

THE IMMEDIATE EFFECTS OF UNILATERAL NEPHRECTOMY ON OPEN GLOMERULI AND URINE OUTPUT

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The phenomenon of oliguria or anuria following operation or manipulation of the urinary tract is well recognized. Few have attempted a definite explanation except on the basis of a ureterorenal or renorenal reflex. Such a hypothesis as this assumes a nervous pathway but does not adequately explain the fundamental changes in the kidney or kidneys. Bieter¹ has recently studied the effects of splanchnic section and stimulation on the blood-containing glomeruli of the frog. With the technique of direct observation he found that the splanchnics were concerned in the control of the glomerular circulation and felt that such a control explains reflex anuria. The Janus green B method of Hayman and Starr² offers another method of approach to this problem and the present paper reports a study of this type.

Method

Two groups of rabbits were studied. In one group, unilateral nephrectomy was done and the animal allowed to recover for 2 hours when the opposite kidney was injected. In the other group, the animal was placed under sodium barbital anesthesia, the right kidney removed and a constant record of blood pressure kept for the 2 hours, when the left kidney was injected. In all experimental animals the right kidney was removed by an extraperitoneal lumbar operation and injected supravivally as described by Moore and Lukianoff.³ The bladder was emptied by catheter at the beginning and by catheter and inspection of the organ at the end of each experiment. Sodium barbital for anesthesia was given intravenously. The blood pressure was recorded from the carotid artery with a mercury manometer and a Becker kymograph. The phenolsulfonephthalein excretion was determined for a period of 1 hour after intravenous injection. Intravital injections and counts of both kidneys were carried out as described by Moore and Lukianoff.³

¹ Bieter, R. N., *Am. J. Physiol.*, 1930, 91, 436; *Proc. Soc. Exp. Biol. and Med.*, 1928-29, 26, 792.

² Hayman, J. M., Jr., and Starr, I., *J. Exp. Med.*, 1925, 42, 641.

³ Moore, R. A., and Lukianoff, G., *J. Exp. Med.*, 1929, 50, 227.

TABLE I
Unilateral Nephrectomies

Rabbit No.	Weight kg.	Fluid intake cc.	Urine volume			P.S.P. per cent	Anesthesia	Average blood pressure mm. Hg	Blood pressure at injection mm. Hg	Weight cortex gm.	Weight sample gm.	Count on sample	Estimate entire kidney	Per cent open glomeruli
			1st hour cc.	2nd hour cc.	Total cc.									
17	2.3	75			0	Ether			S-5.98 I-5.34	0.58 0.58	18,441 4,779	196,844 43,991	23.3	
10	1.5	75			70	"			S-2.82 I-3.05	0.36 0.35	25,058 14,912	196,288 129,947	66.2	
18	3.1	75			60	"			S-5.98 I-7.55	0.65 0.78	20,448 13,419	188,122 129,890	68.0	
19	2.5	75			60	"			S-7.29 I-7.19	0.73 0.73	27,825 1,013	277,865 9,979	3.6	
20	2.1	75			100	"			S-5.29 I-5.15	0.51 0.52	21,640 7,486	222,500 74,140	33.2	
24	2.2	75	1.5	8.5	10	750 mg. sodium barbital	90	38	S-4.43 I-4.47	0.47 0.46	24,815 6,393	167,587 61,985	37.0	
25	2.1	75	1.25	3.0	4.25	750 "	36	20	S-3.47 I-3.72	0.36 0.39	12,159 2,597	117,199 24,771	21.1	
26	2.5	85	0	2.25	2.25	750 "	40	34	S-3.47 I-4.42	0.35 0.44	17,476 3,102	173,261 31,161	17.9	
29	2.6	95	0.5	3.0	3.5	750 "	98	70	S-3.50 I-3.07	0.36 0.35	13,504 1,993	131,288 17,357	13.2	
41	2.5	95	6.0	23.5	29.5	675 "	40	36	S-3.69 I-3.54	0.38 0.38	18,666 9,164	181,256 85,367	47.0	

TABLE II
Sham Operation

Rabbit No.	Weight kg.	Fluid intake cc.	Urine volume			P.S.P. per cent	Anesthesia	Average blood pressure mm. Hg	Blood pressure at injection mm. Hg	Weight cortex gm.	Weight sample gm.	Count on sample	Estimate entire kidney	Per cent patent glomeruli
			1st hour cc.	2nd hour cc.	Total cc.									
12	2.4	75			32	70	Ether			S-4.16 I-4.57	0.41 0.56	15,416 7,040	156,100 57,300	36.7
13	2.3	75			39	100	"			S-4.71 I-4.57	0.54 0.48	20,288 4,107	177,000 39,150	22.2
28	3.4	126.5	0.75	0.50	1.25	7	875 mg. sodium barbital	64	36	S-4.50 I-3.18	0.47 0.32	16,643 7,963	159,345 78,495	49.2
37	2.2	85			8.0	70	565 "	58	38	S-4.01 I-4.34	0.42 0.48	26,770 22,672	255,589 204,991	80.2
38	2.2	85	1.5	3.0	4.5	50	565 "	70	30	S-3.30 I-2.80	0.34 0.29	22,564 13,559	219,004 130,914	59.7
39	2.2	85	7.0	10.0	17.0	85	565 "	62	36	S-3.28 I-2.60	0.33 0.28	25,758 20,352	256,017 188,461	73.6
40	2.4	95	2.8	26.0	28.8	60	675 "	66	19	S-3.65 I-3.49	0.37 0.36	18,514 20,143	182,635 193,172	105.7

TABLE III
Control

Rabbit No.	Weight kg.	Fluid intake cc.	Urine volume			P.S.P. per cent	Anesthesia	Average blood pressure mm. Hg	Blood pressure at injection mm. Hg	Weight cortex gm.	Weight sample gm.	Count on sample	Estimate entire kidney	Per cent patent glomeruli
			1st hour cc.	2nd hour cc.	Total cc.									
11	2.2	75			58	50	—		S-4.70 I-4.90	0.50 0.55	17,922 11,158	168,467 99,407	59.0	
14	1.5	75			33	60	—		S-3.93 I-4.13	0.44 0.42	21,123 16,476	188,800 165,100	87.3	
22	3.2	100	120—75, 18 hrs. before	35	155	80	—	70	S-4.99 I-5.15	0.54 0.58	19,270 7,193	178,068 63,865	36.9	
23	2.2	75	20	10	30	60	—	72	S-4.42 I-4.25	0.47 0.48	17,262 11,760	162,338 103,700	63.8	
30	2.5	95	7	10.5	17.5	80	625 mg. sodium Barbitol	50	S-3.73 I-3.92	0.37 0.44	25,889 7,537	260,880 67,184	25.7	
32	2.4	90			7.8	60	625 “ “	63	S-3.38 I-3.12	0.36 0.38	26,988 5,157	253,277 42,341	16.7	
33	3.4	127			12	60	875 “ “	82	S-4.27 I-2.98	0.42 0.29	17,757 3,280	180,100 33,704	18.7	
35	2.7	100	0	0.3	0.3	0	750 “ “	20	S-4.33 I-3.25	0.44 0.34	16,819 7,368	165,514 70,070	42.3	
36	2.2	85			37	80	560 “ “	52	S-3.20 I-2.59	0.34 0.28	23,289 18,596	219,190 172,012	78.4	

TABLE IV
Supravital Injections

Rabbit No.	Kidney	Weight cortex	Weight sample	Count on sample	Estimate entire kidney
		<i>gm.</i>	<i>gm.</i>		
7	R	3.15	0.35	22,877	205,893
	L	2.94	0.33	22,666	201,933
31	R	3.10	0.31	17,886	178,858
	L	3.38	0.33	18,177	186,410
34	R	3.73	0.37	21,983	221,610
	L	3.32	0.33	21,511	216,411

TABLE V
Distribution of the Findings

Range of open glomeruli	Unilateral nephrectomy		Sham operation		Control	
	Open	One kidney Urine 2 hours	Open	Urine 2 hours	Open	Urine 2 hours
	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>	<i>per cent</i>	<i>cc.</i>
0-10	3.6	4.0				
11-20	13.2	3.5			16.7	7.8
	17.9	2.25			18.7	12.0
21-30	21.1	4.25	22.2	39.0	25.7	17.5
	23.3	0				
31-40	33.2	5.0	36.7	32.0	36.9	155.0
	37.0	10.0				
41-50	47	29.5	49.2	1.25	42.3	0.3
51-60			59.7	4.5	59.0	58.0
61-70	66.2	16.0			63.8	30.0
	68.0	11.0				
71-80			73.6	17.0	78.4	37.0
Above 80			80.2	8.0	87.3	33.0
			105.7	28.8		

RESULTS

The results on the individual animals are given in Tables I, II, III, and IV with a general summary of the urine outputs and open glomeruli in Table V.

Charts similar to Table V show that the open glomeruli vary inversely as the blood pressure, indicating that vasoconstriction for maintenance of pressure is participated in by the kidney arterioles with consequent decrease of glomerular circulation.

With the exception of four animals there is a general correlation between open glomeruli and urine output. Further the output by one kidney for a 2 hour period after unilateral nephrectomy is approximately one-half of that of the control animals. Hence, renal shock was not produced in these animals and the solitary kidney performed its share of the excretory work.

With the exception of Animal 19 with 3.6 per cent of open glomeruli, there is no essential difference in the number of open glomeruli in the normal, sham operation, and experimental groups. The normal average of 47.6 per cent is low when compared to the figures of Hayman and Starr² and Moore and Lukianoff,³ but differs by only 14.6 per cent from the experimental group. The result of 61 per cent for the sham operation animals is well within the range of normal.

The blood pressures are low but essentially the same in all three groups so that this factor would not serve to invalidate the results. The results on the control animals show that an average pressure of above 40 to 50 mm. Hg is sufficient for normal urinary output in the rabbit. Animal 17, with no output for 2 hours after unilateral nephrectomy, was not followed with blood pressure records, but it is probable that there was a low pressure. The 0.3 cc. output in control Animal 35 is accounted for on the low average pressure of 20 mm. Hg. The marked polyuria in Animal 22 is not explained. There is nothing remarkable in the other results on this animal, and the open glomeruli total only 36.9 per cent. The low output in sham No. 28 is also unexplained.

SUMMARY

1. Renal shock with oliguria or anuria after unilateral kidney operation has not been produced in seventeen rabbits.

2. For a period of 2 hours after unilateral nephrectomy the one kidney carries on a proportionate part of the work of the previous two kidneys, and there is no evidence of functional compensation.

3. There is a general correlation between open glomeruli and urine output.

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