Plasma Renin Activity and Excretion of Water and Electrolytes in Stroke-prone SHR Rats

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The elevated levels of plasma renin activity (PRA) in stroke-prone SHR rats (SHRSP) at several months of age were reported by Matsunaga et al (Jap Circulat J 39: 1305, 1975) and Morita and Okamoto (Jap Heart J 18: 573, 1977). Matsunaga et al (Jap Circulat J 40: 889, 1976) divided SHRSP into 2 groups on the basis of water turnover: one had significantly higher water intake and urine volume than the other. In the present study, blood pressure (BP), PRA, water, and electrolytes excretion were determined in SHRSP and compared with those in stroke-resistant SHR rats (SHRSR) and Wistar-Kyoto rats (WKY).

Methods:
Male SHRSP, SHRSR, and WKY were used. Tail BP and heart rate were determined every 1 to 2 weeks. At age 5, 10, 20, and 30 weeks, parts of rats were cannulated into the abdominal aorta through which direct BP was determined and blood samples for PRA determination were obtained. The rats were killed and examined macroscopically for cerebral lesions (CL). PRA was determined by modification of the method of Carvalho et al (Am J Physiol 228: 369, 1975). At age 7, 14, 21, and 28 weeks, the rats were housed in metabolism cages and had free access to standard rat chow and water (Method 1). Volumes of water intake and urine collected for 24 hours were measured. Urine specimens were analyzed for osmolality, chloride, sodium, and potassium. At age 8, 15, 22, and 29 weeks, 50 ml/Kg of bicarbonate saline (110 mM NaCl, 30 mM NaHCO$_3$) was given to rats by a stomach tube (Method 2). The rats were placed in metabolism cages and urine was collected for 3 hours.

Results and Discussion:
BP: SHRSP and SHRSR had significantly higher BP than WKY through the whole experimental period (5-30 weeks). Until 14 weeks of age, no difference in BP between SHRSP and SHRSR was observed. However, from 16 to 30 weeks of age, the BP in SHRSP rose continuously and reached to 250 mmHg, while in SHRSR it remained less than 200 mmHg.

The incidences of CL in SHRSP at age 20 and 30 weeks were 3/11 and 6/11, respectively. The direct mean blood pressure in SHRSP with CL was higher by 10 mmHg than in those without CL.

PRA: At age 20 and 30 weeks, PRA was significantly higher in SHRSP than in SHRSR and WKY, while at age 5 weeks, PRA in SHRSP was somewhat lower than those in SHRSR and WKY. These data confirmed the results reported previously by Matsunaga et al (1975) and Morita and Okamoto (1977). SHRSP with CL had significantly higher PRA than those without CL.

Water and electrolyte excretion: (Method 1) Water intake and excretion in
SHRSP at age 21 and 28 weeks were greater than those in SHRSR and WKY, and increased sodium excretion in SHRSP at age 7 and 28 weeks was observed. At age 7 and 14 weeks, water intake and excretion of water and sodium in SHRSR were greater than in WKY. Water intake and excretion were greater in SHRSP with CL than in those without CL. Similar results have been reported by Matsunaga et al (1976).

(Method 2) At age 8 weeks, excretion of water and sodium in SHRSP and SHRSR were almost twice as much as those in WKY. At age 15 and 22 weeks, SHRSP showed higher water excretion than SHRSR and WKY. At age 29 weeks, SHRSP had slightly increased water and sodium excretion. The exaggerated natriuresis observed after saline load in SHRSP and SHRSR at age 8 week confirms the results in SHR reported by Willis et al (J Lab Clin Med 87: 265, 1976).

These data suggest that at age 20 to 30 weeks, SHRSP is in the course of malignant hypertension similar to renal hypertensive rats reported by Möhring et al (Am J Physiol 228:1847, 1975): increased water and sodium excretion due to high blood pressure induce a reduction in plasma volume, thereby increasing the release of renin, which in turn may maintain or further raise blood pressure.