IV. 3 Regional Cerebral Metabolic Rates for Glucose in Five Patients with Lennox-Gastaut Syndrome

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Introduction
Recently developed positron emission tomography (PET) with fluordeoxyglucose (FDG) has been expected to be a powerful tool for detecting a latent focus or for clarifying an expected abnormality in various types of epilepsy. PET studies, however, of secondary generalized epilepsy such as Lennox-Gastaut syndrome (LGS) are rare in the literature.\(^1-3\) The purpose of this study is to evaluate the regional metabolic rate for glucose (rCMRglc) in LGS and its correlation with EEG findings.

Methods
This study includes 5 patients with LGS, 3 boys and 2 girls, whose ages ranged from 10-15 years (mean: 13 years). All EEGs demonstrated diffuse, irregular slow spike-and-wave activity. Three patients experienced no localized discharges; two patients exhibited localized spikes or polyspikes as well as diffuse slow spike-and-wave activity. Each patient received 2-5 mCi of \(^{18}\)FDG intravenously. Arterial blood samples were obtained serially from a catheter placed in the radial artery at timed intervals until the end of the procedure. Forty-five minutes after the \(^{18}\)FDG injection, two PET slices at 4 and 5 or 6 cm over the orbito-meatal level were scanned for 10 or 15 min using an ECAT II (Ortec) with a spatial resolution of 17 mm. The PET images were reconstructed and corrected by transmission image before injection. rCMRglc in units of mg/100 gm/min was calculated from brain radioactivity, time of testing, plasma radioactivity, and plasma glucose level with the predetermined lumped constant value of 0.42. A weighted mean rCMRglc was calculated in each gyrus or cerebral portion which were determined by comparing with anatomical sections of x-ray CT scans of the individual patient.

Results
Figure was produced in order to delineate a localized or asymmetric hypometabolism in each gyrus or portion of cerebral hemispheres. Figure depicts weighted mean values for rCMRglc in grey matter of the individual lobes and nuclei of the left and right hemispheres with LGS.
It is noteworthy that unilateral hypometabolism of the inferior frontal gyrus and the posterior portion of the superior temporal gyrus were most commonly observed in 3 of the 5 patients. In 2 patients whose EEGs demonstrated localized discharges, the side of the EEG abnormality matched the side of hypometabolism of glucose. Of the other 3 patients whose EEGs did not demonstrate localized changes, 2 revealed unilateral hypometabolism of glucose.

Discussion

The PET studies of epilepsy have mainly contributed to the assessment of epileptic foci in partial seizures by using fluorodeoxyglucose method. In partial epilepsy, Engel et al. reported that the site of focal hypometabolism paralleled the epileptic focus determined by the combined results of all electrophysiologic studies and was epileptogenic.

FDG-PET studies of secondary generalized epilepsy such as LGS have been reported. Gur et al. reported 2 patients with LGS with temporal lobe unilateral hypometabolism. In 1 patient whose seizures were controlled after corpus callosotomy, temporal lobe metabolism became symmetric. They concluded that a temporal lobe focus in their 2 patients was suggested. On the other hand, Theodore et al. reported that FDG-PET study on five patients of LGS demonstrated generalized hypometabolism, most prominent in the frontal and temporal regions in 3 patients and no identifiable abnormalities in 2 patients. No regions of hypometabolism were detected. Chugani et al. reported variable FDG-PET scans of LGS, namely metabolic patterns including unilateral focal, unilateral diffuse, bilateral multifocal, and bilateral diffuse abnormalities. They concluded that metabolic abnormalities were not necessarily in the temporal lobes; this conclusion contrasted with that of Gur et al.. In our study, 1 patient demonstrated bilateral diffuse, 1 patient demonstrated unilateral diffuse, and 3 patients demonstrated unilateral focal hypometabolism.

The regional metabolic rate for glucose does not demonstrate asymmetry between the two hemispheres in healthy subjects, although such clear evidence has not been confirmed in a younger age group less than 20 years of age. Therefore, the asymmetric rCMRglc observed in our study is significant. As observed in partial seizures, the hypometabolic zone of glucose possibly relates to an epileptic focus in generalized epilepsy. If there is a possibility of localized abnormality of glucose metabolism in LGS, either the posterior portion of superior temporal gyrus or the inferior frontal gyrus may be a likelier candidate according to the present study. Gur et al. report may partly support this hypothesis, although they only mentioned temporal lobe hypometabolism.

In our study, the side of EEG localization matched the hypometabolic side in PET if the EEG had focal abnormalities. Even one patient that did not reveal localization, did demonstrate unilateral hypometabolism. These
findings suggest that diffuse electrical discharges observed in scalp EEG may not be primary, and a primarily pathologic lesion in LGS may be localized, and masked by generalization of the vast discharges. FDG-PET study can reveal a latent focal or lateralized abnormality in some patients with nonlocalized EEG changes.

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References

### Fig. 1. Mean regional cerebral metabolic rate for glucose in each cerebral region and gyrus in 5 patients with LGS (black columns: left, white columns: right). The asterisk indicates statistical significance between both hemispheres (p < 0.05). Error bar represent one standard deviation.