CHANGES IN RENAL EXCRETORY FUNCTION IN ANIMALS WITH SEPARATE EXTERIORIZED URETERS

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A considerable degree of renal functional lability and asymmetry has been observed by several authors.

In K. M. Bykov's laboratory [2, 3] the unequal excretions of the two kidneys were observed in spontaneous diuresis, particularly after an increased water intake.

M. I. Olshansky [6] found a difference in the performance of the two kidneys on injecting various pharmocologically active substances. Functional asymmetry has also been reported by A. A. Pavlovskaya [8], A. L. Komendantova [4], V. L. Balakshina [1], and N. A. Myacoedova [5].

However there is some evidence in the opposite direction. S. Streyrer [14] and E. Allard [11] conclude from urological investigations, that both human kidneys function identically and excrete the same quantity of urine. The same view, based on animal experiments, is held by A. R. Cushny [12], and M. Ercole [13]. G. M. Shpuga, having followed changes in diuresis in three dogs, admits the possibility of small differences between the performances of the two kidneys, but considers these to be due only to chance variations.

In studying variations in renal excretory function in animals with separately exteriorized ureters, we usually found unequal amounts of urine excreted by the right and left kidneys. The aim of the present investigation was to find what conditions were relevant to this phenomenon.

METHOD

The experiments were carried out on two dogs with the ureters separately exteriorized by Orbeli's method [7]. Altogether 50 experiments were performed. The conditions were maintained as nearly as possible unchanged throughout the course of the experiments. The feeding routine was always approximately the same. The experiments were performed in the morning and always when the stomach was empty (16-18 hours after feeding). In all experiments, measurements were made of spontaneous diuresis, and diuresis after drinking 40-60 ml per kg body weight of diluted milk. Any one animal always received the same amount of fluid.

In the group of experiments on the action of mercuzal* the animals were given a load of water and milk.

RESULTS

In both dogs the two kidneys each maintained a constant rate of excretion, though there was a difference in the rates between the right and left sides. This functional asymmetry was fairly stable. Usually during a series of experiments, one kidney would predominate. However in some cases the kidneys as it were exchanged rates, not only on different days but within the period of a single experiment.

* Russian trade name.

In the case of spontaneous diuresis, the difference between the volumes of the urine was comparatively small. In the dog Zhuchki, the right to left volume ratio, averaged over a three hour period, varied from 0.87 to 0.95, and in Liski from 1.08 to 1.15.

In the experiments with the water-milk load, or with this load given together with mercuzal, the difference between the two amounts of excretion was increased. After the load had been given, the increase in excretion was different on the two sides, the ratio being 1.6, while after intramuscular injection of 1 ml of a 10% solution of mercuzal together with the fluid load, the ratio rose to 2.0.

If we compare the amounts excreted by each kidney over the relatively short time interval of 15-30 minutes instead of 3 hours, the ratio rises to 2.68.

The chemical composition of the urine excreted by the right and left kidneys was also different. This has been confirmed by the reports of R. O. Faitelberg and A. A. Shapiro [9] and N. A. Myacoedova [5].

According to our results, there was an appreciable but unimportant difference in the chloride concentration of the urine from the two sides. There were also differences in the creatinine concentrations. Thus, for example in pairs of urine samples from the two sides, the creatinine contents were 22 and 24 mg%; 17 and 10 mg%; 28 and 21 mg%, and so forth. Calculation using Reberg's formula suggests that there is a change in both glomerular filtration and tubular reabsorption rates as well as a change in their ratio. The asymmetry did not however prevent the kidneys from being affected as a pair. Their excretion rates were increased or decreased together.

In an attempt to explain the reason for the asymmetry in normal kidney function, we investigated the effect on excretion of partial or complete suppression of the regulatory centers, by means of narcotics, on the assumption that difference in rates between the two sides was due to influences originating in the central nervous system.

For this purpose morphine and chloral hydrate were used. The morphine dose was 1-2 ml of 1% solution injected subcutaneously, and chloral hydrate was given in doses of 0.75-3.0 g together with the fluid.

The subcutaneous injection of morphine caused a reduction in diuresis in all cases. For the first 15-30 minutes after the injection the asymmetry remained unchanged, or even increased somewhat. This coincided with the period of morphine stimulation. Subsequently the difference between the rates on the two sides was considerably reduced, and the two quantities of urine excreted became almost identical. These results lead us to suppose that the functional asymmetry results from the functional condition of the central nervous system.

The results obtained with chloral hydrate also deserve consideration. Shortly after the animal had been given the chloral hydrate, it fell asleep. During sleep, the diuresis of the water-milk load was increased, though the increase was less than in the control experiments in which the same mixture of water and milk was given without the addition of chloral hydrate. After waking, the diuresis began to increase. In one of the experiments, in the thirty minute sleep interval preceding waking, a total of 11 ml was secreted from the two kidneys together; in the same time interval, after waking, 44 ml were secreted, i.e., an increase of 4 times.

Another effect could sometimes be observed, depending on the dose. Thus for instance with small doses of chloral hydrate (0.75 g) the diuresis following the milk-water load was higher than in the control experiments.

Finally, it must be pointed out that under the influence of chloral hydrate, in any dose, the rates of excretion of the two kidneys tend to become equalized, so that both under deep sleep induced by either 3 g of chloral hydrate or by morphine, the difference between the excretion rates of the two kidneys is greatly reduced. However when using small doses of chloral hydrate the asymmetry in the performance of the left and right kidneys was well marked.

Thus in experiments on dogs with separately exteriorized ureters, it has been established that in normal conditions there is a difference in the amount and composition of the urine excreted. This functional asymmetry is but weakly shown in the case of spontaneous diuresis, but appears more clearly in the diuresis following a water-milk load and mercuzal. In deep sleep induced by morphine or chloral hydrate, the excretory rates of the two kidneys became more nearly equal. The functional asymmetry in the action of the kidneys depends evidently on the functional condition of the central nervous system.

TABLE

Effect of Morphine on Diuresis (urine collected at 15 minute intervals)

Conditions of experiment	Volume of urine in ml.		Ratio diuresis right kidney/diuresis left kidney, in %
	Right kidney	Left kidney	
Prior to water-milk load . . .	6 0	5.0	1.20
	7.0	8 0	0.87
After load (600 ml)	12 0	16 0	0.75
2 ml 1% morphine injected	10.0	10 0	1.00
subcutaneously *	14.0	4 0	3.50
	4.0	3.0	1.33
	3.0	3.5	0.86
	3.0	3,0	1.00
	3.0	3,0	1.00
Sleep	1.5	2.0	0.75
	0.5	0.5	1.00
	1.0	1.0	1.00
	1.0	1 0	1.00
	0.5	1.0	0.50
	1.5	1.5	1.00
	1 0	1.5	0.66
Total for 3 hours.	34.0	25.0	1.36

* After the injection of morphine vomiting occurred.

SUMMARY

Experiments on dogs with ureters separately exteriorized have shown that under normal conditions the quantity and quality of urine excreted by each kidney differ.

Functional asymmetry, only weakly marked in spontaneous diuresis is more pronounced in cases of water loading and mercuzal diuresis. Morphine and chloral hydrate narcosis make both kidneys function more evenly. Asymmetry of kidney function is seemingly dependent on the functional state of the central nervous system.

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