no tendency to rise, remaining at a low level for over 3 hours.

Apparently, in the case of dogs with transected spinal cord the water is absorbed at the usual rate but is excreted extremely slowly.

This raised the question whether the diminution of renal excretory function upon transection of the cord was determined by lowering of arterial blood pressure and the associated reduction of filtration.

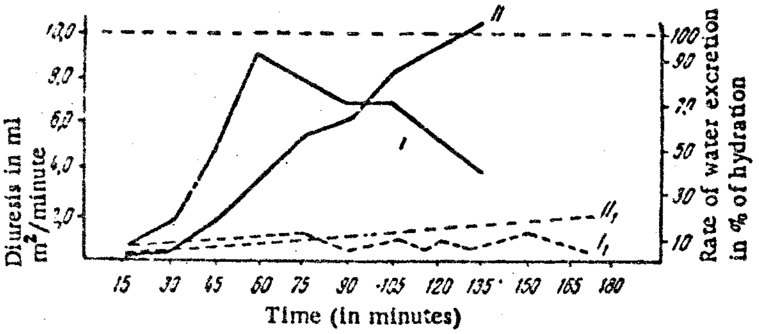

Fig. 1. Reaction to hydration of normal dogs (solid line) and dogs with spinal cord transection at the level T4-T5 (broken line).
I) Change in diuresis; II) percentage renal water excretion.

Determinations of renal filtration capacity by means of the inulin clearance test carried out on rats provide grounds for rejecting such an explanation of the observed phenomenon.

The results of this series of experiments are given in the table (mean values).

Changes in Renal Diuretic Activity Following Transection of the Spinal Cord

| Animals under investigation | Number of experiments | Excretion of urine in 1 hour per 100 g body wt.,ml | Excretion of water in % of amount administered,in 3 hrs. | Filtration in 1 hour per 100 g body wt.,ml |
|---|---|---|---|---|
| Control rats | 20 | 2.2 | 90 | 1.1 |
| Rats with transected spinal cord | 18 | 0.8 | 46 | 1.3 |

The value of inulin clearance in individual experiments is subject to definite individual fluctuations. However, these fluctuations in the operated animals are no different from fluctuations in control animals, whereas the average magnitudes of filtration in both groups practically coincide. The decline in water excretion following operation is, apparently, not connected with impairment of glomerular function.

It remains to suggest that the prolonged retention of excessive water in the body following spinal cord transection is associated with interruption of the afferent part of the osmoregulatory reflex arc.

Under normal conditions this reflex inhibits secretion in the neurohypophysis. Diuresis follows hydration as the direct result of the fact that antidiuretic hormone ceases to pass into the blood. Under conditions of spinal transection, however, the stream of afferent impulses from the tissue osmoreceptors to the hypothalamus is interrupted, and hyperhydration of the organism does not lead to reflex inhibition of pituitary activity as is the case in the normal. There is, consequently, no reduction in the concentration of the antidiuretic hormone in the blood and diuresis is not enhanced.

Such an explanation of reduced rate of water excretion agrees well with the fact that the degree of impairment of renal water excretory activity depends on the level at which the cord is transected. The higher the transection, the smaller the diuresis that develops. Thus, when the transection is made in the upper lumbar region approximately 70-80% of administered water is excreted, while the percentage excreted after transection at the level T4-T5 fluctuates within the range of 18 to 30.

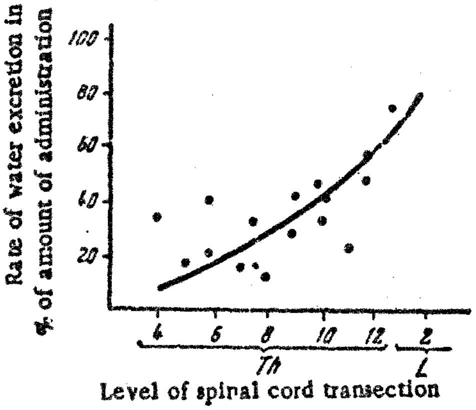


Fig. 2. Relation of the degree of reduction in the rate of excretion of 5% hydration load to the level of spinal cord transection.

The results of these experiments are summarized in Fig. 2. The curve of this graph is plotted on the basis of data obtained from all the experiments, both on dogs and on rats.

Although several of the experiments deviate from the regular course of the curve, it is still clear that water excretory function deteriorates at higher levels of spinal cord transection.

It has thus been established experimentally that following spinal cord transection in dogs and rats water diuresis cannot develop to any significant extent and the excessive amount of water is excreted slowly. This phenomenon cannot be explained by slowed absorption of water from the gastro-intestinal tract or by decreased filtration in the glomeruli.

The reason for deterioration of renal function lies in insufficiency of the osmoregulatory reflex as the result of interruption of afferent pathways from hyper-hydration sensitive tissue receptors to hypothalamic nuclei.

## SUMMARY

It was established that section of the spinal cord brings about decreased water diuresis. The higher the level of the section the greater the developmentofwater diuresis. This phenomenon is not connected with delay in the water absorption from the gastro-intestinal tract, or with decreased filtration in the kidney glomeruli. Disturbance of water excretory function of the kidney following section of the spinal cord is connected with the break of the afferent routes from the osmoreceptors to the nuclei of the hypothalamic area.

## LITERATURE CITED

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