

STATE OF THE HEMODYNAMICS IN THE REMAINING KIDNEY AFTER NEPHRECTOMY

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The state of the hemodynamics of the remaining kidney after unilateral nephrectomy was investigated (determination of the renal blood flow and rheorenography). In two series of experiments nephrectomy was accompanied by blood loss and subsequent autologous and homologous blood transfusion. Nephrectomy led to a decrease in the blood flow in the remaining kidney, which was associated with a reduction in the blood volume and with spasm of the blood vessels. The blood flow later returned to normal (by the end of the 1st day) and continued to rise progressively thereafter. Bleeding during the operation aggravates the hemodynamic disorders in the remaining kidney during the first few hours after the operation. Autologous blood transfusion led to their rapid disappearance (in the course of 2 h) but homologous blood transfusion led to preservation of the hemodynamic disorders for up to 3 days after the operation.

KEY WORDS: rheorenography; renal blood flow; remaining kidney after nephrectomy.

After unilateral nephrectomy hypertrophy of the remaining kidney develops [1, 3, 5, 7], and its intensity is directly dependent on the degree of change in the blood supply to the organ, due to redistribution of the arterial blood flow [4]. It was decided to study changes in the hemodynamics in the remaining kidney at various times after nephrectomy and some of the factors responsible for them. A special study was made of the effect of blood loss during the operation and its subsequent replacement by autologous and homologous blood transfusion on the hemodynamics in the remaining kidney.

EXPERIMENTAL METHOD

Experiments were carried out on 45 adult mongrel dogs weighing from 16 to 23 kg. The left ureter was exposed under intravenous thiopental anesthesia, it was opened through an incision in the middle third, and a platinum electrode on a ureteric catheter specially designed by the writer was introduced into it. The electrode was passed into the pelvis of the kidney. Rheograms of the kidney were recorded by means of a rheographic attachment to the ÉKPSCh-3 electrocardiograph. The amplitude of the rheogram (A) and the index of peripheral resistance (d) were calculated. The latter is the ratio between the amplitude of the lower points of the incisura of the rheographic curve and the amplitude of rapid blood filling and it characterizes vascular tone [6].

The renal blood flow (RBF) was determined by Smith's method after injection of diodone. After the initial indices had been recorded unilateral nephrectomy was performed. In the experiments of series I (15 animals) the nephrectomy was uncomplicated, but in the other two it was accompanied by blood loss to the extent of 200-300 ml (about 30% of the circulating blood volume). In the experiments of series II (15 dogs) the lost blood was replaced by autologous blood transfusion, and in series III (15 animals) by homologous blood transfusion. The renal blood flow was determined before and 1, 3, 7, and 14 days and 1, 3, and 6 months after nephrectomy. Rheorenography was carried out immediately after nephrectomy, 2 h later, and then at the same times as determination of the renal blood flow.

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TABLE 1. Indices of Renal Blood Flow and Rheorenography of Remaining Kidney after Nephrectomy in Experimental Animals

Time of observation	Series I			Series II			Series III		
	RBF	A	α	RBF	A	d	RBF	A	d
Initial indices									
Immediately after nephrectomy	798 ± 12,3	0,18 ± 0,004	0,67 ± 0,019	816 ± 9,7	0,19 ± 0,003	0,70 ± 0,019	820 ± 14,8	0,20 ± 0,007	0,65 ± 0,02
P_1	736 ± 13,0	0,15 ± 0,006	0,71 ± 0,029	693 ± 21,6	0,09 ± 0,006	0,83 ± 0,021	733 ± 16,1	0,10 ± 0,008	0,88 ± 0,016
2 h after	<0,001	<0,001	<0,01	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
P_1	—	—	—	—	0,18 ± 0,004	0,72 ± 0,018	—	0,10 ± 0,006	0,80 ± 0,02
P_2	—	—	—	—	>0,25	>0,5	—	<0,001	<0,001
1 day	806 ± 9,7	0,22 ± 0,009	0,55 ± 0,016	841 ± 12,6	0,24 ± 0,01	0,59 ± 0,014	767 ± 18,1	0,18 ± 0,007	0,77 ± 0,031
P_1	>0,5	<0,001	<0,001	>0,05	<0,001	<0,001	<0,001	>0,1	<0,001
P_2	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,002	<0,001	>0,5
3 days	788 ± 10,7	0,17 ± 0,01	0,70 ± 0,016	811 ± 11,4	0,20 ± 0,01	0,69 ± 0,025	845 ± 16,6	0,22 ± 0,01	0,60 ± 0,19
P_1	>0,5	>0,05	<0,05	>0,5	>0,5	>0,5	<0,01	>0,1	>0,25
P_2	<0,01	<0,001	<0,001	<0,001	<0,001	<0,001	<0,01	<0,001	<0,001
7 days	828 ± 8,8	0,20 ± 0,01	0,64 ± 0,012	865 ± 11,8	0,22 ± 0,008	0,62 ± 0,018	864 ± 15,0	0,20 ± 0,011	0,68 ± 0,023
P_1	<0,02	<0,02	>0,1	<0,02	<0,01	<0,01	<0,001	>0,5	>0,5
P_2	<0,002	<0,001	<0,01	<0,001	<0,05	<0,02	<0,002	<0,001	<0,001
1 months	845 ± 9,4	0,22 ± 0,01	0,70 ± 0,016	886 ± 13,3	0,23 ± 0,007	0,74 ± 0,022	886 ± 16,1	0,24 ± 0,008	0,72 ± 0,015
P_1	<0,002	<0,001	>0,25	<0,001	<0,002	>0,25	<0,001	<0,02	<0,05
P_2	<0,002	<0,001	>0,1	<0,001	<0,01	<0,002	>0,25	>0,1	<0,001
6 months	922 ± 13,5	0,25 ± 0,008	0,78 ± 0,024	960 ± 12,4	0,27 ± 0,007	0,80 ± 0,013	938 ± 14,5	0,28 ± 0,01	0,84 ± 0,016
P_1	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
P_2	<0,001	>0,5	<0,01	<0,001	<0,01	<0,001	<0,001	<0,001	<0,001

Legend. P_1) Significance of difference from initial data; P_2) significance of difference between results of next period and results of previous period of observation.

EXPERIMENTAL RESULTS

The results given in Table 1 show that on the first day after nephrectomy there was a considerable decrease (on average by $62 \text{ ml/min} \cdot \text{m}^2$) in the blood flow in the remaining kidney. Later the blood flow increased, and by 6 months after the operation RBF was higher than its initial level by $124 \text{ ml/min} \cdot \text{m}^2$. If blood was lost during the operation, RBF was considerably lower. Autologous blood transfusion led to its restoration to normal 24 h after the operation. In the case of homologous blood transfusion the normal blood flow was restored only 3 days after nephrectomy, and this was followed by a compensatory increase.

The amplitude of the rheograms of the residual kidney fluctuated in a wave-like manner. It fell initially, indicating a decrease in the volume of blood in the renal vessels. There was a corresponding increase in the index of peripheral resistance. This indicated an increase in tone of the renal vessels. The opposite tendency was observed 24 h after the operation, but starting from the seventh day after nephrectomy the changes in these indices followed a parallel course, although the degree of increase in amplitude of the rheographic wave was greater than the degree of increase in the peripheral resistance of the renal vessels.

In two other series of experiments nephrectomy accompanied by blood loss led to a more marked (almost twofold) decrease in amplitude of the rheogram of the remaining kidney. The normal amplitude was restored 2 h after autologous blood transfusion. Later it increased gradually, just as in the animals in the experiments of series I. Changes in the index of peripheral resistance were opposite in character. After autologous blood transfusion the normal index of peripheral resistance was restored 24 h after the operation. Starting from the seventh day changes in the index of peripheral resistance were parallel with changes in the amplitude of the rheogram.

When the lost blood was replaced by homologous blood transfusion (series III) the normal amplitude of the rheogram was restored 24 h after the operation. Under the influence of the homologous blood transfusion the index of peripheral resistance fell and did not regain its initial level until 3 days after the operation.

The results thus showed that nephrectomy leads initially to a reduction in the blood flow in the residual kidney, due to a rise in the hydraulic resistance of the vessels. Later the normal blood flow is restored on account of a decrease in the vascular resistance. Later still, the blood flow continues to rise against a background of increased vascular tone. These changes are evidently due to an increase in the diameter of the vessels of the glomeruli and the arteries in the remaining kidney [2]. Bleeding during the operation aggravates the hemodynamic disorders in the remaining kidney during the first few hours after the operation. When the lost blood is replaced by autologous blood transfusion these changes are transient in character (not more than 2 h). In the case of homologous blood transfusion these disorders are not corrected until 3 days after the operation.

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