81) Brain metabolism under bilateral arteries ligation of stroke-prone spontaneously hypertensive rats studied with ^{31}P -NMR.
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A unique model, the stroke-prone spontaneously hypertensive rats (SHRSP) have slightly higher blood pressure and a much higher incidence of death by hemorrhagic or thrombotic stroke. McCully et al. reported SHRSP have the impaired skeletal muscle response to exercise as measured with ^{31}P -NMR (Abs. Society of Magnetic Resonance: Aug. 1986). The purpose of this experiment was to see if the disposition to cerebrovascular diseases in SHRSP could be detected before the development of stroke by detecting such impaired brain metabolism as observed in the muscle with ^{31}P -NMR.

MATERIALS AND METHODS

Three-month-old SHRSP and Wistar-Kyoto rats (WKY) were anesthetized with Pentobarbital Sodium (50mg/kg, i.p.). Both carotid arteries were exposed through an incision of the frontal neck and the skull was surgically exposed through a parietal incision for the placement of the coil. ^{31}P -NMR spectra from the brain were obtained using a 14cm bore 4.7 Tesla magnet. Spectra were collected at 2-seconds intervals and 5-minutes accumulations were averaged. Firstly, ^{31}P -NMR spectra were measured before bilateral carotid arteries ligation (BLCL), and then after BLCL the changes of the spectra were observed every 5 minutes till 70 minutes. The peak of creatine phosphate (CP) was assigned a chemical shift of zero. Tissue levels of ATP, CP and inorganic phosphate (Pi) were estimated by integrating areas under individual peaks. The intracellular pH was estimated from the chemical shift (δ_0) of Pi peak by the following equation (Flaherty J.T. et al.: CIRCULATION: 561, 1982): $\text{pH} = 6.90 - \log \{(\delta_0 - 5.85) / (3.29 - \delta_0)\}$.

RESULTS

After BLCL, Pi increased gradually and CP decreased slightly both in SHRSP and WKY. But the degree of these changes, especially in Pi was significantly greater in SHRSP than in WKY. As the results of these changes, the Pi/CP value increased to 175.89% (mean $\pm$ SD, n=4) of the value before BLCL in WKY at 55 minutes after BLCL and markedly increased to as much as 668 $\pm$ 363%, in SHRSP (n=5). At the same time brain pH decreased significantly in SHRSP (87.3 $\pm$ 2.0%) compared with that in WKY (96.4 $\pm$ 2.8%).

Table Changes in inorganic phosphate (Pi) / creatine phosphate (CP) and pH after bilateral carotid artery ligation (BLCL)

		15 - 20	25 - 30	35 - 40	45 - 50	55 - 60(min)
Pi/CP	SP	257 $\pm$ 172	491 $\pm$ 386	559 $\pm$ 453	650 $\pm$ 411	669 $\pm$ 361*
	WKY	129 $\pm$ 22	168 $\pm$ 41	169 $\pm$ 44	161 $\pm$ 65	175 $\pm$ 87
pH	SP	93.5 $\pm$ 7.4	93.5 $\pm$ 5.5	86.1 $\pm$ 6.7*	87.8 $\pm$ 3.4*	87.6 $\pm$ 2.0**
	WKY	98.4 $\pm$ 1.9	96.5 $\pm$ 3.8	97.1 $\pm$ 2.8	95.2 $\pm$ 4.4	96.4 $\pm$ 2.8

The values of Pi/CP expressed as percent of pre-BLCL. Each point represents the mean $\pm$ SD. * and ** show significant difference compared with WKY at $P < 0.05$ and $P < 0.01$, respectively.

DISCUSSION

These results suggest that the brain of SHRSP is more vulnerable to hypoxia or ischemia. Yamori et al. reported regional cerebral blood flow (rCBF) decreased in SHRSP before the development of stroke (STROKE 8: 456, 1977). In addition to such a decrease in rCBF, the vulnerability to hypoxia or ischemia in the brain first demonstrated in this study may be the cause of stroke-proneness of SHRSP.