INFLAMMATORY PROCESSES IN DOGS AFTER RESECTION OF THE KIDNEY

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The morphological changes taking place in the resected and control kidneys have been demonstrated in many experimental investigation [4, 5, 7, 8, 10-12], but the functional changes in the kidneys following resection of one of them have been studied very inadequately [1, 2, 9, 13]. It has been concluded from the changes in diuresis, the indigocarmine test, and the blood nonprotein nitrogen level in these studies that resection of the kidney has little effect on its functions. However, the indices which have been studied are known to reflect the state of the glomeruli and tubules of the kidneys inadequately.

The object of the present investigation was to study the inflammatory processes taking place in the kidneys after resection of one of them by examining the function of the different parts of the nephrons.

EXPERIMENTAL METHOD

The investigation was conducted on four dogs with the orifices of their ureters exteriorized on to the anterior abdominal wall. After the control experiments, in two dogs one pole (about one-quarter) of the right kidney was removed, and in the other two dogs both poles (about one-half) of the right kidney were removed in one stage. The function of the resected and intact kidneys was studied on the first days after the operation, and then weekly for 2 months. The glomerular filtration and the reabsorption of water in the tubules were determined by the inulin method and the effective renal plasma flow and the secretory ability of the tubules by means of diodrast. The experimental results were expressed per square meter of body surface for comparison and analyzed by statistical methods (Tables 1 and 2).

EXPERIMENTAL RESULTS

On the first day after resection of the kidney a slight hematuria was observed, and in one case, anuria. It follows from Tables 1 and 2 that the diuresis of the partially resected kidney during the first day after resection of one pole was lowered by 26.1%, and after resection of both poles, by 55.5%. The diuresis of the intact kidney was increased during this period by 51.9% and 69.8% respectively. These changes in diuresis are statistically significant. During the next 2 months the changes in diuresis were not significant.

The plasma flow in the resected kidney during the first days after removal of one pole was reduced by 32.2%, and after removal of both poles – by 60.8%. The plasma flow of the intact kidney was increased during the first days after the operation by 23.7% and 44.8% respectively. The changes in the plasma flow in every case are significant. Subsequently the plasma flow in the resected and intact kidneys remained almost unchanged throughout the period of observation.

The glomerular filtration of the resected kidney fell during the first few days after resection of one pole by 42.1%, and after resection of both poles by 66.3%. This decrease is highly significant ($P < 0.001$). The glomerular filtration of the intact kidney increased at this time after resection of one pole of the kidney by 17.2%, and after resection of both poles by 42.5%. During the next 2 months the glomerular filtration of the resected kidney remained almost unchanged. The filtration of the intact kidney continued to increase, and by the end of the period of observation it exceeded the initial level by 26.4% and 61.9% respectively ($P < 0.05$ and $P < 0.001$).

The reabsorption of water by the resected kidney fell by 43.5% during the first few days after resection of one pole, and by 67.1% after resection of both poles. The reabsorption of water by the intact

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TABLE 1. Effect of Resection of One Pole of the Right Kidney on Renal Function in Dogs

Index of renal function	Statistical index	Before resection		After resection of one pole of the right kidney					
				1st-2nd day		1st month		2nd month	
		R*	L	R	L	R	L	R	L
Diuresis (in ml/min/m^2)	$M \pm m$ P	4,29±0,50	4,02±0,43	3,17±0,19 >0,05	6,11±0,60 <0,02	2,62±0,12 <0,01	4,19±0,49 >0,5	2,87±0,48 >0,05	5,76±0,95 >0,1
Renal plasma flow (in ml/min/m^2)	$M \pm m$ P	162,02±8,28	165,39±8,65	109,92±7,37 <0,001	204,64±8,41 <0,01	89,13±5,69 <0,001	179,94±17,6 <0,5	107,19±10,32 <0,01	216,19±34,95 >0,1
Glomerular filtration (in ml/min/m^2)	$M \pm m$ P	50,50±1,34	50,65±0,80	29,28±2,42 <0,001	59,38±4,27 >0,05	28,41±0,88 <0,001	55,26±1,44 <0,001	31,92±2,79 <0,001	64,03±5,99 <0,05
Filtration fraction (in %)	$M \pm m$ P	32,0±1,99	31,4±1,76	27,4±3,90 >0,2	29,2±2,71 >0,5	31,6±2,02 >0,5	30,8±1,94 >0,5	30,0±2,02 >0,2	31,4±4,6 0
Reabsroption of water (in ml/min/m^2)	$M \pm m$ P	46,20±1,24	46,72±1,02	26,11±2,52 <0,001	53,26±4,41 >0,1	25,79±0,80 <0,001	51,06±1,31 <0,02	29,05±2,52 <0,001	58,27±5,76 >0,1
Secretion by diodrast (in mg/min/m^2)	$M \pm m$ P	15,24±1,54	12,99±1,55	9,39±1,13 <0,01	17,35±2,27 >0,05	8,31±1,48 <0,01	16,16±3,54 >0,2	9,57±2,84 >0,05	19,07±3,78 >0,1

*Legend here and in Table 2: R) right kidney, L) left kidney.

TABLE 2. Effect of Resection on Both Poles of the Right Kidney on Renal Function in Dogs

Index of renal function	Statistical index	Before resection		Renal function after resection of both poles of the right kidney					
				1st-2nd day		1st month		2nd month	
		R	L	R	L	R	L	R	L
Diuresis (in ml/min/m^2)	$M \pm m$ P	3,39±0,26	3,28±0,36	1,51±0,41 <0,01	5,57±0,72 <0,02	1,33±0,11 <0,001	5,03±0,48 <0,01	1,65±0,17 <0,001	5,55±0,47 <0,01
Renal plasma flow (in ml/min/m^2)	$M \pm m$ P	188,42±5,89	203,73±8,21	73,99±24,22 <0,001	295,16±16,72 <0,001	68,87±7,07 <0,001	249,46±16,0 <0,05	70,76±3,26 <0,001	268,09±6,85 <0,001
Glomerular filtration (in ml/min/m^2)	$M \pm m$ P	46,46±2,07	45,12±2,25	15,69±3,48 <0,001	64,32±4,75 <0,05	16,81±1,71 <0,001	57,37±3,65 <0,02	20,48±2,24 <0,02	73,07±4,65 <0,001
Filtration fraction (in %)	$M \pm m$ P	24,08±1,99	22,3±1,76	22,9±2,08 >0,2	22,2±2,72 >0,5	24,6±1,48 >0,5	23,5±1,86 >0,2	28,5±2,20 >0,1	27,1±1,86 >0,05
Reabsorption of water (in ml/min/m^2)	$M \pm m$ P	43,07±2,05	41,84±2,10	14,18±3,10 <0,001	58,76±4,33 <0,01	15,48±1,62 <0,001	52,34±3,40 <0,02	18,82±2,08 <0,001	67,53±4,54 <0,001
Secretion by diodrast (in mg/min/m^2)	$M \pm m$ P	17,47±1,50	16,84±1,68	5,45±1,86 <0,001	20,29±3,31 >0,2	6,81±1,08 <0,001	21,00±1,81 >0,1	6,06±0,04 <0,001	24,82±3,51 <0,05

kidney during the first days after the operation rose by 13.9% and 40.4% respectively. During the next 2 months the reabsorption of water in the resected kidney varied only very slightly. In the intact kidney the reabsorption of water increased by 24.7 and 61.4% respectively.

The secretory power of the tubules by the diodrast method fell significantly (by 39.4%) after resection of one pole, and by 68.9% after resection of both poles. During the next 2 months the maximal secretion of the tubules of the resected kidney remained unchanged. The changes in the secretory power of the tubules of the intact kidney during the first few days after resection were negligible. Two months after the operation the maximal secretion of the intact kidney exceeded the initial level by 46.8% and 47.3% respectively.

Analysis of these results shows that after resection of one pole of the kidney all the indices of the function of the resected kidney were lowered by 32.2-43.5%. After resection of both poles the function of the kidney was lowered by 55.5-68.9%. Consequently, the kidney function after resection fell by an amount directly proportional to the amount of kidney tissue removed.

Characteristically the function of the resected kidney fell during the first few days after the operation and thereafter remained almost unchanged for the next 2 months. None of the indices of function of the resected kidney returned to normal. However, from the first few days after resection of one kidney, the function of all parts of the nephrons of the contralateral, intact kidney was increased: after resection of one pole by 14.3-23.7%, after resection of both poles by 20.4-44.9%. The function of the intact kidney increased gradually throughout the period of observation.

Consequently, the remaining nephrons of the resected kidney do not develop regenerative hypertrophy if the second kidney is present, and they do not compensate for the removed part of the kidney. Compensation takes place as a result of an increase in the function of the contralateral intact kidney.

It is of great interest to discover whether the combined function of both kidneys is restored after resection of one of them. The results of these experiments show that the combined function of the two kidneys was completely restored after resection of a pole of one kidney. After resection of both poles of one kidney the plasma flow in the kidneys was not fully restored. The maximal secretion of the tubules by the diodrast method in this case also reached its combined preoperative level.

These results confirm the conclusion reached by L. D. Liozner [6], namely that paired organs can respond to injury in two ways: either by regeneration or by compensatory hypertrophy. However, the compensatory mechanism is more labile and is brought into play sooner, whereas the regeneration takes place only in certain conditions. The resected organ does not regenerate, not because it is incapable of regeneration, but because the rapid involvement of the mechanism of compensatory hypertrophy of the paired intact organ does not allow the capacity for regeneration to be exhibited. After removal of the contralateral organ the resected kidney intensifies its own function quickly and considerably [3].

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