CHANGES IN THE RENAL HEMODYNAMICS IN EXPERIMENTAL UNILATERAL HYDRONEPHROSIS

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Hydronephrosis is a serious disease which often requires operative treatment by nephrectomy [1, 3]. During its progressive stage and also after removal of the affected kidney, the compensatory powers of the residual kidney assume great importance for the maintenance of homeostasis [2].

The state of the renal circulation is an important indicator of the compensatory activity of the kidney [4].

The renal circulation has not been studied in the various stages of development and treatment of unilateral hydronephrosis, although an understanding of this problem is essential for the prognosis of the disease and for the institution of proper corrective treatment.

The object of this investigation was to study the hemodynamics in both kidneys during the development of hydronephrosis in one of them, and also to study the effect of increasing intrapelvic pressure on the blood flow and the state of the circulation in the residual kidney after removal of the hydronephrotic kidney.

EXPERIMENTAL METHOD

Experiments were carried out on ten adult mongrel dogs of both sexes weighing from 11 to 16 kg. Under intravenous thiopental anesthesia a midline laparotomy was performed. Both renal arteries were isolated and a sensor applied to each in turn to record the initial renal volume blood flow with the aid of an electromagnetic flowmeter and the RKÉ-1 apparatus. The left ureter was then mobilized in its middle portion and its diameter measured, after which a chromium-plated brass ring, with an internal diameter such that it compressed the lumen of the ureter by half, was applied to it. The abdomen was closed without drainage. The renal blood flow in both kidneys was determined 7 and 30 days after constriction of the ureter by the method described above (through the laparotomy incision). Thirty days after recording the renal blood flow, the kidney with the constricted ureter was removed. The volume blood flow of the remaining kidney was studied 7 and 30 days after nephrectomy by the method described above. At the same time, the blood pressure (BP) was measured in the femoral artery by the Mingograph-34 apparatus and the pressure inside the pelvis of the hydronephrotic kidney was measured by means of Waldman's apparatus. The intrarenal vascular resistance (IVR) was then calculated by the equation:

$$\mathrm{IVR} = \frac{\Delta P}{\mathrm{RBF}},$$

where ΔP is the pressure gradient and RBF the renal blood flow.

EXPERIMENTAL RESULTS

It will be clear from Table 1 that 7 days after the operation the renal blood flow in the kidney with the constricted ureter was reduced to 73% of its original value, IVR was increased by 40% compared with initially, and the pressure in the pelvis of the kidney was

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TABLE 1. Dynamics of Indices of Renal Blood Flow and Intrapelvic and Arterial Blood Pressure in Dogs with Unilateral Hydronephrosis, M ± m

Index	Initial value	7 days after constriction of ureter	P_1^*	30 days after constriction of ureter	P_1	$P_2^†$	7 days after removal of hydronephrotic kidney	P_1	P_2	30 days after removal of hydronephrotic kidney	P_1	P_2
Renal blood flow in hydronephrotic kidney, ml/min/m²	235±2,8	171±3,4	<0,001	133±1,8	<0,001	<0,05	—					
Renal blood flow in contralateral kidney, ml/min/m²	240±4,6	288±3,6	<0,001	312±4,8	<0,001	<0,05	336±2,8	<0,001	<0,05	348±1,8	<0,001	<0,05
Pressure in pelvis of hydronephrotic kidney, mm Hg	14,6±4,2	73,2±2,6	<0,001	149±3,3	<0,001	<0,001	—			—		
Vascular resistance in hydronephrotic kidney, dynes·sec·cm^{-5}/m²	3094±66,5	4299±34,6	<0,001	5408±48,4	<0,001	<0,001	—			—		
Vascular resistance of contralateral kidney, dynes·sec·cm^{-5}/m²	3030±52,4	2553±28,8	<0,001	2305±32,4	<0,001	<0,05	2212±44,2	<0,001	<0,05	1998±36,6	<0,001	<0,01
Mean BP, mm Hg	91±4,1	92±3,2	>0,5	90±4,2	>0,5	>0,5	93±3,6	>0,5	>0,5	87±2,6	<0,05	<0,05

*P_1) significance of difference from original data.
†P_2) significance of difference between data at last time of observation from previous time.

five times higher than initially. At the same time, the renal blood flow in the contralateral kidney was increased by 20% but IVR was reduced by 16% compared with its initial level. BP was unchanged.

The changes were still more marked 30 days after the operation.

The renal blood flow in the residual kidney 7 days after removal of the kidney with the constricted ureter was increased by 10% (compared with the previous time), IVR was further reduced (by 27%), but BP was unchanged. The same tendency persisted also 30 days after nephrectomy. The renal blood flow in the residual kidney continued to rise, to a level 45% above its initial value, but IVR fell by 34% below its initial level. BP also fell a little. In the control group the renal blood flow at all stages of observation remained at the same level.

Consequently, during obstruction to the flow of urine from the kidney leading to development of unilateral hydronephrosis, profound changes take place in the renal blood flow. As the pressure in the renal pelvis rises, IVR rises and the renal blood flow falls. A tenfold increase in the intrapelvic pressure is accompanied by a reduction in the renal blood flow by half. Meanwhile, in the contralateral kidney, a compensatory progressive increase in the renal blood flow takes place, so that by the end of the first week it was 20%, and at the end of the first month it was 30% higher than initially. This well-marked compensatory increase in the volume blood flow in the healthy kidney can serve as an indicator of renal function to determine whether the animal is fit for the operation. Nephrectomy can be performed only if the blood flow in the healthy kidney rises distinctly as the intrapelvic pressure rises with the development of hydronephrosis in the affected kidney.

Removal of the hydronephrotic kidney is followed by a further increase in the blood flow in the remaining kidney.

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