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Evaluation of a Supratentorial Effect Remote from Brainstem or Cerebellar Lesion

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Abstract An effect remote from supratentorial lesions to the cerebellum, the so-called crossed cerebellar diaschisis, has been widely reported. We used a single photon emission computed tomography to study supratentorial cerebral blood flow and search for the presence of any supratentorial remote effect from brainstem or cerebellar lesion. In patients with cerebellar lesion, a sufficient increase of asymmetry index was seen in the cerebral cortex and thalamus. There was an especially significant correlation between the cerebellum and the thalamus in the grade of asymmetry index. The patients with brainstem lesion revealed no significant changes in asymmetry and cerebellar index. But, quantitative data by a single photon emission computed tomography showed a symmetrical mild low cerebral blood flow. Our present findings demonstrated a supratentorial effect remote from cerebellar and brainstem lesion, and furthermore suggested that the thalamic pathway was closely related to the mechanism of this supratentorial remote effect.

Key Words : Remote effect, Brainstem, Cerebellum, Single photon emmission computed tomography

Introduction

A transient reduction of cerebellar blood flow from the primary supratentorial lesion is been well known in patients with various diseases[1] and also in animals[2,3]. Metabolic depression distant from this lesion has also been found by positron emission computed tomography (PET)[4,5]. However, the presence of a supratentorial effect remote from the posterior fossa lesion has been controversial. Therefore, we used single photon emission computed tomography (SPECT) to study supratentorial cerebral blood flow(CBF) and search presence of any supratentorial remote effect in the patient with brainstem or cerebellar lesion.

Material and Methods

The relative distribution of CBF was measured in 18 normal volunteers with a mean age of 39.4 years and 25 patients hospitalized between September 1988 and November 1990 with lesion of the posterior fossa. The patients were divided into two groups. One was a cerebellar hemispheric lesion group including 6 patients with cerebellar homorrhage, 5 with cerebellar infarction, 2 with cerebellar tumor, and 3 with cerebellopontine tumor. The other was a brainstem

lesion group including 4 patients with brainstem hemorrhage, 1 with brainstem infarction and 2 with brainstem tumor. All were confirmed by CT to have a primary lesion only in the posterior fossa. The patients comprised 22 men and 3 women with a mean age of 57.4 years. CBF measurement was started by rotated SPECT (Tohshiba GCA-901A) 20 min after intravenous injection of 3 mCi [123-I] iodoamphetamine (IMP). Regions of interest (ROI) on the CBF image were located in the cerebral cortex (anterior cerebral artery: ACA, middle cerebral artery: MCA and posterior cerebral artery: PCA territory), basal ganglia, and cerebellar hemisphere (Fig.1). The asymmetry and cerebellar index of the RI count in the ROI were calculated in 25 patients.

$$\text{Asymmetry index} = \frac{|\text{Rt ROI count} - \text{Lt ROI count}| \times 100}{(\text{Rt ROI count} + \text{Lt ROI count})/2} \ \%$$

$$\text{Cerebellar index} = \frac{\text{ROI count} \times 100}{\text{mean cerebellar ROI count}} \ \%$$

Statistical analysis was performed using student t-test.

Results

1) In the normal group, the mean assymmetry index was 4.4±2.1 (mean±SD)% in the ACA area, 2.6±1.8% in the MCA, 4.2±2.4% in the PCA, 5.0±1.0% in the basal ganglia, 4.6±3.1% in the thalamus and 4.5±2.4% in the cerebellum.

2) In patients with cerebellar lesion, the mean asymmetry index was 9.7±7.1% in the ACA area, 9.9±7.7% in the MCA, 8.7±4.7% in the PCA, 6.8±6.4% in the basal ganglia, 9.0±5.8% in the thalamus and 26.6±12.2% in the cerebellum. A sufficient increase of asymmetry index was seen in the cerebral cortex and thalamus in the cerebellar lesion group (Fig.2,3). There was an especially significant correlation ($R = 0.711379$, $0.02 < p < 0.05$) between the control and the thalamus in the grade of asymmetry index (Fig.4).

3) In the patients with brainstem lesion, the mean asymmetry index was 5.9±6.0% in the ACA area, 8.0±3.6%in the MCA, 6.8±3.1% in the PCA, 8.1±5.2% in the basal ganglia, 3.9±2.1% in the thalamus and 5.0±4.8% in the cerebellum. There was no significant change in the asymmetry index in this group (Fig.5,6). Mean cerebellar index in the normal group was 106.5±11.4 (mean±SD)% in the ACA area, 106.1±8.3% in the MCA, 112.4±7.5% in the PCA, 100.9±6.3% in the basal ganglia and 96.9±7.5% in the thalamus. In the patients with brainstem lesion, the mean cerebellar index was 101.3±11.4% in the ACA area, 97.3±13.2% in the MCA, 111.6±11.7% in the PCA, 91.9±13.1% in the basal ganglia and 86.6±13.3% in the thalamus. The patients with brainstem lesion revealed no significant changes in supratentorial asymmetry and cerebellar index (Fig.7).

Case 1

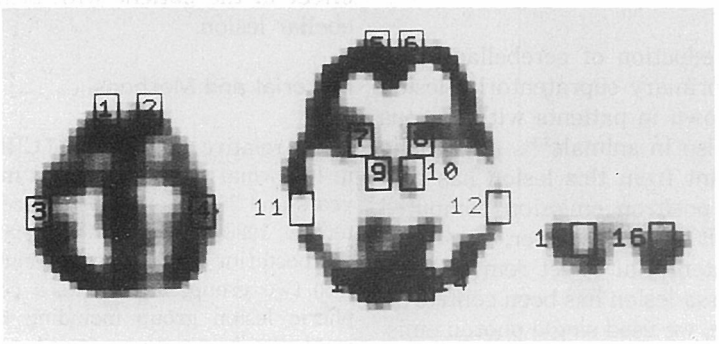

Fig.1 Regions of interest in ACA, MCA, PCA, territory, basal ganglia, thalamus and cerebellum as used for analysis of IMP SPECT

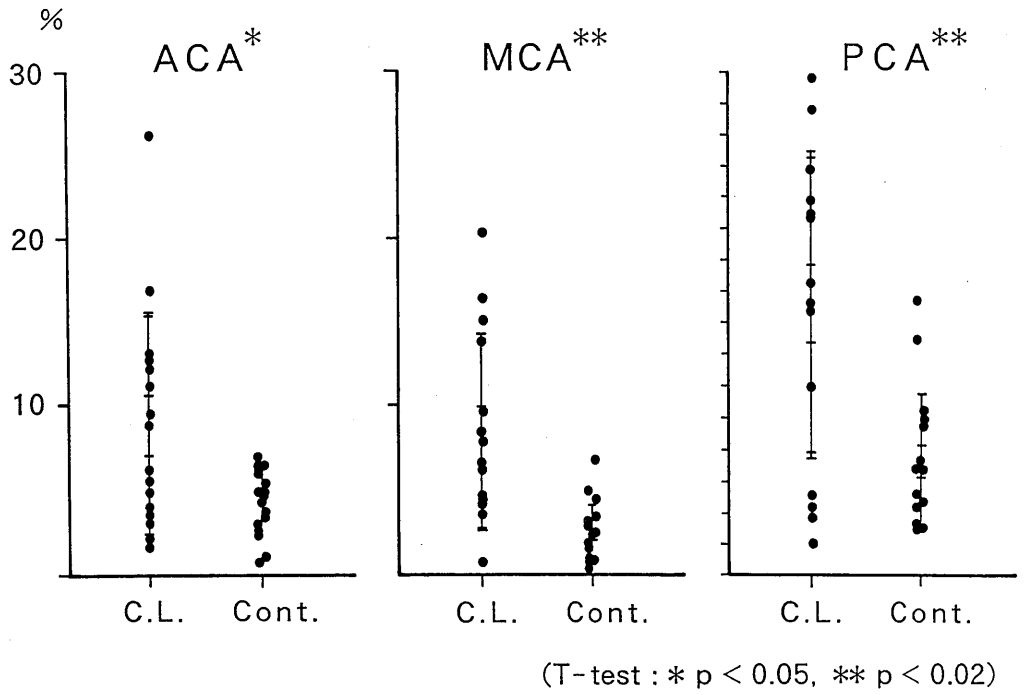

Fig. 2 Asymmetry index between control and cerebellar lesion group shows significant differences in ACA, MCA and PCA territory. (C.L.: Cerebellar lesion group, Cont.: control group: t-test *=p<0.05, **p<0.02)

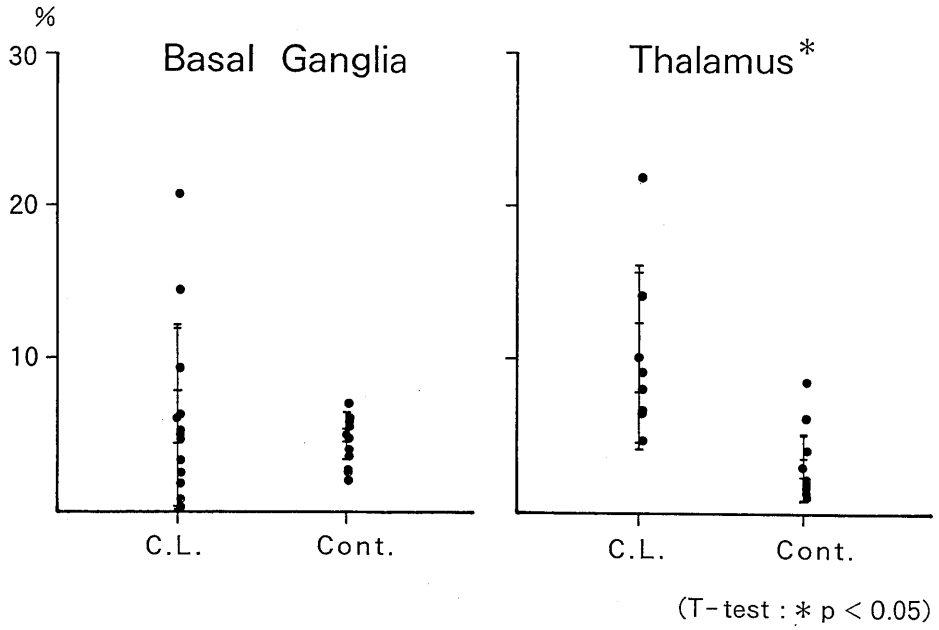

Fig. 3 Asymmetry index between control and cerebellar lesion group shows significant difference in thalamus, but no difference in basal ganglia. (C.L.: Cerebellar lesion group, Cont.: control group: t-test *=p<0.05)

A 75-year-old male suffered occipital headache of sudden onset, dizziness, slurring of speech and several episodes of vomiting on September 10, 1990. CT scan revealed left cerebellar hemorrhage and a normal supratentorial appearance. Within a few weeks, neurological symptoms gradually disappeared with conservative therapy. Cerebral and cerebellar blood flow was measured using IMP-SPECT 4 weeks after onset. A reduced IMP uptake was observed in the affected cerebellar hemisphere and unaffected supratentorial tissue, with the most marked reduction in the frontal region (Fig. 8).

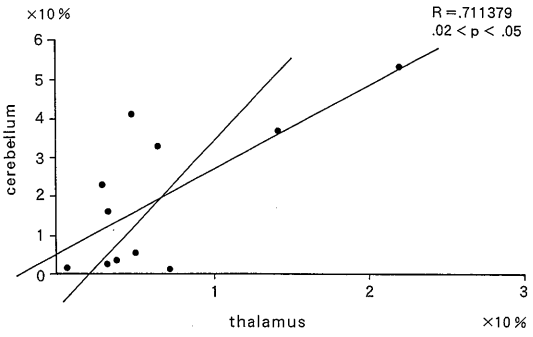

Fig. 4 There is a significant correlation between thalamus and cerebellum in the grade of asymmetry index and 90% confidence limits for slope of correlation. (R=0.711379, 0.02p<0.05)

Case 2

A 51-year-old female gradually noticed mild disturbance of visual acutity and double vision. CT scan showed a normal appearance. MRI showed a solitary low intensity ring lesion in the brainstem by T1-weighted imaging and a high-intensity lesion by T2 imaging. Regional cerebral blood flow was calculated using IMP-SPECT with arterial bloos sampling. CBF was 55ml/100g/min in the Rt ACA, 52 in the Lt ACA, 40 in the Rt MCA, 39 in the Lt MCA, 49 in the Rt and Lt PCA, 41 in the Rt cerebellum, and 42 in the Lt cerebellum. The CBF image showed no asymmetricla lesion, but CBF data suggested a slightly diffuse decreased flow in the supra - and infratentorial tissue (Fig.9). After

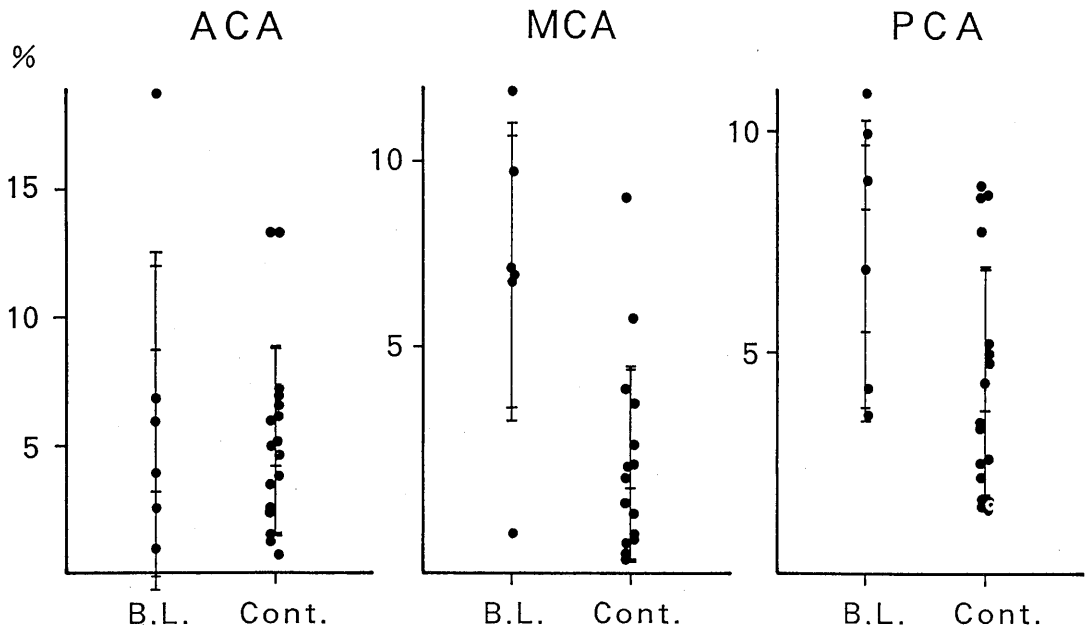

Fig. 5 Assymetry index between control and brainstem lesioin group shows no significant differences in ACA, MCA and PCA territory. (B.L.: Brainstem lesion group, Cont.: control group)

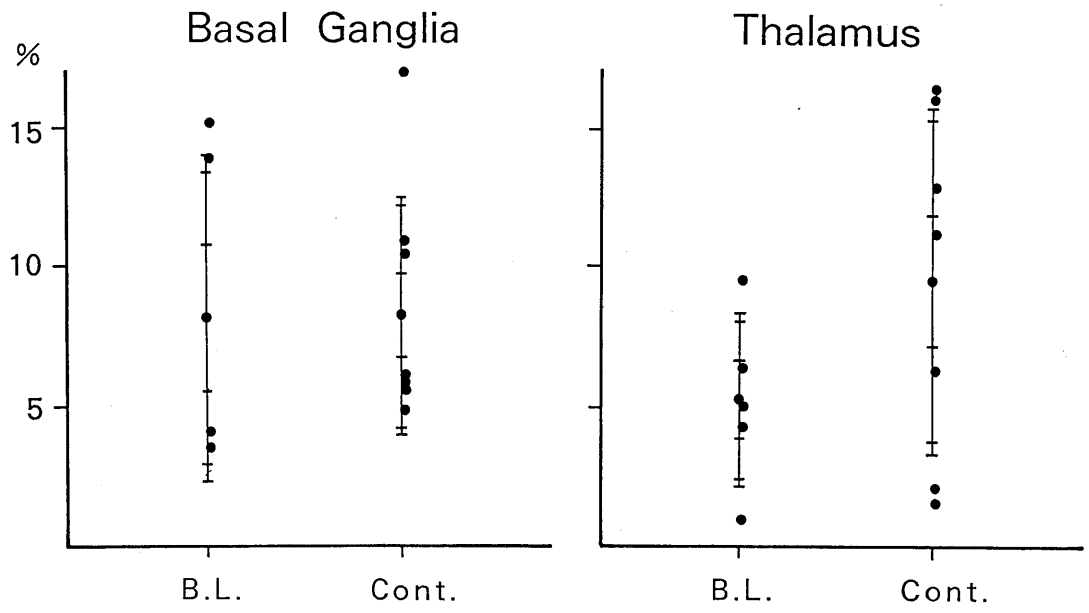

Fig.6 Asymmetry index between control and brainstem lesion group shows no significant differences in thalamus and basal ganglia. (B.L.: Brainstem lesion group, Cont.: control group)

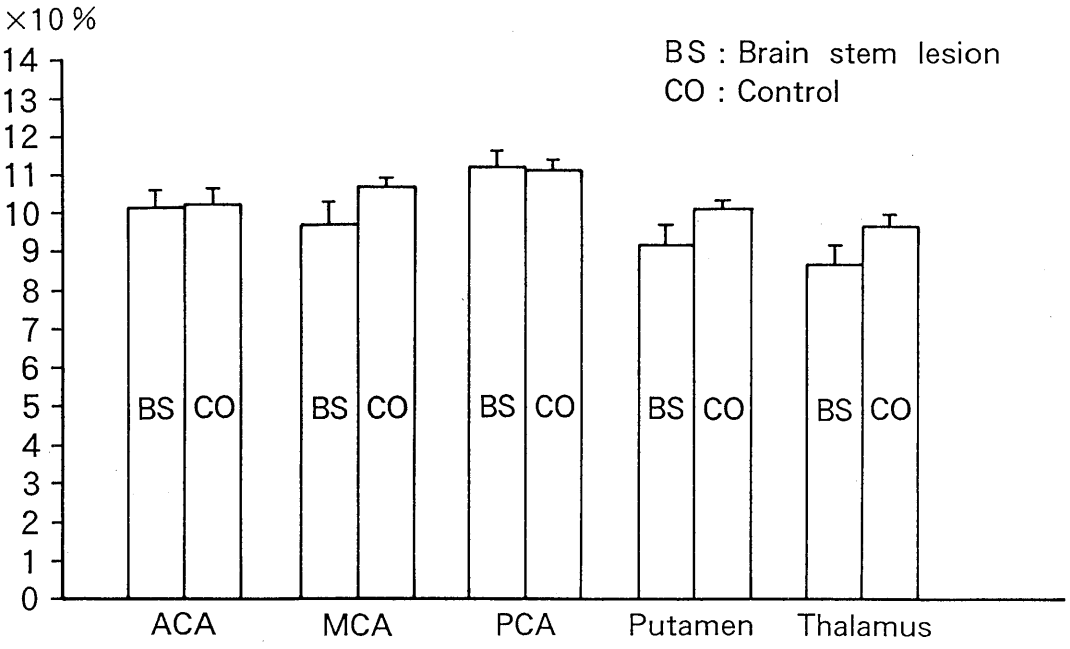

Fig.7 Cerebellar index between control and brainstem lesion group shows no significant differences in ACA, MCA, PCA territory, thalamus, basal ganglia and cerebellum.

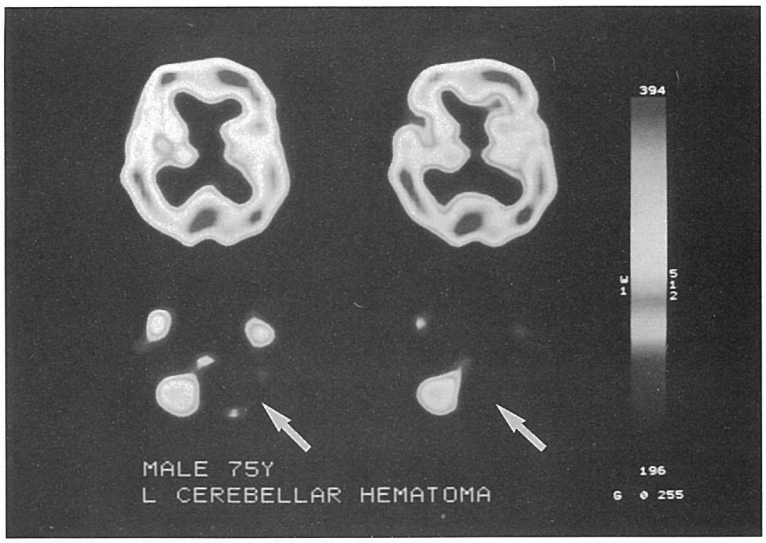

Fig.8 IMP-SPECT image of left cerebellar hemorrhange in case 1 shows no uptake in left cerebellum (arrows) and a slightly reduced uptake in right cerebrum compared to left side.

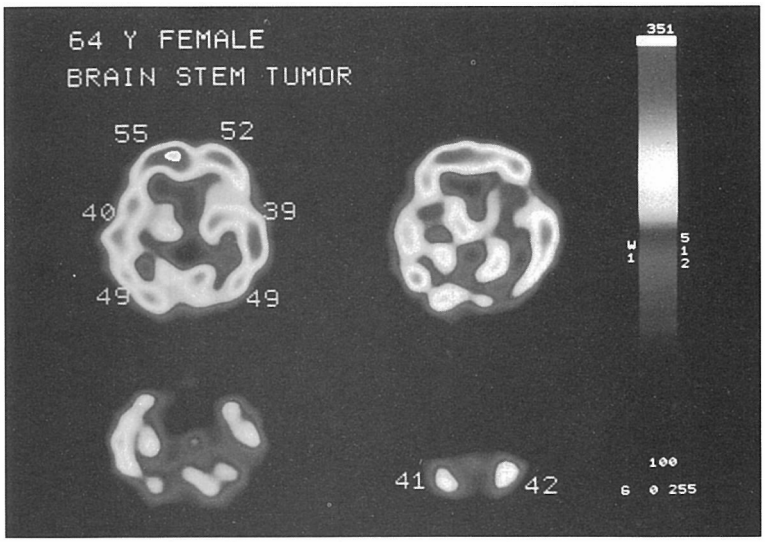

Fig.9 IMP-SPECT of brainstem tumor in case 2 revealed no uptake in brainstem and almost symmetrical pattern in supratentorial tissue.

admission, whole-body CT scan and systemic RI scintigraphy demonstrated pulmonary cancer and a solitary metastasis in the brain.

Discussion

An effect remote from supratentorial

lesions to the cerebellum, so-called crossed cerebellar diaschisis, has been widely reported. This phenomenon is probably caused by neuronal deactivation of the cortico-ponto-cerebellar pathway[4]. However, there are only a few reports[6,7,8] of reduced supratentorial blood flow primary cerebellar or brainstem lesion, and the presence of such a phenomenon has been controversial. Our present findings clearly demonstrated a supratentorial effect remote from cerebellar lesion, and furthermore suggested that the thalamic pathway was closely related to the mechanism of this supratentorial remote effect. On the other hand, the characteristic pattern of brainstem lesion may be a symmetrical mild low cerebral blood flow. There are several reasons why a supratentorial effect remote from the posterior fossa lesion can not to be found by usual examination. One may be the smaller number of efferent nerve fibers from the cerebellum compared with afferent fibers to it. Therefore, damage to the cerebellum produces only small changes in supratentorial tissue[8]. Secondly, almost all cases of posterior fossa lesion are accompanined by brainstem damage, either severe or mild. There are many vital centers in the brainstem which can modify the circulatory and metabolic sysmtem. Damage to the brainstem diffusely influences neuronal activity in the cerebrum and thus masks the supratentorial asymmetry. In summary, the present clinical data might explain the presence of a supratentorial effect remote from brainstem and cerebellar lesion by the transneural pathways.

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