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The effect of main artery occlusion of one kidney on blood pressure of dogs

(experimental renal hypertension/unilateral renal ischemia/plasma renin)

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ABSTRACT **Occluding the main artery of one kidney in each of six dogs resulted in an average increase in the renin concentration of the peripheral blood from the original 0.040 to 0.198 milliunit/ml of serum. During the same time (3–4 days), the occlusion also resulted in a significant rise of directly measured mean systemic blood pressure from an average basal level of 104 to 139 mm Hg. This is in agreement with results obtained by Fekete *et al.* (e.g., [*Acta Med. Acad. Sci. Hung.* 27, 191–204 (1970) and 28, 181–196 (1971)], but we established that the blood pressure remained significantly elevated for only about 2 weeks or less. Furthermore, contrary to the findings of Fekete [*Inf. Urol. Nephrol.* 2, 391–400 (1970)], we found that excision of the ischemic kidney did not result in persistence of the hypertension, but in a prompt fall of the blood pressure to the normal level. Therefore, the Fekete method of occlusion of a main renal artery cannot be regarded as a suitable model for the study of chronic, experimental, renal hypertension.**

Fekete and collaborators (1–5) have reported that, in dogs, *occlusion* of the main artery of only one kidney, with the circulation of the contralateral kidney intact, resulted in the prompt development of a significant degree of hypertension, which they attributed to the renin-angiotensin humoral mechanism resulting from unilateral renal ischemia. The kidneys with the renal artery occluded, developed foci of cortical necrosis, and eventually became atrophic to a variable degree. However, they did not promptly become completely necrotic, a fact which Fekete *et al.* attributed to the invariable presence of sufficient extrarenal accessory circulation to the kidney from several neighboring sources, the existence of which has long been recognized (6). They claimed also that excision of the ischemic kidney, while the blood pressure was elevated, was followed by persistent hypertension at various levels. This persistence of the hypertension was attributed to the development of intrarenal obliterative vascular disease in the contralateral kidney. They therefore considered their method an experimental model for the production of persistent renovascular hypertension.

The results of Fekete and collaborators with unilateral renal ischemia due to *occlusion* of the main artery of only one kidney, in the dog, are in some respects contrary to the results of our previous experiments (7) with unilateral renal ischemia due to partial *constriction* of one main renal artery. In our dogs, we found that the blood pressure reached a maximum in 2 weeks or less, but occasionally remained significantly elevated for more than 6 weeks after the partial constriction of one main renal artery (7; in this paper, see Fig. 1, Dog 7, LK). Even in such dogs, however, the blood pressure promptly returned to normal after excision of the ischemic kidney. Fekete's report of persistence of the hypertension after excision of the ischemic kidney was surprising to us, since we never have observed the development of obliterative vascular disease in the contralateral kidney of our dogs with unilateral renal ischemia. For this reason we decided to test the procedure of Fekete, in a few animals and obtained some surprising results.

Abbreviations: LK, left main renal artery moderately constricted; LKO, left main renal artery occluded; LN, left nephrectomy; 1 mm of Hg is equal to 1.33×10^2 Pascal units.

MATERIALS AND METHODS

In six conscious female dogs of various breeds and weights, fed Purina Dog Chow, the normal direct mean blood pressure was first determined for a variable period (32–85 days) by the direct percutaneous puncture of a femoral artery, and measured by means of a mercury manometer. Then, the dogs were anesthetized with Nembutal, and the left main renal artery was occluded (Fig. 1, Dogs 1–6, LKO) by means of two silk sutures tied tightly around the artery, located close to the aorta. After a variable period (110–230 days), the ischemic kidney was excised (Fig. 1, Dogs 1–6, LN).

In one additional dog, the main renal artery of one kidney was not occluded, but merely moderately *constricted* (Fig. 1, Dog 7, LK). In this animal, the blood pressure remained moderately elevated for a longer time (120 days) than is usual after the constriction of one main renal artery. The ischemic kidney was then excised (Fig. 1, Dog 7, LN).

The concentration of renin in the serum of these dogs was measured by the bioassay procedure previously reported (8). For this purpose, samples of arterial peripheral blood were obtained by percutaneous puncture of a femoral artery of the conscious dogs before, and at various periods after, the occlusion or constriction of the renal artery.

RESULTS AND DISCUSSION

In five of the six animals a significant, but moderate, rise of the direct mean blood pressure occurred during the first week or two after the occlusion of the main artery of only one kidney (Fig. 1, Dogs 1–3 and 5–6, LKO; and Table 1). This promptly subsided but in some animals (Dogs 2 and 4) a slight rise persisted for many weeks after the occlusion. With the exception of the considerable, acute rise, which lasted only a few days, the resultant elevation of blood pressure should hardly rate as significant hypertension, and the animals certainly did not qualify as models for research on experimental chronic renal hypertension, as claimed by Fekete. More important, however, in none of our six dogs did a persistent significant elevation of blood pressure occur after the excision of the ischemic kidney (Fig. 1, Dogs 1–6, LN). Even in those that had shown a slight elevation, the pressure fell promptly and invariably to the original normal level, or even lower, after the excision of the ischemic kidney. The ischemic kidneys exhibited various degrees of atrophy, from moderate to severe, but neither focal nor diffuse necrosis.

The effects on the blood pressure, after either occlusion of

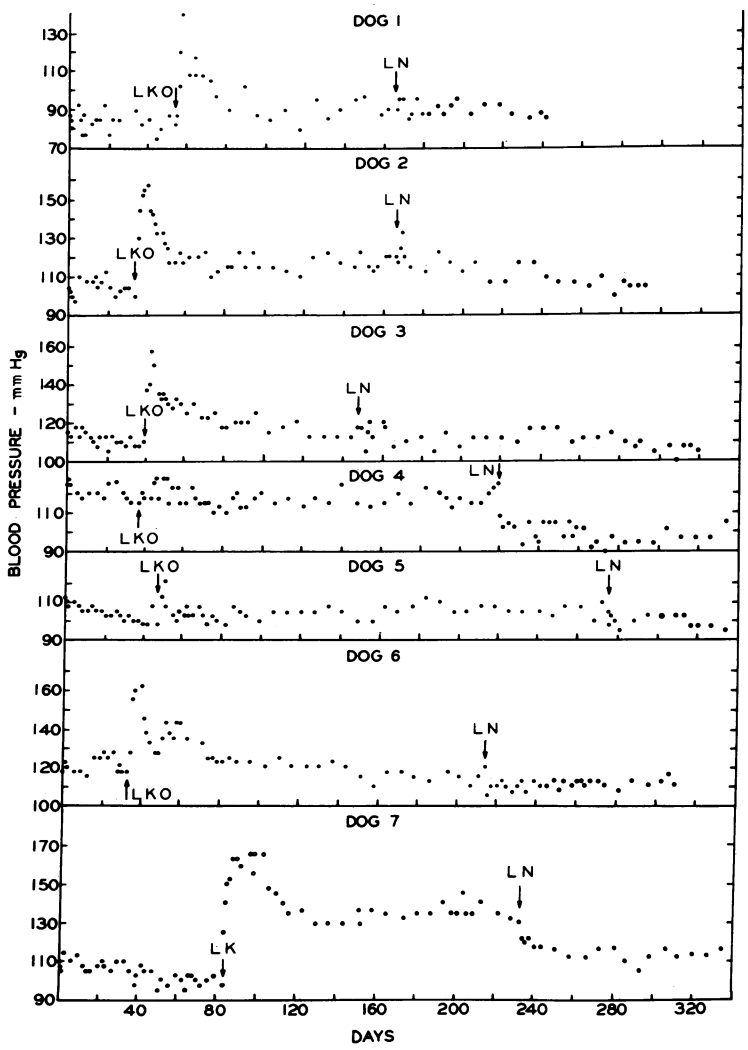

FIG. 1. LKO, left main renal artery occluded; LK, left main renal artery moderately constricted; LN, left nephrectomy.

a renal artery (Dogs 1–6) or partial constriction of a renal artery (Dog 7), have been compared in Fig. 1. One hundred twenty days after the constriction (LK), the blood pressure of Dog 7 was still appreciably elevated, and it returned promptly to the basal normal level after the excision of the ischemic kidney (Fig. 1, Dog 7, LN).

The pronounced increase in the concentration of renin in the serum observed after the occlusion of one main renal artery (Table 1), was accompanied by an increase in blood pressure. With the return of the concentration of serum renin to normal, the blood pressure fell to the preocclusion values. The temporary increase in the concentration of serum renin indicates the participation of the renin-angiotensin humoral mechanism in the brief acute elevation of the blood pressure which results from the occlusion of one main renal artery in the dog.

Our experimental results, i.e., the return of the concentration of renin in the peripheral blood to normal values (Table 1), differ from those of Fekete *et al.* (4) who reported the persistence of an increased level of renin activity in the peripheral blood of some of their dogs, even during periods of 20–180 days after the occlusion.

In Dog 7 (Table 1 and Fig. 1), the left renal artery had been partially constricted while the opposite kidney remained untouched. As a result, the blood pressure, as well as the concentration of renin in the peripheral blood, were elevated during the initial 11 days. The blood pressure continued to be moderately elevated for the remaining period of observation (150 days), and the concentration of renin in the systemic blood, likewise, remained somewhat above the normal preconstriction level.

Thus, our study touches briefly, but was not specifically designed to deal with, the presently undecided controversy about the participation of renin in the so-called "two-kidney hypertension", i.e., the type of hypertension which occurs when the renal artery of one kidney is constricted and the other kidney is untouched. In our experience with such dogs, constriction of one renal artery in the presence of a contralateral intact kidney does not result, as a rule, in sustained hypertension. Contralateral nephrectomy usually has been necessary for the production of persistent hypertension due to the ischemia of only one kidney in the dog.

Lupu *et al.* (9) have shown, however, more recently that chronic hypertension can be induced in the dog by unilateral constriction of the renal artery in the presence of the opposite untouched kidney. Ipsilateral nephrectomy, 4–16 months after constriction, returned the elevated arterial blood pressure to preconstriction normal values. They concluded that this type of experimental hypertension in the dog is renal dependent in both the acute and in the chronic stages, but they have not investigated a possible role of renin.

Table 1. Blood pressure and renin concentration increase in the systemic serum after occlusion or partial constriction of one main renal artery

	Before occlusion		After occlusion for 3–4 days			After occlusion for 7–161 days		
Dog no.	Blood pressure, mm of Hg	Renin, milliunit/ml of serum	Time, days	Blood pressure, mm of Hg	Renin, milliunit/ml of serum	Time, days	Blood pressure, mm of Hg	Renin, milliunit/ml of serum
1	82	0.015	4	140	0.236	7	108	0.041
2	100	0.020	3	152	0.255	58	120	0.025
3	110	0.043	3	158	0.250	52	120	0.021
4	115	0.049	4	117	0.118	133	118	0.010
5	98	0.071	4	108	0.129	161	105	0.099
6	118		3	160		91	120	
Mean	104	0.040	3.5	139	0.198	84	115	0.039
	Before constriction		After partial constriction for 11 days			After partial constriction for 150 days		
7	100	0.065	11	160	0.22	150	130	0.093

Fasciolo *et al.* (10), in earlier studies, did not find a consistent increase of the "renin content" in the plasma of six dogs after unilateral renal ischemia, for periods of 6–42 days. Bianchi *et al.* (11) reported a return of plasma renin concentration (and of the blood pressure) in conscious dogs to essentially normal values, in 6–7 days after the constriction of the main artery of one kidney when the opposite kidney was left intact.

This relationship between blood pressure and "plasma renin activity" during the development of hypertension was studied also more recently by Basso *et al.* (12) in 20 dogs. They found a consistent increase in the plasma renin activity of all the animals developing hypertension; the mean arterial blood pressure increased immediately after unilateral constriction of the left renal artery (two-kidney hypertension), and remained elevated until day 28. The plasma renin activity was increased 3-fold, on the average, within 24 hr of arterial constriction and remained significantly increased until day 28. Contralateral nephrectomy (removal of the intact, normal, right kidney) resulted in a return of the plasma renin activity to normal preconstriction levels, while the blood pressure remained elevated. Thus, a clear dissociation between plasma renin activity and blood pressure was observed in the latter (one-kidney) type of hypertension.

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