Upsala J Med Sci 81: 109–111, 1976

Influence of Sympathetic Nerve Activity on Renal Haemodynamics and Release of Renin

A Preliminary Communication

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ABSTRACT

The role of the sympathetic nerve system is still unknown in different types of hypertension. The procedure used in the evaluation of suspect renovascular hypertension has been revised in such a way that renal blood flow, renal arterial blood pressure and plasma renin activity in renal vein could be determined prior to and after splanchnic blockade. A new device—videovolumeter—has been used to investigate the blood flow. Some preliminary data are given.

INTRODUCTION

The significance of the sympathetic nerve system in different types of hypertension is still obscure in many respects (5). It is known, however, that this nerve system is one of several mechanisms involved in the regulation of renin release (4, 9). Renin has attracted considerable interest in recent years in association with hypertension, not only the secondary but also the primary form (2), and consequently increasing research has been devoted to the role of the sympathetic nerve system in these conditions. As the kidney plays a central part not only with regard to renin but also concerning other, partly unknown, circulation-regulating substances, it would be of value to gain more knowledge on the effect of sympathetic impulses on the haemodynamics of the kidney and on renin release. In the autumn of 1975 an investigation on these problems was begun, with the use of partly new methods. A preliminary report of the initial results is presented in this paper.

MATERIAL

Six patients—4 men and 2 women—in the age range 36 to 63 years, with hypertension of suspected renal origin, have been investigated hitherto. The patients took no medication for at least 4 weeks prior to the investigation, and for the last week of these 4 they stayed in hospital. For 5 days prior to the investigation a low-sodium diet was given (*c.* 20 mmol Na^+ per day) and also 40 mg furosemide (Lasix®) daily. This is the routine procedure in our department in all investigations for suspected renovascular hypertension (7).

METHOD

For investigating the effect of splanchnic blockade on the renal haemodynamics and renin release, we chose to make an extra study of the right kidney in addition to the routine investigation of both kidneys aimed at revealing the presence of any significant renal arterial stenosis. The reason for this choice was that on the right side there is a greater distance between the kidney and the lung, which diminishes any possible influence of the lung on the ^{133}Xenon measurement of the renal blood flow.

A polyethylene catheter with an outer diameter of 18 gauche was inserted so that its tip lay at the level of the right anterior margin of the vertebral body L 1. This was done on the day before the investigation, so that the procedure should not affect the conduction capacity of the autonomous nerves and thereby the sympathetic flow to the kidney at the time of the investigation. The catheter was inserted under general anaesthesia, which was induced by 200–500 mg propanidid (Epontol®). On the morning of the investigation day a catheter was inserted into the femoral vein by the Seldinger technique and advanced further. Blood samples were taken from the inferior vena cava and the left and right renal veins for renin determination. This catheter was left *in situ* with its tip in the right renal vein for further sampling. A red Ödman catheter with end-holes and no side-holes was then introduced through the contralateral femoral artery, also by the Seldinger technique. The pressures in the aorta and right renal artery were then recorded via the latter catheter, using an EMT 34 pressure transducer (Siemens-Elema, Sweden). The renal blood flow was then measured by videodensitometry, with selective injection of

8 ml Angiografin® into the right renal artery under a pressure of 295 kPa. The results were analysed later by a videovolumeter (1). Selective arteriography was subsequently performed, with 12 ml Angiografin®, under a pressure of 295 kPa, and with an exposure frequency of three frames per s for 3 s, two frames per s for 2 s, one frame every other s for 6 s, or (in 2 cases) with cine-recording at 50 frames per s.

The renal blood flow was then determined by selective injection 0.3–0.4 mCi ^{133}Xe into the right renal artery via the same catheter as mentioned above, which had been left in an unchanged position. Recordings were made over the kidney with a NaI scintillation spectrometer. The detector, which had a crystal diameter of 5 cm, was fixed in a cylindrical collimator with the anterior surface of the crystal lying about 8 cm from the margin of the collimator. The collimator was placed as close to the patient's skin as possible. The detector was placed on the ventral side of the patient, and was centred over the kidney under fluorescent control.

The number of impulses that passed through the analyser was recorded in both analogue and digital form for subsequent analysis in a 2-compartment model. Further recordings of the blood pressure in the right renal artery were made, after which blood samples were again taken from the right renal vein for renin determination. With the patient in the same position, splanchnic blockade was induced with 40 ml of 0.25% plain bupivacaine (Marcaine®) injected into the polyethylene catheter inserted on the previous day. The arterial blood pressure was recorded 10 and 20 min after induction of the blockade, and the renal blood flow was again determined by the Xenon method. Blood samples were also taken for renin determination. The patient, the collimator and the polyethylene catheter were kept in the same position throughout the examination.

With the patient still in the same position, densitometry and angiography were repeated, after which the arterial blood pressure was recorded and blood samples were again taken from the right and left renal veins for renin determination. The investigation was completed with a left-sided renal angiography.

The plasma renin activity was determined by a modified radioimmunoassay method (8).

RESULTS

After the induction of splanchnic blockade the mean blood pressure in the renal artery decreased by 15 to 20% in all assessable patients. This blood pressure reduction is of the same order of magnitude as has been reported previously after splanchnic blockade in patients without cardiovascular disorders (9).

The total blood flow through the kidney, measured with ^{133}Xe, decreased in all patients.

Our preliminary results indicate that there is good correspondence between blood flows measured densitometrically and those calculated from the ^{133}Xe washout curve. Moreover, from the 3 patients for whom technically satisfactory curves were obtained by both methods of flow measurement, it seemed that flows measured from videodensitometric recordings over the areas in which the renal cortex dominates corresponded relatively well with the flows calculated from the most rapid component of the ^{133}Xe curve.

In 4 patients the blood flow through the renal cortex decreased after the blockade, while in one patient it increased. One patient was excluded from these results for technical reasons.

After the blockade the vascular resistance in the investigated kidney was reduced in 3 patients, unchanged in 2 and somewhat increased in one (this latter patient had a vasovagal reaction). In the patients with the highest mean arterial blood pressures the vascular resistance was reduced, while in those with more normal pressures it was less affected.

Despite the decrease in blood pressure and in the total renal blood flow, an increased release of renin was not noted in any of the patients.

DISCUSSION

Renovascular hypertension is still, more than 40 years after Goldblatt's important discoveries, difficult to understand in certain respects. By determination of the plasma renin activity (PRA) in the renal veins, significant stenosis of the renal arteries can be revealed. More problematical, however, is the question of how, with a normal peripheral PRA, stenosis can give rise to hypertension (6).

The mechanisms of renin release have been partly established, but we still have relatively little knowledge about the interactions between them and their individual contributions to the total events. How great, for example, is the role of the sympathetic nerve system in comparison with that of the baroreceptor mechanism? Further, it is possible that the answer to this question might not be the same for individuals with healthy kidneys as for those with disorders of the kidneys and renal arteries. One of the aims of the present investigation is to elucidate the role of the sympathetic nerve system in renal arterial stenosis. This is only a preliminary report and is intended mainly as a methodological description. Some observed tendencies are of interest, however, and deserve some discussion. Despite the fact that the autonomous

nerve blockade resulted in a reduced perfusion pressure in the kidney, PRA did not increase. The explanation for this must be that this blockade, which acts mainly upon the sympathetic nerves, eliminates the effect of a reduced renal arterial pressure. It is too soon to draw definite conclusions, as our investigation is only in its early stages. It would seem reasonable to propose, however, that the sympathetic nerve system plays a predominant role in the release of renin and perhaps overshadows the effect mediated by baroreceptors in afferent renal arterioles. No absolute conclusions can yet be drawn as to differences in the behaviour of the sympathetic nerve system in kidneys with normal arteries and those with arterial stenosis. Another interesting finding is the relative reduction in the cortical blood flow after the splanchnic blockade. Corresponding shunting, but in the other direction—from medulla to cortex—has been observed in dogs after stimulation of the renal nerves (3).

Finally, it must be mentioned that none of the patients suffered any noteworthy discomfort from the investigation, even though it was somewhat longer than the selective renal vein catheterization, including nephroangiography, usually undertaken in these patients with renal arterial stenosis. No complications occurred in connection with the investigation, which was approved by the Ethical Committee of the Faculty of Medicine.

REFERENCES

1. Björk, L., Erikson, U. & Hallström, A.: The videovolumeter. Upsala J Med Sci *79:* 148, 1974.
2. Brunner, H. R., et al.: Essential hypertension: renin and aldosterone, heart attack and stroke. N Engl J Med *286:* 441, 1972.
3. La Grange, R. G., Sloop, C. H. & Schmid, H. E.: Selective stimulation of renal nerves in the anesthetized dog. Circ Res *33:* 704, 1973.
4. Michelakis, A. M. & McAllister, R. G.: The effect of chronic adrenergic receptor blockade on plasma renin activity in man. J Clin Endocrinol Metab *34:* 386, 1972.
5. DeQuattro, V. & Miura, Y.: Neurogenic factors in human hypertension: Mechanism or myth? Am J Med *55:* 362, 1973.
6. Schambelan, M., Glickman, M., Stockigt, J. R. & Biglieri, E. G.: Selective renal-vein renin sampling in hypertensive patients with segmental renal stenosis. N Engl J Med *290:* 1153, 1974.
7. Strong, C. G., Hunt, J. C., Sheps, S. G., Tucker, R. M. & Bernatz, P. E.: Renal venous renin activity. Enhancement of sensitivity of lateralization by sodium depletion. Am J Cardiol *27:* 602, 1971.
8. Wide, L.: Personal communication.
9. Wiklund, L.: Postoperative hepatic blood flow and its relation to systemic circulation and blood gases during splanchnic blockade and fentanyl analgesia. Acta Anaesthesiol Scand (Suppl.) *58:* 5, 1975.
10. Winer, N., Chokshi, D. S., Yoon, M. S. & Freedman, A. D.: Adrenergic receptor mediation of renin secretion. J Clin Endocrinol Metab *29:* 1168, 1969.

Received January 29, 1976

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