rCBFand the rCMRglucose in experimental hydrocephalus measured by the double tracer method of autoradiography

著者	Sato S., Shirane R., Yoshimoto T.
journal or publication title	CYRIC annual report
volume	1992
page range	160-164
year	1992
URL	http://hdl.handle.net/10097/49719

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Introduction

There have been many reports regarding regional cerebral blood flow (rCBF) and the regional cerebral metabolic rate of glucose (rCMRglu) in the hydrocephalic rat[1,2,3], but only a few reports have referred to the relationship between rCBF and the rCMRglu. The authors studied this relationship in kaolin induced experimental hydrocephalic rats using the double tracer method of autoradiography.

Material and method

Five-week-old male Wister rats (body weight 100-120g) were used for this study. Kaolin (hydated aluminum silicate, Al2Sio4) induced hydrocephalus was induced using the techunique of Yamaki[4]. Rats were anesthetized with an intraperitoneal injection of pentobarbital sodium (30mg/ kg). A kaolin saline suspension (250mg/ ml) was administered into the cisterna magna per the atlanto-occipital membrane. The injected volume was 0.2 ml for each rat. Some rats were injected only saline as a control group. The rCBF and rCMRglu were measured during the acute phase, one to two weeks after the injection of kaolin and during the chronic phase, four to six weeks after the injection. The measurments of rCBF and rCMRglu were performed using the double tracer method of Kameyama[5].

Rats were anesthetized with pentobarbital sodium (30mg / kg). Sequential arterial blood samples were taken from the femoral artery following the administration of an ^{18}F-fluorodeoxyglucose saline solution (20-40mCi/kg). After 44 min., 4-Iodo-(N-methyl-^{14}C)-Antipyrine (Amersham, CFA.592) (100uCi/kg), ^{14}C-IAP, was injected from the femoral veins and sequential arterial blood samples were taken from the femoral artery again. The rats were decapitated at 45 seconds after the administration of ^{14}C-IAP. Frozen brains were cut into 20 um thick sections in a cryostat. The sections were then exposed to KODAK NMC-1 film twice, first, for six hours to obtain the image of ^{18}F and then seven days later for 7 days to obtain the image of ^{14}C. The regional cerebral metabolic rates of glucose were calculated

from the optical density of the autoradiogram and blood sampling data. The applied value of lumped constant was 0.7243). Then rCBF was calculated using the method of Sakurada[6].

The rCBF and rCMRglu data were assessed as to percent changes in comparison with the control group. They were calculated using the following formulas:

% changes in rCBF = [(rCBF hydr.)-(rCBF cont.)] x 100/(rCBF cont.)
% changes in rCMRglu. = [(rCMRglu.hydr.) (rCMRglu.cont.)] x 100/(rCMRglu.cont.).

"Hydr." means hydrocephalus and "cont." means the control group.

Results

During the acute phase, the rCBF values in the hydrocephalus were reduced nearly the whole cerebrum compared to those of the control group. The reduction in rCBF was marked in paraventricular regions, especially in caudate putamen, corpus collosum, septal nucleus, and pons. This reduction was more apparent during the chronic phase than during the acute phase (Fig. 1).

On the other hand, there seems to be a tendency for the rCMRglu to decrease during the chronic and/or severe stages of hydrocephalus according to reduction of rCBF. However, the regions in which reduction of rCBF was observed during the acute phases did not always show a reduction in the rCMRglu. The value of rCMRglu increased in 13 out of 20 regions, and was stationary in 3 out of 20 regions, though the rCBF decreased (Fig. 2).

Discussion

Measurment of the rCMRglu using ^{18}FDG autoradiography is an established method. The lumped constant used for our study which was calculated for rats receiving general anesthesia with pentobarbital sodium, was 0.724[3]. ^{18}F has a short physiological half time ,$T_{1/2}$ = 110 min. The^{14}C, on the other hand, has a long half time, 5730 years. Therefore, the influence of ^{18}F on the total radioactivity of brain slices is negligible days after injection. For this reason, a combination of ^{14}C-IAP and ^{18}F-FDG is suitable for quantitative measurements of the rCBF and rCMRglu by autoradiography[5].

In this study, the rCBF values decreased in accordance with the aggravation of hydrocephalus. This result is compatible with previous reports. The decrease was most striking in the paraventricular regions. The change in the rCMRglu , however, was not consistent with the course of hydrocephalus. The rCMRglu decreased in some regions and some were increased in others in the acute phase of hydrocephalus. About the changes in glucose metabolism in experimental hydrocephalus, many authors reported that a glucose metabolism was stationary or decreased[1,2,3]. There is no reports that mentioned an increase in glucose metabolism in the acute and /or mild stages of hydrocephalus. The CBF-CMRglucose uncoupling like our result is also observed during "misery-perfusion" in

ischemic stroke subjects. And it is thought this uncoupling is a result of activation of anaerobic glycolysis. In hydrocephalus, it is thought that a decrease of perfusion pressure due to intracranial hypertension may be cause a decrease in rCBF. Therefore it may be possible to say that this uncoupling during the acute phase of hydrocephalus reveals being in "misery -perfusion" state. During the chronic phase of hydrocephalus, however, rCMRglu decreased in accordance with the rCBF that decreased more than in the acute phase. Cerebral tissues seem to get glucose enough if cerebral blood flow decrease to 50 % of its normal value, so that cerebral blood flow usually supplies cerebral tissues with glucose several times as large as their demands[8]. On the other hand histological examinations revealed cortical damages in the chronic phase of hydrocephalus. Moreover perfusion pressure increased in the chronic phase than the acute phase of hydrocephalus. Taking account of above mentioned facts, we conclude that decreases in rCBF and the rCMRglu during the chronic phase of hydrocephalus are due to irreversible neuronal damages in contrast to its acute phase. And It seems that measurement of rCBF and rCMRglu is useful in evaluating neuronal damage in hydrocephalus.

References

1) Higashi K. et al., Neurological Research **8** (1986)169.
2) Richards H. K., Pickard J. D., and Punt J., Z. Kinderchir **40**, suppl.1(1985)9.
3) Wako N., Brain & Nerve **35**(1983)693.
4) Yamaki T. et al., Neurosurgery **5**(1977)537.
5) Kameyama M. et al., J. Cerebral Blood Flow Metabol **3** suppl.1(1983)s109.
6) Sakurada O. et al., Am. J. Physiol **234**(1978)H59.
7) Kameyama M. et al., J. Cereb Blood Flow Metabol **5** suppl 1(1985) s667.
8) Cremer J. E., Cunningham V.J., Seville M.P. Cereb Blood Flow Metabol **3** (1993) 291.

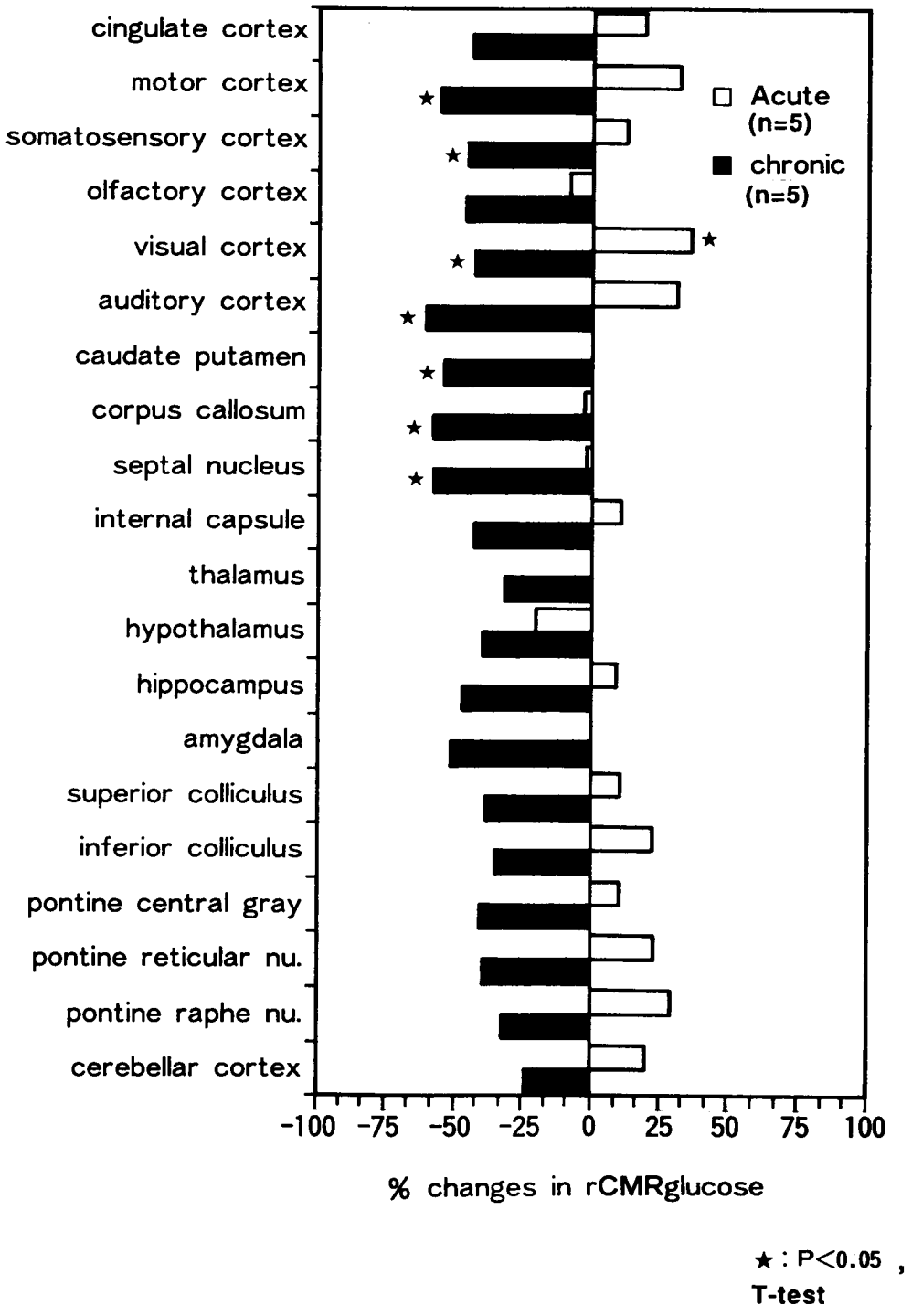

Fig. 1. % changes in rCBF (*: p<0.05, T-test)

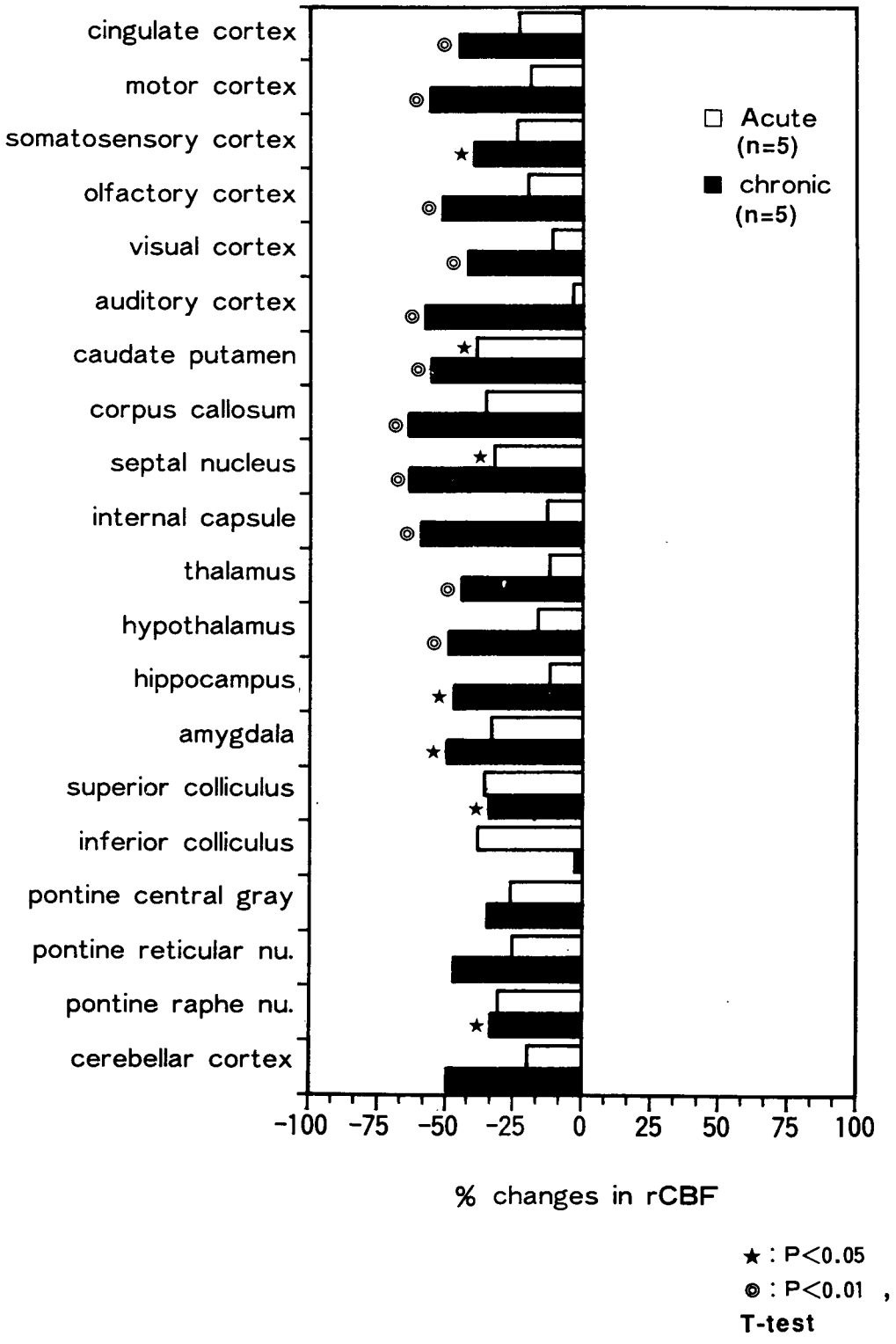

Fig. 2. % changes in rCMRglucose (*: p<0.05, #<0.01, T-test).