Whole Body Venous Tone in Spontaneously Hypertensive Rats

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Mean circulatory filling pressure (MCFP) is determined by total blood volume (BV) and the sum of the arterial and venous compliances (Guyton). Since arterial compliance is quantitatively insignificant, measurements of MCFP and BV offer a means to assess the compliance of the entire venous system. And therefore MCFP reflects mostly venous tone at any given BV. We determined MCFP and BV to assess whole body venous tone in spontaneous hypertensive rats (SHR, Okamoto and Aoki rats).

Male SHR and Wistar Kyoto rats (WKY) were subjected to study at the ages of 4 and 5.5 mo. Rats were briefly anesthetized with ether, and were prepared with the femoral arterial, central venous, carotid arterial, and newly developed right atrial balloon catheters. After allowing the rat to recover from surgery and anesthesia for 3 hrs, we measured plasma volume with 125-I serum albumin and red cell volume with 51-Cr tagged red cells, thereby calculating BV. Then MCFP was measured by momentarily stopping the circulation with inflation of an indwelling right atrial balloon. During this procedure, central venous pressure increased to a high plateau, converging to MCFP. No reflexogenic venoconstriction interfered with this value if it was reached within 4-5 sec of inflation, and repeated measurements were made without appreciable side effects.

In 8 SHR and 8 WKY, aged 4 mo, mean arterial pressure was 173 ± 4 mm Hg and 119 ± 2 mm Hg (p<0.01). Despite no difference in BV between the groups (SHR, 60.9 ± 0.7 ml/kg vs WKY, 59.6 ± 0.8 ml/kg), MCFP was significantly increased in SHR than in WKY (9.5 ± 0.3 mm Hg vs 8.5 ± 0.2 mm Hg, p<0.02). This suggested that increased MCFP was brought about by decreased venous compliance due to increased venous tone.

In 5.5-month-old SHR and WKY (n=9, each), mean arterial pressure was 178 ± 5 mm Hg and 121 ± 3 mm Hg, respectively (p<0.01). With respect to SHR, significantly increased MCFP (9.4 ± 0.2 mm Hg against WKY, 8.5 ± 0.3 mm Hg) was associated with significantly increased BV (60.2 ± 0.6 ml/kg against WKY, 57.8 ± 0.9 ml/kg, p<0.05). Furthermore, percentage decreases in MCFP and MCFP/BV after autonomic blockade by hexamethonium (25 mg/kg) were not different between the groups. These findings indicated that increased MCFP was brought about by increased BV rather than increased venous tone in this age of SHR.

Thus, the present results suggested that a generalized constriction of the venous system prevailed in 4-month-old SHR, but did not in 5.5-month-old SHR. This appeared to be consistent with the notion that the sympathetic nervous system is activated in early phases of SHR hypertension, while it returns to normal in intermediate to advanced phases (Yamori or others). (All data are mean ± SE. This work was supported in part by NIH grants HL-20572 and HL-22261).