Blood Flow Distribution in Anesthetized Normal and Spontaneously Hypertensive Rats

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Summary Using an electromagnetic flowmeter, regional blood flow was measured at the carotid, celiac, superior mesenteric, renal, and iliac arteries in normal Wistar rats and spontaneously hypertensive rats anesthetized with pentobarbital sodium. The sum of the mean values of the flow rate normalized per 100 g body weight for all the arteries was similar for both groups. About a half of the sum was drained through the superior mesenteric artery in both groups. The normalized flow rate was similar for both rat groups for each artery excepting the renal artery where the flow rate was significantly greater in the hypertensive rats.

Key Words: SHR, flow distribution, renal flow.

Regional blood flow and peripheral resistance were compared for several arteries between normal Wistar rats and spontaneously hypertensive rats (SHR, OKAMOTO and AOKI, 1963). Rats were anesthetized with pentobarbital sodium (50 mg/kg, i.p.) and fixed in the supine position. A polyethylene tube (Clay Adams 7410) was introduced into the right femoral artery for measurement of mean arterial pressure. The trachea was intubated to secure the airway for spontaneous breathing. The left common carotid artery was exposed, isolated from the surrounding tissues, and prepared for application of an electromagnetic flow probe. After midline laparotomy, the left iliac, left renal, superior mesenteric, and celiac arteries were likewise prepared for flow measurement. The preparation was made under a binocular microscope at a magnification of 40× to avoid damage to adjacent nerves.

Blood flow rate in the arteries was measured with a Nihon Kohden Model MFV-1100 electromagnetic flowmeter. A flow probe with an internal diameter of 1 mm was applied to the arteries, one by one, usually starting from the iliac artery and moving upwards. The use of the same probe for all the arteries is advantageous for making comparisons of flow rate among the different arteries.
Fig. 1. Simultaneous recording of arterial pressure and renal flow in a spontaneously hypertensive rat (SHR) and a normotensive control rat (NCR). Flow signals were smoothed to observe mean flow rate. At the center of each record, the renal artery was occluded for a few seconds to determine the zero flow level. Note that renal flow rate per body weight was larger in SHR. Pressure changes during and immediately after occlusion are changeable complex phenomena. The point is that the flow was in a steady state before occlusion.

Fig. 2. Regional blood flow (from bottom upward) and peripheral resistance (from top downward) in spontaneously hypertensive rats (SHR) and normotensive control rats (NCR). Numbers above the flow columns indicate the numbers of rats used to derive mean values. P's indicate the significance level of comparison between SHR and NCR by the group t-test. Mean arterial pressure±S.D. while renal flow was being measured was 179±20.5 (n=6) mmHg for SHR and 125±15.9 (n=7) mmHg for NCR. The rats weighed 309±16.8 g (SHR, n=7) and 344±63.7 g (NCR, n=9) and were 16.0±4.4 weeks (SHR) and 13.2±1.7 weeks of age (NCR).
The flow signals were smoothed to facilitate the reading of mean flow rate and were recorded simultaneously with arterial pressure. Each example of flow recording at the renal artery in a hypertensive and normal rat is presented in Fig. 1. The zero flow level was determined by occluding the artery immediately distal to the probe. The flowmeter was calibrated by passing a known amount of 0.9% saline through a rat common carotid artery with the probe attached around it. The flow rate in ml/min was normalized to 100 g of body weight. The peripheral resistance index was obtained by dividing mean arterial pressure by the above value. The mean values ± S.D. of the normalized flow and resistance are presented in Fig. 2 for regional as well as group comparison.

Under this experimental condition in pentobarbital anesthesia, by far the largest amount of blood was flowing in the superior mesenteric artery in both normal and hypertensive rats. On a comparison between the normal and hypertensive rats, the flow rate per body weight was similar in all the arteries tested except in the renal artery, where the flow was significantly greater in the hypertensive rats than in the normal ones. The peripheral resistance index was significantly greater in the hypertensive rats than in the normal ones in all the arteries excepting the renal.

The sum of the mean values of the normalized flow rate for all the arteries, where flow measurement was performed, was comparable for the normal and hypertensive rats (5.77 vs. 5.78 ml/(min·100 g)), which suggests that the cardiac index was similar for both groups. This is consistent with our previous results (IRIUCHIJIMA, 1973).

The reason why in the renal area alone vascular resistance was not elevated in the hypertensive rats is obscure. It cannot be ascribable to the selection of the usual Wistar rats as controls: the same result was obtained using Wistar Kyoto rats. In all the relevant literature, an elevation of renal vascular resistance which is not less than that in other regions has been reported, with the exception of one perfusion study (FOLKOW et al., 1971), in which a lower renal resistance in the spontaneously hypertensive rat than in the normotensive control rat was observed at maximal vasodilatation produced by papaverine.

REFERENCES

