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EFFECT ON THE RENAL HYPERTENSION BY CONNECTING THE RENAL VEIN TO THE PORTAL VEIN

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Since Goldblatt and his associates in 1934 reported their great success in making the marked and persistent hypertension in dogs by partially constriting the main renal artery with a siver clamp, a great deal of works have been done in an effort to clarify the causal principle. Houssay and Fasciolo in 1937 first demonstrated that the kidney of which artery was constricted released something essential to the elevation of the blood pressure. Interests of all investigators of this problem, then, seemed to be focused on finding the humoral pressure substance. It may be certain now that angiotensin II, which was already synthetized, is the final effective substance and it appears in the blood as the product resulting from the complicated enzyme action of renin. It is already clarified that renin is poured into the blood by the kidney, which is being exposed to ischemic condition and its substance, that is, angiotensinogen, of which origin may be in the liver, always exists in the circulating blood under the normal condition.

The inactivation of angiotensin II in the body has also been studied but in this field of investigation much is still unknown. Angiotensin II is destroyed by an enzyme called angiotensinase and this enzyme is present in many organs, especially in the plasma and erythrocytes. According to Sapirstein, Reed and Page, angiotensinase in the plasma may play the most important role in the destruction of angiotensin II in the body. If it were so, the corresponding decrease of angiotensinase in the plasma should occur in the experimental renal hypertension. Recent studies have revealed that there was no significant difference in quantity of this substance before and after the introduction of hyperthnsion.

In this series of experiments, in order to investigate the possible ability of the liver to detoxicate angiotensin II, we connected the renal vein to the portal vein so that whole blood from the kidney returning to the heart was forced to pass through the liver.

METHOD

Well trained adult mongrel dogs of either sex were used in the present experiment.

Blood pressure was measured by the auscultatory method without anesthesia by mean of the carotid bridge previously made. By this method, not only the systolic but also the diastolic blood pressure was obtainable. The control level of the blood pressure was obtained as long as possible until the dogs became familiar with the procedure.

The renal hypertension was produced in two ways ;

1) The right main renal artery was clamped partially with a tantalum clamp after Goldblatt and about a week later the left kidney was removed.

2) The nephrotoxic nephritis was produced in the dog of which left kidney had already been removed, by the intravenous administration of 2-3 cc/kg body weight of the rabbit anti-dog kidney serum previously prepared.

For the purpose of portalization of the renal venous blood, the distal end of the divided right renal vein was connected to the lateral side of the portal trunk. It was necessary to divide completely the numerous venous shunts between the renal surface and the inferior vena cava, because the dilatation of these shunts was immediately followed by the occulsion of anastomosis. For this purpose, the kidney was completely isolated from the surrounding tissues except for the ureter.

RESULTS

In both types of the renal hypertension, the portalization of the renal venous blood was performed before and the induced hypertension was developed.

Figure I shows the elevation of the blood pressure following the application of the Goldblatt clamp to the right main renal artery. The blood pressure, both systolic and diastolic, rose gradually during the first week following the clamping. This rising tendency of blood pressure still continued after the removal of the left kidney until it reached its peak in a week or so. Once the blood pressure reached its peak, this condition was maitained for a long period thereafter.

In the Goldblatt type hypertension, the anastomosis of the renal vein to the portal vein was followed by marked fall of the elevated blood pressure (Fig. 2). This fall of blood pressure could be seen within one day or two following the anastomosis and lasted for a long time. In general, the blood pressure returned only the control level after the procedure but in some cases it declined beyond the control level and became hypotensive (Fig. 3). In the cases in which the anastomosis between the renal vein and portal vein had already being made before the renal artery was constricted, nos ignificant fluctuation of the blood pressure could be noted after the anastomosis and still after theconstriction of the main renal artery (Fig. 4).

We happened to encounter a case in which, in spite of the initial establishment of the anastomosis, a marked elevation of the blood pressure was noted after the

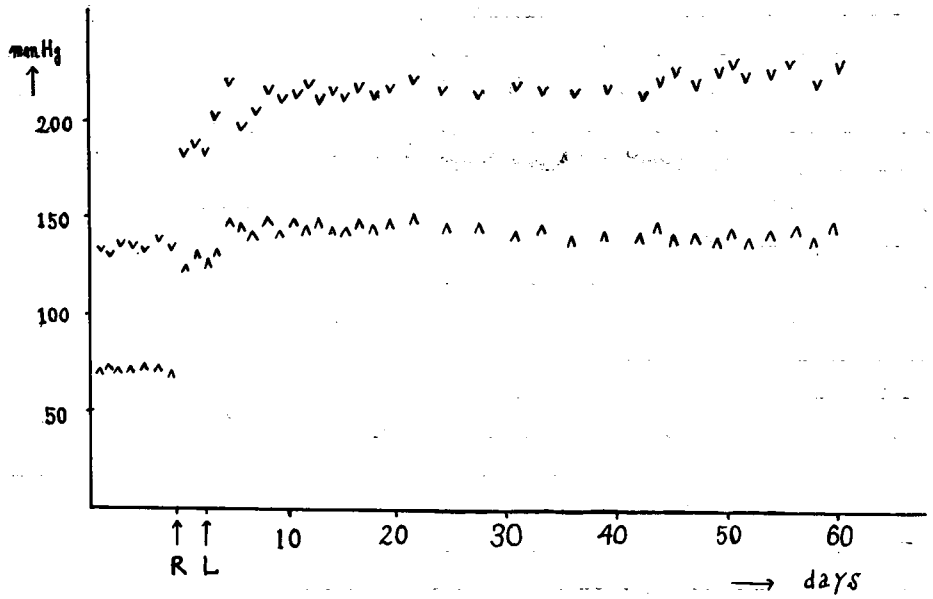

Fig. 1 Marked and perisstent hypertension was produced by constriction of the right main renal artery followed by the removal of the left kidney several days later.

V : systolic blood pressure.
Λ : diastolic blood pressure.
R : constriction of the right main renal artery.
L : left nephrectomy.
A : anastomosis of the right renal vein to the portal vein.
A·L : anastomosis of the right renal vein to the portal vein and the removal of the left kidney were simultaneously performed.
I : intravenous injection of the rabbit anti-kidney serum.

constriction of the renal artery. This is shown in Fig. 5. In this case the occulsion of the anastomosis due to thrombus and the development of many venous shunts from the kidney to the inferior vena cava were revealed by autopsy. This is one of early cases in which the freeing of the kidney from the neighboring tissues was not so complete. Fig. 6 is the picture of the surprisingly dilated venous shunts from the kidney to the inferior vena cava.

Compared with the hypertension produced by Goldblatt's technique, the elevation of the blood pressure in acute nephrotoxic nephritis was not so remarkable. The moderate rise in the blood pressure was already observed on the following day after the injection of the nephrotoxic serum with remarkable visible hematuria, severe albuminuria and increasing general edema (Fig. 7). In Fig. 8, it is shown that the elevation of the blood pressure following nephrothxic serum injection was prevented by the initial reno-portal anastomosis. The autopsy revealed patent anastomosis. When the anastomosis was

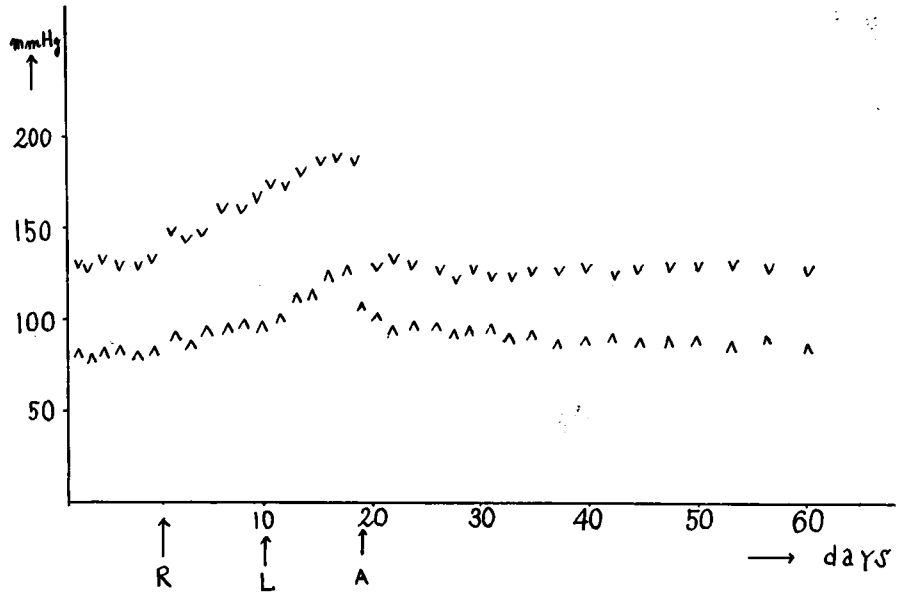

Fig. 2 Marked fall of the elevated blood pressure was noted following the establishment occulded, of the anastomosis between renal and portal vein.
Hypotensive condition could not be noted.

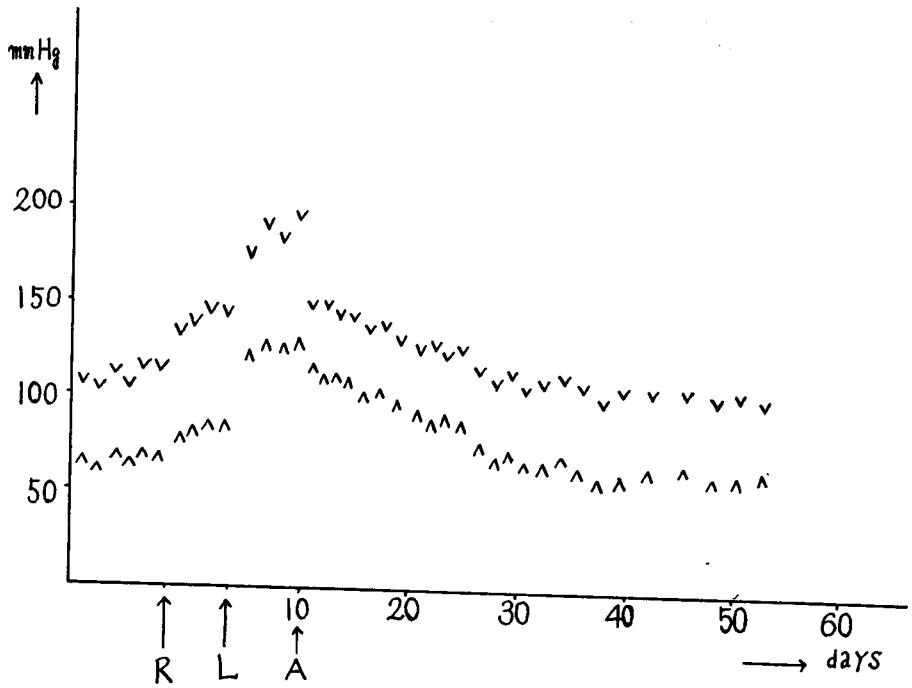

Fig. 3 The hypotensive condition was obtained by connecting the renal vein to the portal vein in Goldblatt type hypertension.

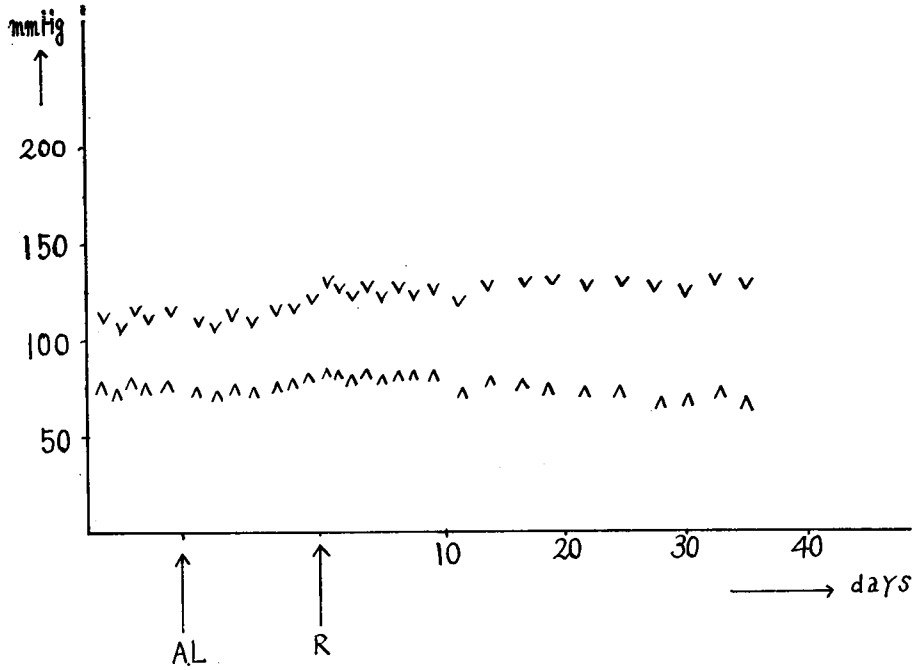

Fig. 4 No fluctuation of the blood pressure could be noted even after the constriction of the right main renal artery, when portalization of the renal vein was done previously.

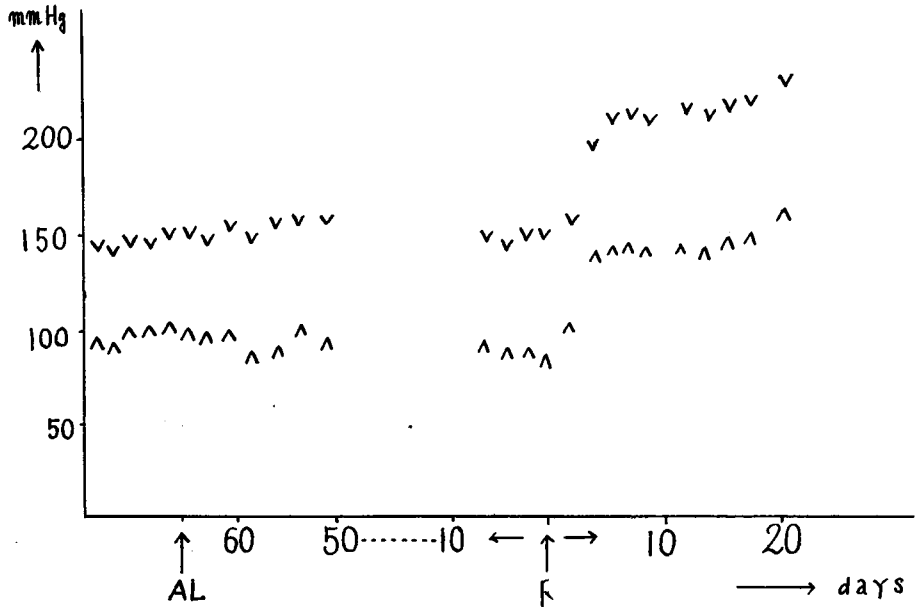

Fig. 5 In spite of the initial establishment of the portalization, the marked elevation of the blood pressure was noted by use of the constriction of the right renal artery. Obstruction of the anastomosis was revealed by autopsy.

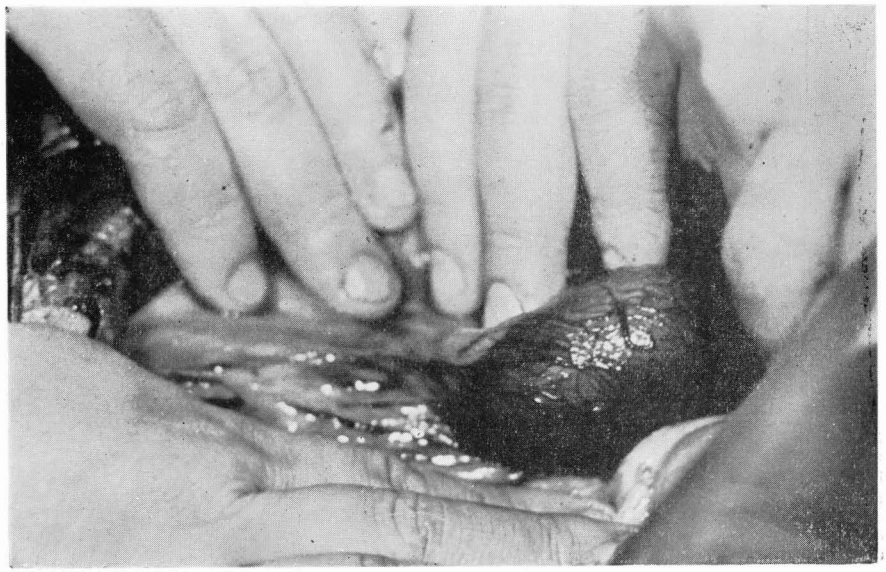

Fig. 6 Surprisingly dilated venous shunts from the renal surface to the inferior caval vein.

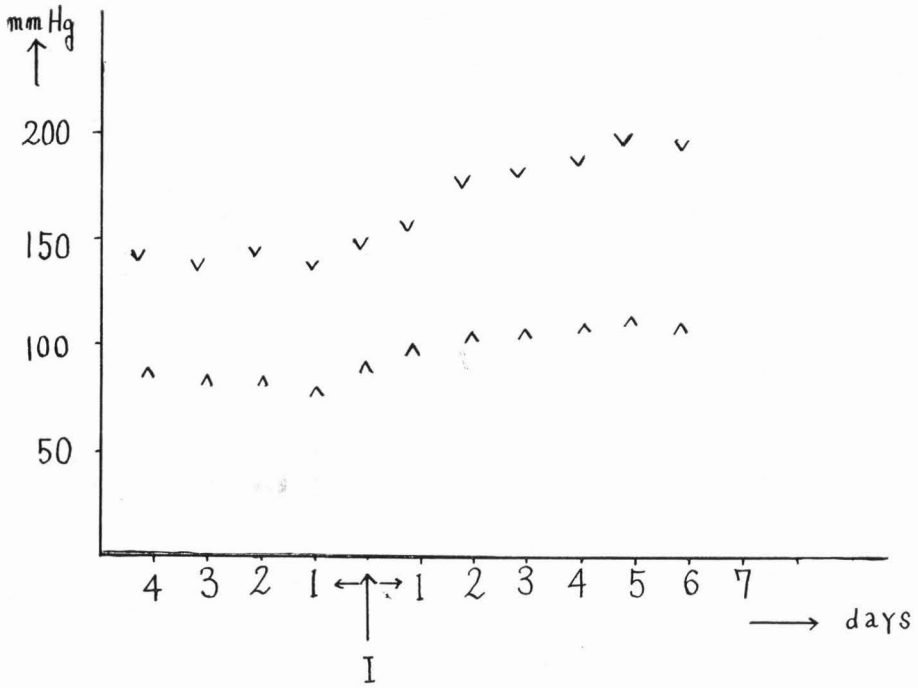

Fig. 7 A moderate rise in blood pressure after intravenous injecton of the rabbit anti-dog kidney serum.

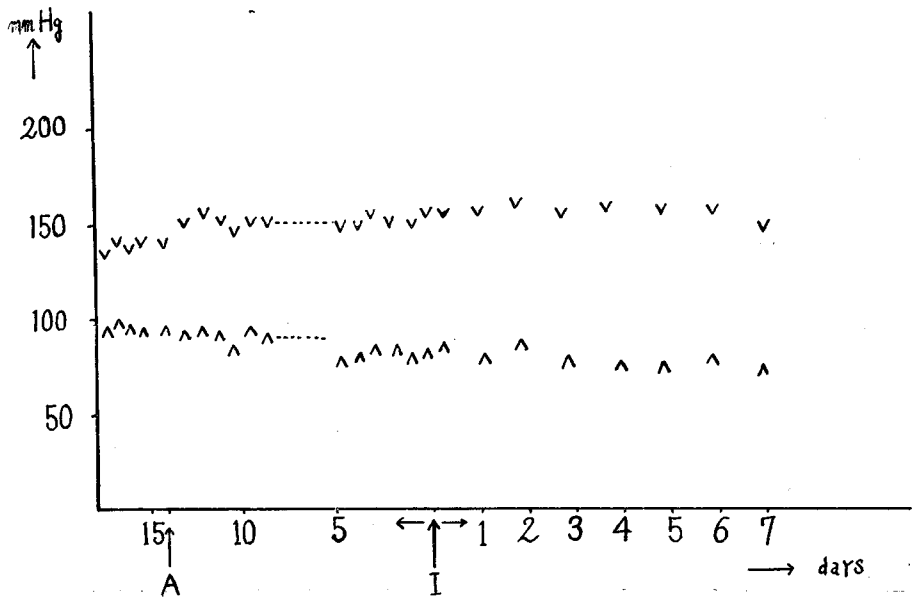

Fig. 8 The elevation of blood pressure following injection of the nephrotoxic serum was prevented by the initial establishment of the reno-portal anastomosis. The patent anastomosis was revealed by autopsy,

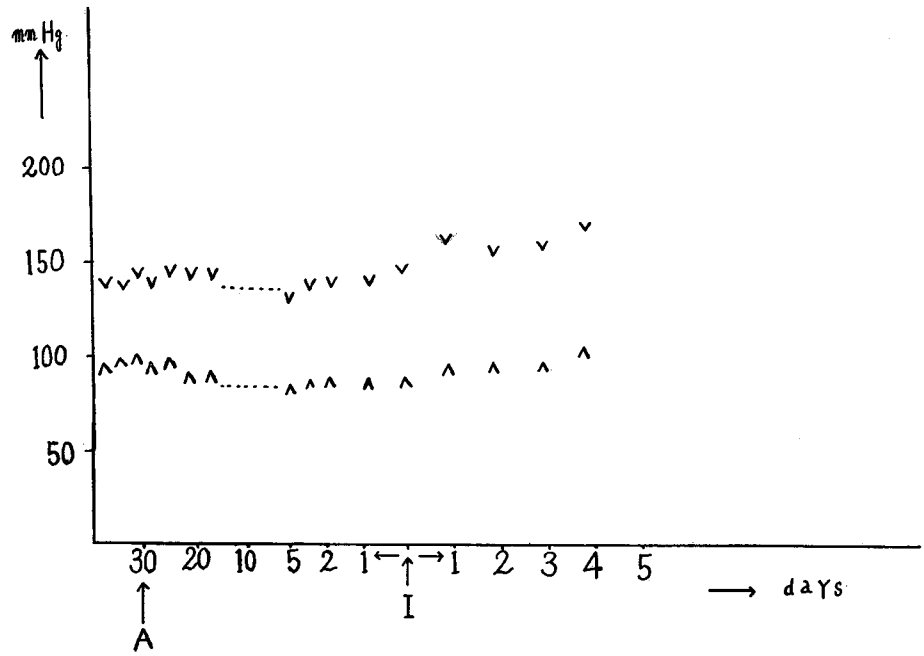

Fig. 9 In spite of the initial establishment of the reno-portal anastomosis moderate increase of blood pressure was noted by the injection of nephrotoxic serum. The occlusion of anastomosis was revealed by autopsy.

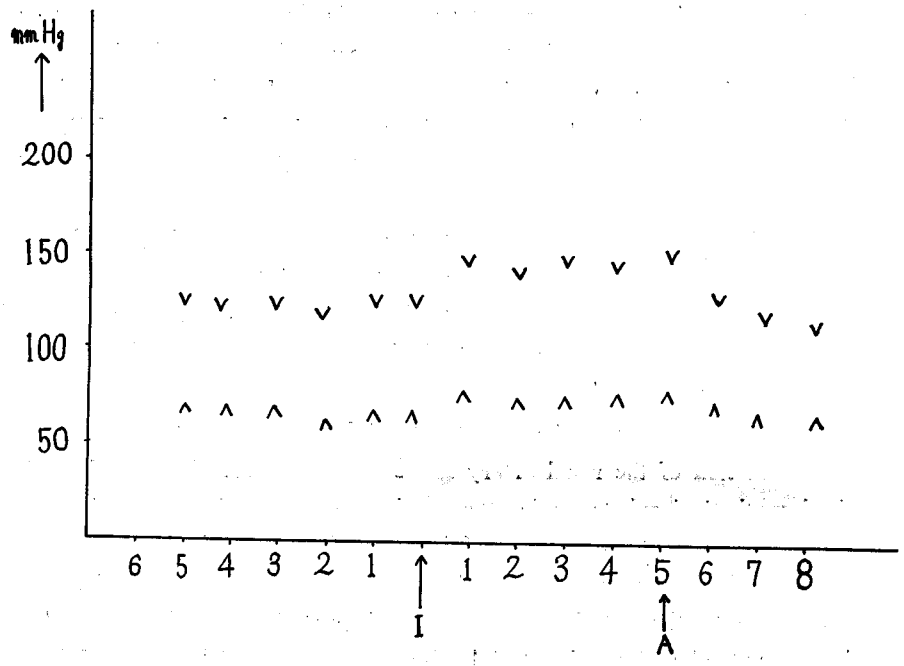

Fig. 10 Decrease of elevated blood pressure following successful portalization of the renal effluent bood was noted in the nephrotoxic nephritis.

occluded elevation of blood pressure did occur as soon as the nephritis was produced similar to the case when the anastomosis was not made (Fig. 9). It was very difficult to connect the renal vein to the portal vein successfully in dogs which weakened by the acute nephritis. Several dogs which were made hypertensive by acute nephritis were operated upon and only one could survive for a few days to show the fall of blood pressure (Fig. 10).

DISCUSSION

At the beginning of these experiments, we tried to anastomose the distal end of the left kidney to the proximal end of the splenic vein and were unsuccessful. Many dogs were lost in uremia due to the occulsion of the anastomosis.

After having these bitter experiences we used in turn the right kidney instead of the left and connected the distal end of the right renal vein to the portal trunk directly. During and after this procedure heparin was administered to prevent the thrombus formation. Thus, most of the dogs operated upon could survive and the experiment become possible.

There was another difficulty in completing the portalization of the renal venous

blood. On the renal surface there are many small, visible and invisible, venous shunts to the inferior vena cava. We made it a rule to dissect them completely by mean of isolating the kidney from the surrounding tissues except for the ureter. Whenever they were left intact they dilated to the surprising size in a few days following the operation probably due to the higher venous pressure in the portal vein than in the inferior vena cava. As soon as these venous shunts were developed enough, a large part of the blood from the kidney returned to the heart by way of the inferior vena cava, thus the venous blood flow through the anastomosis into the liver seemed to cease. Consequently, the anastomosis site seemed to be occluded by thrombus. Once the compensatory dilation of the venous shunts had occurred the animal could survive even if the anastomosis was occluded.

Levy and his colleagues in 1934 connected the left renal vein to the splenic vein prior to the constriction of the renal artery and studied the possible role of the liver in removing the hypothetical substance for the renal hypertension from the blood. They reported that the experiments were successful only in four out of eleven dogs and in all four dogs arterial blood pressure rose after produdtion of renal ischemia.

In our experiments, the initial establishment of portalization of the renal venous blood could prevent elevation of arterial blood pressure which would follow after constriction of the renal artery as well as after intravenous injection of the nephrotoxic serum. When the portalization was made after the blood pressure became high enough, dramatic fall in the blood pressure was ensued in both types of renal hypertension.

These results do not agree with that of Levy and his colleagues. The reason of this difference may be due to the different technique of portalization. The portalization technique employed them was rarely successful for us.

Maluf in 1956 attempted the portalization of the renal vein for the purpose of finding if this procedure would result in hypertension and of indicating an renal antipressor inactivated by the liver.

His result does not accord with ours too. It is assumed that his portalizing method was too complicated to be successful.

In normotensive dogs. no significant fluctuation in the blood pressure was noted after the portalization of the renal vein. The drop of the elevated blood pressure in the renal hypertension following the portalization was remarkable and the blood pressure returned to its control level. Occasionally it went down beyond the control level but never markedly. From these facts it may be considered that in normotensive dogs no significant amount of renin is released from the kidney.

The importance of the plasma angiotensinase in destroying angiotensin II in the body was emphasized by Sapirstein and his co-workers This, however, still lacks the conclusive evidence.

A decrease in plasma angiotensinase could result in the increased angiotensin II in the blood and the elevation of the blood pressure. Recent studies have failed to note the correlation between the decrease of plasma angiotensinase and the elevation the blood pressure in the hypertensive dog, although the marked fluctuation of this enzyme, far beyond the normal range, has been noted.

The destruction of angiotensin II in vivo still leaves much to be explained. In this question it ts most likely that liver plays the important role inactivating angiotensin II.

SUMMARY

The possible role of the liver in destroying angiotensin II in vivo studied in the left nephrectomized dogs by way of making the anastomosis between the right renal vein and the trunk of the portal vein. In some cases, the anastomosis was made before the hypertension was produced and in others after the marked elevation of blood pressure had been produced. To obtain the elevated blood pressure, two types of the experimental hypertension were produced, one was of Goldblatt type and the other of nephritis type.

In both types of the experimental hypertension; the elevated blood pressure was reduced to the control level by the connection of the renal vein to the portal system. When the anastomosis was made prior to the produdtion of hypertension there was hardly any significant elevation in the blood pressure after the constriction of the renal artery and still after the injection of nephrotoxic serum.

REFERENCES

1) H. GOLDBLATT, J. LYNCH, R. F. HANZAL, and W. W. SUMMERVILLE : J. of Exper. Med., 59: 346, 1934.
2) O. M. HELMER : Circulation, 25: 66, 1962,
3) L. A. SAPIRSTEIN, R. K. REED, and E. W. PAGE : J. of Exper. Med., 83: 425, 1946.
4) C. D. HARAKAL, D. A. COLLINS : Circulaton Research, 4: 612, 1956
5) S. E. LEVY, and A. BLALOCK : Surgery, 3: 899, 1938.
6) N. S. R. MALUF : A. J. of Physiol., 187: 466, 1956.
7) P. J. FOUTS, A. C. CORCORAN, and I. H. PAGE : A. J. of Med. Sciences, 201: 313, 1941.