CHANGES IN GLOMERULAR FILTRATION OF THE KIDNEYS IN GLAUCOMA

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A marked decrease in glomerular filtration and a decrease in diuresis and sodium excretion are observed in patients with primary glaucoma. The blood sodium and potassium levels and the potassium excretion are unchanged. Since the renal blood flow remains unchanged, the decrease in filtration can be regarded as the result of a systemic disturbance of permeability of the filtering membranes in glaucoma. Data on changes in water and salt metabolism in glaucoma have recently been published [1, 2, 6]. No detailed investigation of kidney function in this disease has been carried out.

Considering that the circulation of the intraocular fluid has certain features of similarity with the processes taking place in the nephron [4], the writers have studied the main indices of kidney function in glaucoma, paying particular attention to glomerular filtration.

EXPERIMENTAL METHOD

The investigation was carried out on 60 persons with normal intraocular pressure (control group) and 182 patients with primary glaucoma. All the subjects were of about the same age (mean 50 years) and were hospitalized under the same conditions. No disease of the cardiovascular system or kidneys was found in them.

The following renal function tests were studied: the 24-hour diuresis, the excretion of sodium and potassium and their concentration in the plasma (by flame photometry) the filtration and reabsorption of water (relative to endogenous creatinine), and the renal plasma flow after a single injection of cardiotrast by Merzon's method [3]. Creatinine was determined by Folin's method, and cardiotrast by the method of Bak et al. [5].

TABLE 1. Renal Function in Healthy Subjects and Patients with Glaucoma (M ± m)

Index	Healthy persons	Patients with glaucoma	P
24-h diuresis (in ml)	1378±60	1167±27	<0.001
Glomerular filtration (ml/min)	88±2.0	54±1.1	<0.001
Reabsorption (%)	98.87±0.06	98.62±0.04	<0.001
Plasma sodium concn. (meq/liter)	144±2.0	142±0.5	>0.5
Potassium concn. in plasma (meq/liter)	4.5±0.10	4.4±0.02	>0.5
Sodium excretion (meq/day)	227±10.5	187±5.6	<0.001
Potassium excretion (meq/day)	42±2.4	37±1.4	<0.1

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TABLE 2. Filtration and Renal Hemodynamics in Healthy Subjects and Patients with Glaucoma (M ± m).

Index	Healthy persons	Patients with glaucoma	P
24-h diuresis (in ml)	1479±94	1198±41	<0,01
Filtration (ml/min)	90±1,8	60±2,6	<0,001
Renal plasma flow (ml/min)	786±25,2	784±27,1	>0,5
Filtration fraction	0,12±0,003	0,08±0,004	<0,001

EXPERIMENTAL RESULTS AND DISCUSSION

The 24-hour diuresis in the 142 patients with glaucoma was on the average 15.3% less than in 40 subjects of the control group. The glomerular filtration was very considerably lowered (Table 1). The decrease was compensated for to some degree by a small decrease in the percentage of reabsorption, and for this reason diuresis was lowered less than filtration. The plasma electrolyte concentration was practically the same in both groups; the potassium excretion in the urine likewise was indistinguishable in the patients and the control, but the sodium excretion was significantly lowered. This was entirely due to the decreased filtration of this cation.

The results thus showed that changes in renal functions in glaucoma are linked chiefly with a reduction in glomerular filtration.

The rate of glomerular filtration is known to depend on several factors, the most important of which are the renal circulation and the permeability of the glomerular membrane. It was therefore important to establish whether the renal blood flow is reduced simultaneously with the filtration, for in that case the decrease in filtration could be easily explained. On the other hand, an increase in the renal blood flow could indicate dilatation of the efferent arterioles; the decrease in filtration would then depend on a fall of filtration pressure.

The results of tests on 40 patients with glaucoma and 20 persons of the control group, given in Table 2, confirmed the principle outlined above as regards the decrease in diuresis and filtration, and they showed that the renal blood flow (plasma flow) remains absolutely stable in glaucoma while the filtration fraction is reduced by an amount corresponding to the decrease in the rate of filtration. The decrease in glomerular filtration is thus not connected with a change in the renal hemodynamics, but it evidently depends on changes in the permeability of the glomerular membrane.

The results apparently indicate that in glaucoma there is not only a disturbance of the hydrodynamics of the eye, but also a general decrease in permeability of the filtering surfaces in the rest of the body. The possibility cannot be ruled out that this phenomenon is characteristic not only of the kidneys, which were studied in the present investigation, but also of other organs in which ultrafiltration takes place.

The fact that a decrease in filtration, diuresis, and sodium excretion is found, as described in this paper, can also be used to explain the changes in water metabolism and, in particular, an increase in the volume of extracellular fluid [6], observed by some investigators in glaucoma.

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