

## DISTINGUISHING LATERAL TEMPORAL NEOCORTICAL AND MESIAL TEMPORAL LOBE EPILEPSY

### Differential Features of Metabolic Abnormalities between Medial and Lateral Temporal Lobe Epilepsy: Quantitative Analysis of $^{18}\text{F}$ -FDG PET Using SPM

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**PURPOSE:** Because limited resection could yield an equally good surgical outcome as standard anterior resection in temporal lobe epilepsy (TLE), the differentiation of medial from lateral TLE is important. We tried to find the differential features in metabolic abnormalities between medial and lateral TLE groups by using quantitative analysis including statistical parametric mapping (SPM).

**METHODS:** We examined 113  $^{18}\text{F}$ -fluorodeoxyglucose-positron emission tomography (FDG-PET) scans of TLE patients who had surgically and pathologically proven lesions and a good surgical outcome (78 medial TLE, 35 lateral TLE). Each scan was compared with those of 22 healthy control subjects to detect hypometabolic regions by using a *t* test of the SPM method and interhemispheric asymmetry using two-group, two-condition analysis on SPM. Group analysis was performed between medial and lateral TLE by using mirrored PET images. The sensitivity was defined as the detection rate of hypometabolism in the ipsilateral temporal lobes, and the specificity was defined as the nondetection rate in the contralateral lobes. The extent of the hypometabolism was calculated as the number of significant voxels, and the severity was calculated by the asymmetry index (ASI), in the medial or lateral temporal lobes on Statistical Probabilistic Anatomic Map template images.

**RESULTS:** The hypometabolism in the temporal lobes was detected ipsilateral to the seizure focus in 76% of the TLE patients (76% in medial TLE, 77% in lateral TLE) but on the contralateral temporal lobes in 32% of the patients. After considering interhemispheric tempo-

ral asymmetry, the sensitivity was found to be 89%, and the specificity was 91% without differences between the medial and lateral TLE groups. In both medial and the lateral TLE, the hypometabolism was more prominent in the lateral cortical structures than in the medial structures. The hypometabolism in the medial temporal structures was found less frequently in the lateral TLE group, and the extent of the hypometabolism was significantly larger in the medial TLE group. ASIs of the medial temporal structure and superior temporal gyrus of the lateral temporal structure were significantly higher in the medial TLE group.

**CONCLUSIONS:** SPM analysis of  $^{18}\text{F}$ -FDG-PET in TLE patients could localize accurately the seizure focus and helped in the discrimination of the medial TLE from the lateral TLE. We suggest the lateral TLE, rather than the medial TLE, should be considered when glucose metabolism is relatively preserved in the medial temporal structures.

### COMMENTARY

Planning of resections is more difficult in patients thought to have lateral rather than mesial temporal lobe seizure foci, especially when no gross pathologic findings are present on magnetic resonance imaging (MRI). Positron emission tomography (PET) with  $^{18}\text{F}$  fluorodeoxyglucose ( $^{18}\text{F}$ FDG-PET) is a proven tool for lateralization of temporal lobe epileptic foci, but controversy has arisen about its potential to distinguish mesial from lateral temporal foci (1). Kim et al. studied  $^{18}\text{F}$ FDG-PET in 78 patients with medial temporal lobe epilepsy (TLE), a diagnosis based on the presence of hippocampal sclerosis on MRI, and confirmatory ictal video electroencephalogram (EEG) monitoring, and 35 patients who had lateral TLE based on ictal video-EEG. Only 11 of the lateral TLE patients had normal MRI.

The method used by Kim and colleagues has some interesting features. They used the PET Statistical Parametric Mapping (SPM 99) standard PET template for spatial normalization and smoothed the images to 16-mm resolution, which is a much lower resolution than the original PET scans, to

“increase the signal-to-noise ratio.” They also removed effects of global metabolism by normalizing each voxel to total brain radioactivity counts. Each patient’s scan was compared with those of 22 normal volunteers, and within-patient comparisons for side–side asymmetry were made as well.

With SPM, in comparison with the healthy control group, 76% of medial- and 77% of lateral-EEG focus patients had significant hypometabolism. Twenty-five medial and 12 lateral patients had contralateral hypometabolism as well (3 falsely lateralized patients had only contralateral hypometabolism). Fifteen of 27 patients without hypometabolism, when compared with normal volunteers, and 27 of 34 patients with bilateral temporal hypometabolism had significant interhemispheric asymmetry, with the more severe hypometabolism on the side of the epileptic focus. Interestingly, the SPM-based individual comparison of each patient with the set of control subjects did not show greater sensitivity than visual analysis for seizure-focus localization.

In both mesial and lateral TLE groups, asymmetry was significantly higher in lateral than mesial temporal structures. However, the comparison with normal volunteers by using SPM showed that medial hypometabolism was less extensive and severe in the lateral TLE patients than in medial TLE patients. Sixty-three percent of lateral TLE patients had only lateral temporal hypometabolism; unfortunately, both lateral and medial temporal structures were involved in 64% of medial TLE patients. The minority of patients with purely lateral hypometabolism had lateral temporal foci.

This study confirms the results of earlier investigations showing that it may be difficult to use [<sup>18</sup>F]FDG-PET, except in a small minority of nonlesional cases, to differentiate mesial from lateral temporal neocortical foci (1–5). In each of these studies, patients with lateral temporal neocortical foci, as a group, had relatively greater lateral temporal hypometabolism. However, individual variation was too great for [<sup>18</sup>F]FDG-PET to be used for clinical localization.

Kim et al. may have reduced the sensitivity of their method by smoothing the scans to a relatively low resolution that might tend to impair their ability to distinguish regional metabolic rates. Moreover, they did not perform a partial-volume correction, so the hypometabolism they did detect could be due

in large part to patients’ structural lesions (6). As only a few subjects in their study had normal MRIs, the additional information provided by PET appears to have been limited.

Several other PET tracers may potentially be useful for identifying neocortical temporal epileptic foci, including [<sup>11</sup>C]flumazenil, [<sup>11</sup>C]α-methyl-L-tryptophan, and [<sup>18</sup>F]WAY10063 (7–9). Only limited studies have been performed with these agents, and their role in localizing neocortical foci is not yet clear.

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