

Crossed Cerebellar Hyperperfusion in Symptomatic Epilepsy

—Two Case Reports—

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Abstract

A 74-year-old female with cerebral infarction and a 78-year-old female with cerebral glioblastoma suffered complex partial seizure. Ictal perfusion single photon emission computed tomography in these patients showed the interesting phenomenon of 'crossed cerebellar hyperperfusion,' a reversed crossed cerebellar diaschisis. The mechanism is probably spread of electrical seizure through efferent projections, and may be related to the cerebellar atrophy seen in patients with long-standing partial epilepsy.

Key words: epilepsy, single photon emission computed tomography, cerebellar hyperperfusion

Introduction

Single photon emission computed tomography (SPECT) has been used to confirm the localization of epileptic foci for the surgical treatment of medically intractable complex partial seizure. In general, ictal SPECT shows hyperperfusion and interictal SPECT shows hypoperfusion in the epileptic focus.^{5,8,13,14,20)}

Here we report the interesting observation of 'crossed cerebellar hyperperfusion,' a reversed phenomenon of crossed cerebellar diaschisis, in two patients undergoing ictal SPECT for symptomatic epilepsy.

Case Reports

Case 1: A 74-year-old female with 8-month history of cerebral infarction was followed up at our out-patient clinic for medically intractable complex partial seizure. She was transported to our hospital by ambulance because of convulsive seizure. On admission she had motor seizure in the right face, arm, and leg with clouding of consciousness. Diazepam was administered intravenously to control the seizure. 740 MBq of technetium-99m-labeled hexamethylpropyleneamine oxime (^{99m}Tc-HMPAO) was simultaneously injected during the seizure. Im-

mediately after the seizure ceased, brain perfusion SPECT imaging was performed to obtain the ictal image. The ictal perfusion SPECT image was compared with the magnetic resonance (MR) image and the interictal perfusion SPECT image obtained 2 weeks later.

The T₂-weighted MR image showed a large, old cerebral infarction in the left middle cerebral artery territory (Fig. 1 upper row). The interictal ^{99m}Tc-HMPAO SPECT image showed hypoperfusion in the lesion area and the contralateral cerebellar hemisphere (crossed cerebellar diaschisis) (Fig. 1 middle row). The ictal ^{99m}Tc-HMPAO SPECT showed significant hyperperfusion in the frontal cortex and basal ganglia adjacent to the lesion. The hyperperfused area seemed to indicate the epileptic focus. Furthermore, significant hyperperfusion was detected in the contralateral cerebellar hemisphere (crossed cerebellar hyperperfusion). However, the lesion area was still hypoperfused (Fig. 1 lower row).

Case 2: A 78-year-old female was followed up at our out-patient clinic after receiving operation, irradiation, and chemotherapy for cerebral glioblastoma about 4 months previously. She was transported to our hospital by ambulance because of convulsive seizure. On admission she had motor seizure in the left face and arm with clouding of consciousness.

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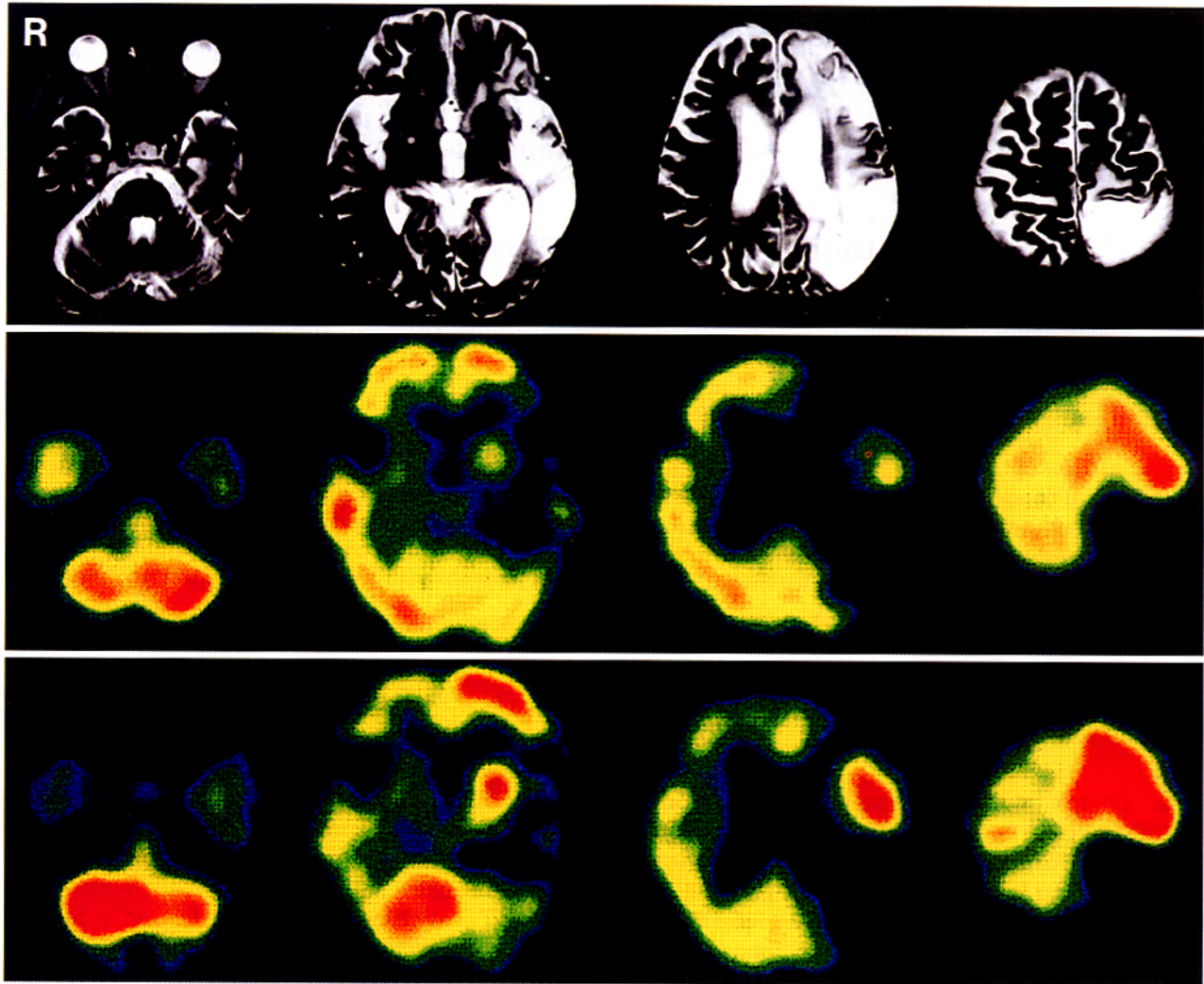


Fig. 1 Case 1. upper row: T₂-weighted magnetic resonance images showing a large cerebral infarction in the left middle cerebral artery territory. middle row: Interictal technetium-99m-labeled hexamethylpropyleneamine oxime (^{99m}Tc-HMPAO) single photon emission computed tomography (SPECT) images showing crossed cerebellar diaschisis. lower row: Ictal ^{99m}Tc-HMPAO SPECT images showing crossed cerebellar hyperperfusion.

Diazepam was administered intravenously to control the seizure. 740 MBq of technetium-99m-labeled ethyl cysteinate dimer (^{99m}Tc-ECD) was simultaneously injected during seizure. Immediately after the seizure ceased, brain perfusion SPECT imaging was performed to obtain the ictal image. The ictal perfusion SPECT image was compared with the MR image and the interictal perfusion SPECT image obtained 2 months before.

The T₁-weighted MR image with gadolinium showed subtotally resected tumor scar in the right frontal lobe (Fig. 2 upper row). The interictal iodine-123-labeled isopropyl iodoamphetamine SPECT image showed hypoperfusion in the lesion

area and the contralateral cerebellar hemisphere (crossed cerebellar diaschisis) (Fig. 2 middle row). The ictal ^{99m}Tc-ECD SPECT showed a significantly hyperperfused area indicating the epileptic focus in the frontal cortex adjacent to the lesion. Furthermore, significant hyperperfusion in the contralateral cerebellar hemisphere was detected (crossed cerebellar hyperperfusion). However, the lesion area was still hypoperfused (Fig. 2 lower row).

Discussion

A lesion in one cerebral hemisphere may be associated with decreased glucose metabolism, oxygen

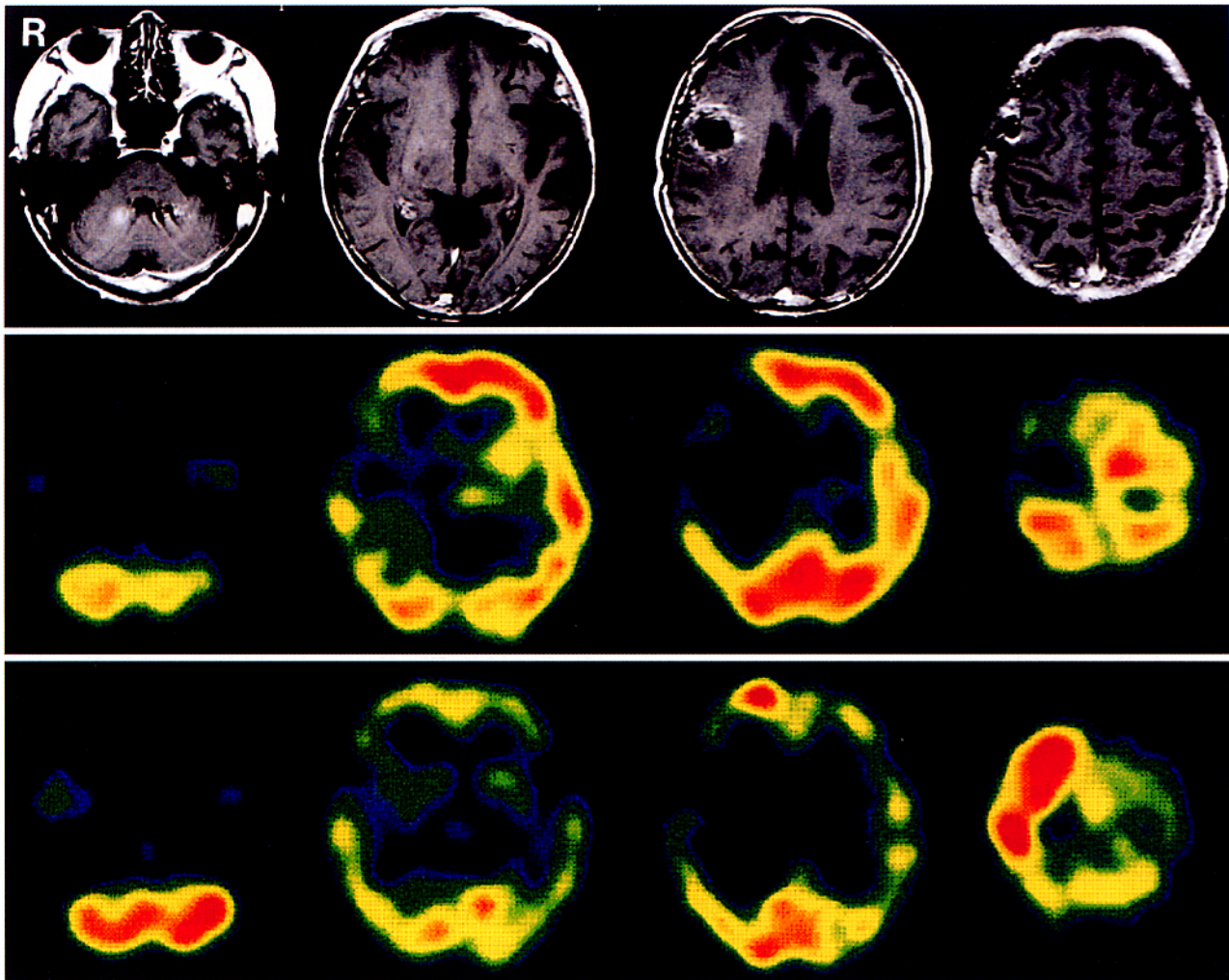


Fig. 2 Case 2. upper row: T₁-weighted magnetic resonance images with gadolinium showing subtotally resected tumor scar in the right frontal lobe. middle row: Interictal iodine-123-labeled isopropyl iodoamphetamine single photon emission computed tomography (SPECT) images showing crossed cerebellar diaschisis. lower row: Ictal technetium-99m-labeled ethyl cysteinate dimer SPECT images showing crossed cerebellar hyperperfusion.

metabolism, and blood flow in the contralateral cerebellar hemisphere (crossed cerebellar diaschisis).^{2,7,9,11,12} This well-known phenomenon is interpreted as a functional deactivation caused by loss of excitatory afferent inputs. Clinically, this phenomenon is observed on the SPECT images of patients with cerebral infarction. This effect is thought to be a result of functional disconnection between the cerebral cortex and the contralateral cerebellar hemisphere through the cortico-ponto-cerebellar pathway. In this study, we described the reverse phenomenon, 'crossed cerebellar hyperperfusion,' observed on the ictal SPECT images of symptomatic epilepsy patients. This phenomenon has been reported previously.^{3,5,8,16,19} Crossed cere-

bellar hyperperfusion seems to be modulated by a mechanism similar to that of crossed cerebellar diaschisis, namely, electrical seizure in the cerebral cortex spreads through efferent projections to the contralateral cerebellar hemisphere.

Crossed cerebellar hyperperfusion was detected only when the epileptic focus was in the frontal lobe of our patients. For example, contralateral cerebellar hyperperfusion was not detected in a patient with an epileptic focus in the temporal lobe. The specificity of crossed cerebellar hyperperfusion for frontal lobe foci is known.^{5,8} Anatomical studies in the monkey have demonstrated more extensive efferent projections to the contralateral cerebellum from the frontal cortex than from other cerebral

cortices.⁶⁾ An electrical stimulation study in the monkey also demonstrated that the frontal cortex-evoked potentials in the cerebellum more readily than other cerebral cortices.¹⁵⁾ Furthermore, a study with positron emission tomography showed that the frontal cortex, particularly the premotor and prefrontal area, exerts a strong modulating influence on the metabolism in the contralateral cerebellum in humans.⁶⁾ These findings seem to be a likely explanation of the specificity for frontal lobe foci.

Crossed cerebellar hyperperfusion may facilitate the lateralization of the epileptic focus in clinical situations. Furthermore, cerebellar atrophy is a common finding in patients with long-standing partial epilepsy.^{1,4,10,17,18)} Although our patients had suffered no cerebellar atrophy because of the short duration of seizure history, repeated excitotoxic neuronal damage mediated through the cortico-ponto-cerebellar pathway due to electrical seizure in the cerebral cortex may be a possible explanation of such cerebellar atrophy.

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