CORRELATION BETWEEN THE RENAL BLOOD FLOW AND THE FILTRATION DURING WATER DIURESIS

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We showed in a previous article [2] that when the diuresis is increased after drinking or intravenous injection of fluid, the sharp decrease in tubular reabsorption is often observed to be accompanied by an increase in glomerular filtration. This agrees with the findings of other workers [1, 4, 6]. Meanwhile, in most experiments the renal blood flow was increased. A similar effect has also been noted by Kerr [9] in experiments on dogs, and by Ek [8] in man. However, we have been unable to determine whether any relationship exists between the changes in filtration and in the blood flow, for on account of the method used (the blood flow was estimated by means of phenol red) these indices could not be determined simultaneously. We know, however, that in some cases the changes in filtration and in the blood flow may differ. In hypertension, for instance, a reduction in the blood flow may be observed while the filtration is unchanged or increased [5], whereas during exposure to high altitudes the opposite may take place [10]. Bucht and co-workers [7] gave intravenous infusions of glucose solution to human subjects and observed an increase in diuresis and filtration and only a small increase in the blood flow.

The object of the present investigation was to compare the changes in the renal blood flow and filtration during water diuresis in the same experiments in order to clarify the correlation between these indices.

EXPERIMENTAL METHOD

A chronic experiment was carried out on 5 dogs in which the ureters were exteriorized. We determined the filtration, the reabsorption, and the renal plasma flow before and after a water load in the course of several 20-minute clearance periods. The water load consisted of giving a water-milk mixture by mouth in a dose of 30-40 ml/kg body weight. Intravenous injections of 0.85 or 0.45% sodium chloride solution were given in a dose of 20-30 ml/kg body weight at a rate of 15-20 ml per minute.

The filtration was determined by the endogenous creatine and the renal plasma flow by means of cardiotrast. This substance was injected intramuscularly in the form of a 35% solution (containing 0.5% novocain) in a dose of 0.25-0.3 ml/kg body weight 30 minutes before the collection of urine began. The blood cardiotrast was then determined in the middle of each 20-minute period. By carrying out the experiment in this way we were able to study the renal plasma flow in the dogs for 1½ hours or even longer. A similar method has been used clinically by A. K. Merzon [3].

In a series of control experiments the filtration was determined simultaneously by the creatine and insulin methods, and cardiotrast was injected intravenously throughout the experiment together with insulin solution.

We performed 22 experiments in the course of which 126 simultaneously estimations of the filtration and blood flow were made. For each clearance period we calculated the filtration fraction (the ratio between filtration and plasma flow in %).

EXPERIMENTAL RESULTS

The experiments showed that water diuresis after drinking or intravenous injection of fluid is brought about mainly by a sharp decrease in the reabsorption of water. However, in the first period of water diuresis (roughly 40-60 minutes), as a rule the filtration and also the renal plasma flow increased.

In most experiments the increase in the filtration and the blood flow during the rise of diuresis after water intake by mouth followed a parallel course (Fig. 1), so that the filtration fraction did not undergo any significant

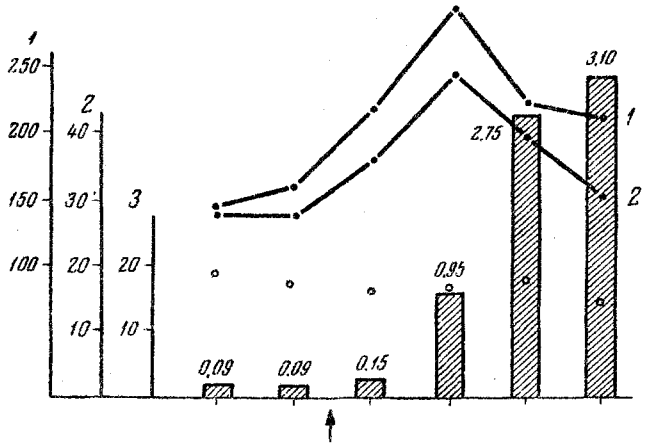

Fig. 1. The effect of a water load in filtration and blood flow. The dog Taina, weight 17 kg, experiment No. 9. 1) Renal plasma flow; 2) filtration; columns – diuresis (in ml/minute); circles – filtration fraction; arrow – water load (700 ml). Along the axis of ordinates: 1) plasma flow (in ml/minute); 2) filtration (in ml/minute); 3) filtration fraction (in %); along the axis of abscissas – time (20 minutes).

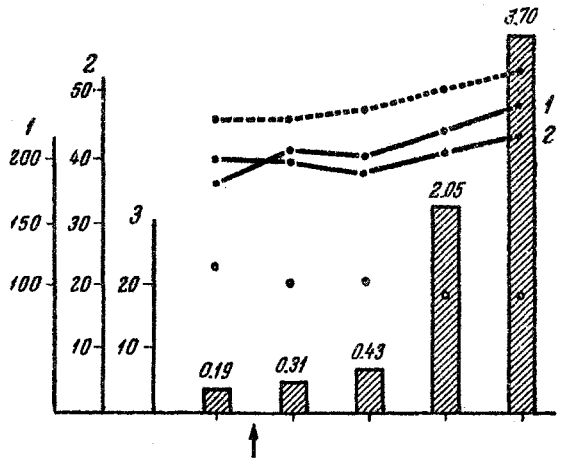

Fig. 2. The effect of a water load on the filtration and blood flow. The dog Zhuchka, weight 15 kg, experiment No. 16. The broken line denotes the filtration by the insulin method. Remaining legend as in Fig. 1.

change. The degree of increase in filtration and blood flow was not, however, directly proportional to the magnitude of the diuresis. In some cases the plasma flow rose more than the filtration, which led to a slight decrease in the filtration fraction.

After the intravenous injection of fluid analogous changes were observed in the filtration and blood flow (see Table 1).

In the experiments in which filtration was determined by the insulin method, the diuresis was already increased before the water load as a result of infusion of the solution containing insulin and cardiotrast. Probably, therefore, the additional water load altered the blood flow and, in particular, the filtration to a much lesser degree. In this case, too, however, it could be seen that the filtration and the blood flow underwent parallel changes (Fig. 2).

Adam [1] suggested that the increased filtration during water diuresis takes place as a result of dilatation of the afferent vessels of the glomeruli, causing an increase in the filtration pressure. According to our findings the increased filtration is based on an increased renal blood flow. The latter is evidently associated with an increase in the number of functioning nephrons, and partly to the dilatation of both the afferent and efferent vessels of the glomeruli. Support for this hypothesis is given by the parallel changes in filtration and blood flow after a water load.

In conclusion we must point out that although the increase in blood flow and filtration is not the leading factor in the mechanism of water diuresis, it must be taken into account whenever the results of the determination of these values are assessed in clinical practice. The preliminary water load usually used may itself affect the results obtained and, moreover, not always to the same extent.

TABLE 1. Filtration and Renal Plasma Flow during Water Diuresis (the Dog Taina, Experiment No. 11, from 11.15 A.M. to 11.40 A.M. 400 ml of 0.45% sodium chloride solution was injected intravenously)

Time of collection of urine	Diuresis (in ml/min)	Concentration index		Filtration (in ml/min)	Plasma flow (in ml/min)	Filtration fraction
		creatine	cardiotrast			
10.55 A.M. to 11.15 A.M.	0.05	449.4	2597.4	22.5	129.9	17.3
11.15 A.M. to 11.35 A.M.	0.06	412.4	2411.9	24.7	144.7	17.1
11.35 A.M. to 11.55 A.M.	0.23	144.9	788.9	33.3	181.4	18.4
11.55 A.M. to 12.15 A.M.	0.68	59.5	333.8	40.5	227	17.8
12.15 A.M. to 12.35 A.M.	1.84	17.6	117.5	32.4	216.2	15.0

LITERATURE CITED

1. G. Adam, The Connection between Renal Function and the Cerebral Cortex, Candidate Dissertation [in Russian], Leningrad, 1955.
2. E. B. Berkhin, Byull. Éksper. Biol., 9, 20 (1959).
3. A. K. Merzon, Ter. Arkh., 6, 69 (1957).
4. N. N. Pronina, Byull. Éksper. Biol., 5, 12 (1955).
5. N. A. Ratner, Hypertension [in Russian], 1, p. 139, Moscow, 1950.
6. P. Bálint, A. Fekete, and J. Sturcz, Plüg, Arch. ges. Physiol., Bd. 265, S. 23 (1957).
7. H. Bucht, J. Ek, B. Josephson, et al., Clin. Sci., v. 15, p. 617 (1956).
8. J. Ek, Scand. J. clin. lab. Invest., v. 7, Suppl. 19, p. 9 (1955).
9. W. S. Kerr, Jr., J. Urol. (Baltimore), v. 80, p. 205 (1958).
10. R. K. McDonald and V. C. Kelley, Am. J. Physiol., v. 154, p. 193 (1948).