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High Reproducibility of Regional Abnormalities on Interictal ^{123}I-IMP SPECT Brain Scans in Adults with Partial Epilepsy

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Summary. The reproducibility of two *N*-isopropyl-(iodine 123) *p*-iodoamphetamine (^{123}I-IMP single photon emission computed tomography (SPECT) scans both taken during interictal periods was studied in 13 adult patients with partial epilepsy who had normal CT scans. The frequency of the seizures and the nature of the ictal symptoms were virtually unchanged during the interval between the two SPECT scans performed in each case. In 8 (72.7%) of 11 patients who had abnormal images consisting of focal hypofixation images of ^{123}I-IMP, i.e. zones of decreased regional cerebral blood flow on the first scans, complete or partial regional reproduction of the SPECT abnormalities was observed. This high reproducibility supports the usefulness of SPECT scans in the regional diagnosis of epileptic foci.

Key words: Epilepsy – Brain scan – Single photon emission computed tomography (SPECT) – *N*-Isopropyl-(iodine 123) *p*-iodoamphetamine (^{123}I-IMP) – Regional cerebral blood flow

Introduction

Past studies of functional brain imaging with single photon emission computed tomography (SPECT) [2, 4–7, 9–14], positron emission computed tomography (PET) using $^{15}O_2$ [1, 3] and ^{133}Xe [8], have demonstrated that the epileptic foci in patients with partial epilepsy are usually visualized as zones of decreased regional cerebral blood flow (rCBF) or hypometabolic zones reflecting functional inactivation during the interictal stage. In the present study using SPECT scans with *N*-isopropyl-(iodine 123) *p*-iodoamphetamine (^{123}I-IMP), we examined the reproducibility of such abnormal images in scans repeated during interictal periods in patients with partial epilepsy who had normal CT scans. Documentation of such reproducibility would be important in establishing the usefulness of SPECT scans in the regional diagnosis of epileptic foci. However, reproducibility in such cases has not been specifically reported in past studies including those with PET and ^{133}Xe, although serial SPECT studies during ictal, postictal and interictal stages have been reported [6, 7, 10].

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Subjects and Methods

The subjects were 13 adult patients (7 males, 6 females) with partial epilepsy who had normal findings on CT. Patients were selected in whom the frequency of seizures and the nature of the ictal symptoms were virtually unchanged during the interval between the two SPECT scans which were performed in each case. Their ages ranged from 18 to 58 years (mean, SD: 31.8, 11.7 years) at the time of the first SPECT scan. The classification of epilepsy and seizure types for each patient are listed in Table 1. The time between seizure onset and the first SPECT scan in these patients ranged from about 1 to 31 years (mean, SD: 13.6, 9.7 years). The classification of epilepsy was based on the clinical seizure symptomatology and repeatedly recorded interictal or ictal routine scalp EEGs. The cause of the epilepsy was unknown in all patients. All of the 13 patients had antiepileptic drug (AED) treatment consisting of monotherapy or polypharmacy with phenytoin, phenobarbital, carbamazepine, valproate, and clonazepam at the time of both SPECT scans. Despite AED treatment, 7 of the 13 patients had intractable seizures at a frequency of more than once a month, while the remaining patients had seizure-free intervals of months to over a year. Five of the 7 patients had intractable temporal lobe epilepsy.

Tomographic scans were obtained using a rotating camera system with a single head (Siemens ZLC/3700; Siemens Gammasonics, Des Plaines, Ill.), equipped with a high-resolution low-energy collimator and combined with a minicomputer (Scintipac 70A; Shimadzu, Kyoto, Japan). ^{123}I-IMP of 2–3 mCi (Nihon Medi-Physics, Takarazuka, Japan) was injected into an arm vein. Thereafter, patients were made to lie on a bed for about 30 min and close their eyes. Then, acquisition of projection data was started and lasted for 30 min. Data were accumulated from 60 angles for 60 s per angle. The filtered back projection method was used for image reconstruction after preprocessing the projection data using a Butterworth filter. No attenuation correction was made. The slice thickness was 12 mm and the window level in imaging was set to 20%–90% of the maximum counts in radiological monitoring.

Table 1. Clinical findings in 13 epileptic patients

Classification of epilepsies	Case no.	Classification of seizures			Epileptic foci on EEGs	SPECT findings		
		Simple	Complex	GTC		First SPECT	Second SPECT	Accordance
Frontal lobe epilepsies (3 cases)	1	−	+*	+	R-F	R-F (+)	R-F (+)	○
	2	−	+	−	R-F	R-F (+)	R-F (+)	○
	3	−	+	−	R-F, L-F	L-F (+)	Normal	×
Temporal lobe epilepsies (7 cases)	4	−	+*	+	L-T	Inferior R-T (−)	R-T, R-F (−)	○
	5	−	+*	−	R- & L-T	Inferior L-T (+)	Inferior L-T (+)	○
	6	−	+*	+	L-T	Inferior R-T, R- & L-F (−)	Inferior R-T, R-F (−)	○
	7	−	+*	−	L-T	L-T (+)	L-T (+)	○
	8	−	+	+	R-T	R-T (+)	Normal	×
	9	−	+*	−	R-T	Normal	L-F (−)	×
	10	−	+	+	L-T	Normal	Normal	○
Occipital lobe epilepsy	11	+*	−	+	R-O	R-O (+)	R- & L-O (+)	○
Unclassified partial epilepsies	12	−	+	−	?	L-F, L-P	R- & L-F	○
	13	−	+	+	?	L-P	Normal	×

GTC, Generalized tonic-clonic convulsion; simple, complex, simple and complex partial seizures; +,−, presence and absence of seizures; *, intractable seizures; R, right; L, left; F, frontal lobe; T, temporal lobe; P, parietal lobe; O, occipital lobe; ?, not known.
In SPECT findings, abnormal sites are indicated. Normal, normal SPECT finding. Symbols (+) and (−) on SPECT findings express, respectively, regional agreement and disagreement between the epileptic foci on EEGs and the hypofixation sites on SPECTs. Further, the presence and absence of reproduction of the first SPECT findings on the second SPECTs are indicated by symbols ○ and ×, respectively

After transverse and coronal images had been obtained with three-dimensional reconstruction, results were interpreted by visual analysis.

The two SPECT scans per patient were performed during interictal periods at intervals of about 6 months to 2.7 years (mean 1.9, SD 0.8 years). An interictal scalp EEG with a 10–20 electrode system was recorded soon after each SPECT scan. Possible sites of epileptic foci in each patient were determined from visual inspection of these and the other EEGs, which were repeatedly recorded before the first SPECT scan.

Results

Regional Relationships Between SPECT Abnormalities and Epileptic Foci on EEGs

The possible sites of epileptic foci on EEGs, findings on the two SPECT scans, and the accordance of the two SPECT scans are indicated in Table 1. Eleven and 9 patients had abnormal images on the first and second SPECT scans respectively. All of the SPECT abnormalities showed zones of decreased uptake of ^{123}I-IMP, i.e. focal hypofixation images localized in one or more cortical areas in one or both cerebral hemispheres. Three patients with intractable temporal lobe epilepsy had hypofixation images mainly located in the inferior part of one temporal lobe (cases 4–6), whereas the other patients had hypofixation images in superior or relatively diffuse parts of each cortical site shown in Table 1. Next, the possible sites of epileptic EEG foci were determined in 11 patients. Most of them had a single focus, but 2 patients had multiple foci with independent focal epileptic discharges in the right and left cortical regions (cases 3, 5). Nine patients with EEG foci also had areas of hypofixation on the first SPECTs. Five of these patients showed complete regional agreement between EEG foci and SPECT hypofixation (cases 1, 2, 7, 8, 11). Two other patients showed partial regional agreement (casses 3, 5). Complete or partial regional agreement between the EEG foci and the hypofixation sites on the second SPECTs was observed in 5 of 8 patients. Thus, there was a rather good localizational agreement between regional SPECT abnormalities and EEG foci.

Reproducibility of SPECT Findings

Comparing the findings of the first and second SPECTs, 1 patient had normal images on both (case 10). Four patients had complete regional reproducibility of the region of hypofixation (cases 1, 2, 5, 7, Fig. 1), while the remaining 4 patients showed partial reproducibility (cases 4, 6, 11, 12). Thus, altogether, in 9 patients the SPECT findings were reproducible. Combining the complete and partial reproductions of the hypofixation images, reproduction of the SPECT abnormalities was observed in 8 of the 11 patients with hypofixation images on the first SPECTs. Thus, there was a high degree of reproducibility of the SPECT abnormalities. Among the 8 patients, 5 showed reproducibility of the hypofixation images at sites consistent with the epileptic EEG foci (cases 1, 2, 5, 7, 11).

Changes of SPECT Findings

In 3 patients the initially abnormal SPECT findings changed to normal ones (cases 3, 8, 13). One patient had the reverse (case 9). Enlargements of the hypofixation sites

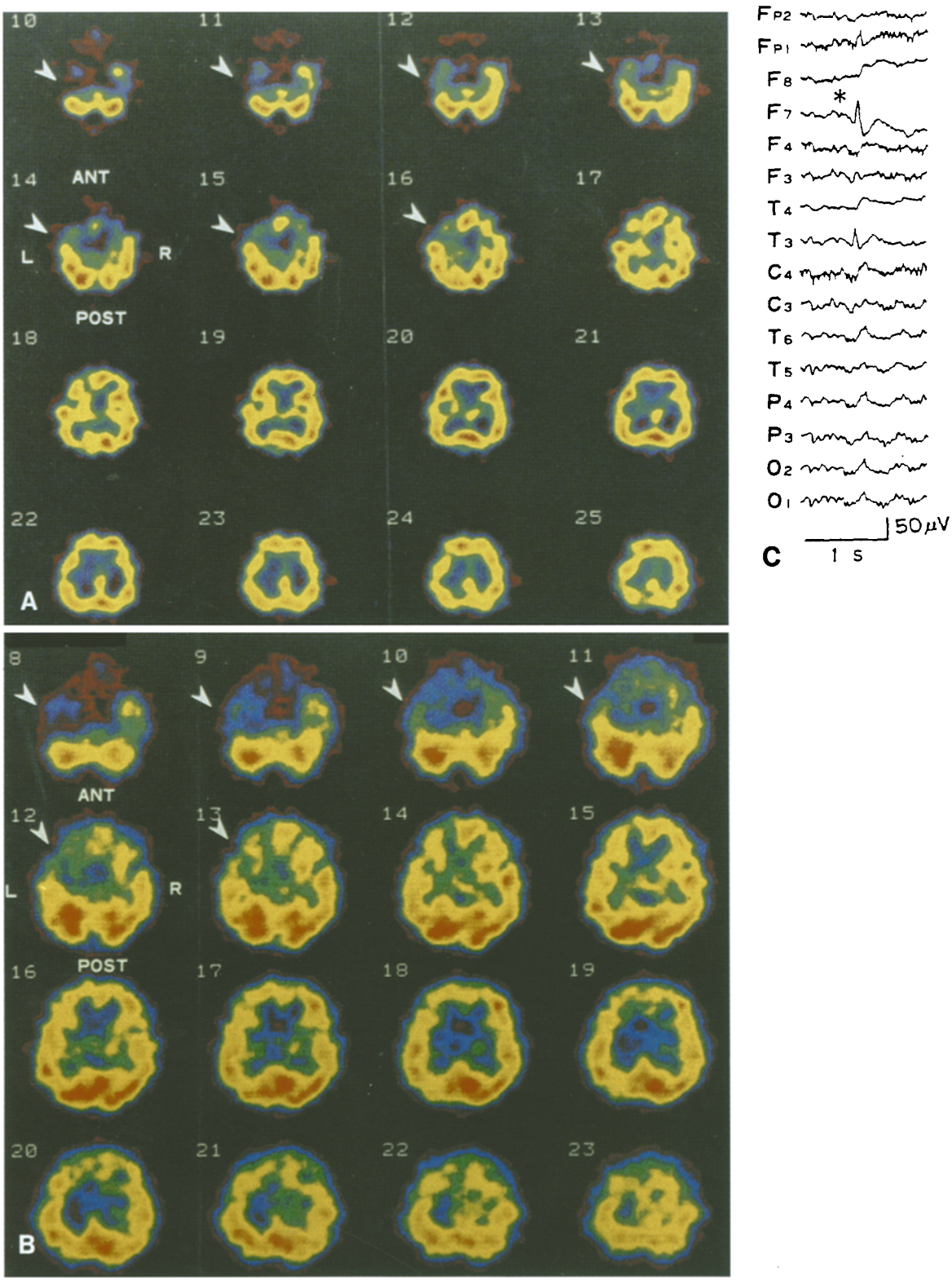

Fig. 1. Good correspondence between regional SPECT abnormalities and epileptic EEG focus. Data from case 5 in Table 1 are presented. The upper and lower SPECTs indicate the first and second ones, respectively. *Arrows,* Hypofixation sites in the inferior part of the left temporal lobe; *, the epileptic discharge showing the EEG focus located in the anterior portion of the left temporal lobe. The numerals in SPECTs indicate the heights of slices sectioned every 6 mm from the orbitomeatal line towards the vertex

were seen in 2 patients (cases 4, 11), while 1 patient showed a reduction in the hypofixation sites (case 6).

Discussion

The present study indicates that SPECT abnormalities during interictal periods in epileptic patients, characterized by stable seizure frequency and ictal symptoms, exhibit high regional reproducibility. It has already been shown from studies with SPECT, PET and ^{133}Xe that there is generally good regional agreement between these abnormalities and ictal or interictal epileptic foci on EEG, although there are considerable discrepancies in the details between these studies [1–14]. In the present study, there was relatively good regional agreement between the SPECT abnormalities and EEG foci. These findings suggest that SPECT abnormalities reflecting epileptic foci are highly reproducible. In fact, the majority of the patients in this study showed reproducible SPECT abnormalities, and the regional hypofixation areas were in localizational agreement with epileptic EEG foci. This high reproducibility supports the usefulness of SPECT scans in the diagnosis of epileptic foci.

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