Evaluation of Interictal Tc-99m ECD SPECT in Adults With Medical Refractory Epilepsy

Shung-Shung Sun, Der-Yang Cho[1], Feng-Ju Chuang

Departments of Nuclear Medicine, and [1]Neurosurgery, China Medical College Hospital,

Taichung, Taiwan, R.O.C.

Background. Accurate detection and localization of epileptic focus are very important, especially for presurgical evaluation. However, both magnetic resonance imaging (MRI) and electroencephalography (EEG) have limitations. Regional cerebral blood flow single photon emission computed tomography (SPECT) has proven to be a valuable method for detecting epileptic focus. The purpose of this study was to evaluate the clinical value of interictal Tc-99m ethyl cysteinate dimer (ECD) SPECT for detecting epileptic focus in adults with medical refractory epilepsy.

Methods. We performed interictal Tc-99m ECD brain SPECT on 54 adults (28 men and 26 women; age range: 21 to 45 yr) with a history of medical refractory epilepsy. Twenty-six patients presented with generalized tonic clonic seizure (GTCS), 27 with complex partial seizure (CPS) and one with both conditions (GTCS + CPS). Eight of the 27 patients with CPS underwent epilepic surgery on the basis of the preoperative Tc-99m ECD brain SPECT results.

Results. Interictal Tc-99m ECD brain SPECT showed areas of hypoperfusion in 18 of 26 patients with GTCS (69%), in 23 of 27 patients with CPS (85%) and in one patient with both GTCS and CPS. The condition of eight patients with CPS improved greatly after epileptic surgery.

Conclusions. Interictal Tc-99m ECD brain SPECT is a useful and accurate imaging modality for the detection and localization of epileptic focus in adults with medical refractory epilepsy. **(Mid Taiwan J Med 2002;7:76-81)**

Key words

interictal, medical refractory epilepsy, Tc-99m ECD SPECT

INTRODUCTION

Epilepsy is a relatively common neurological disorder and is considered a social disease because of its elevated prevalence and incidence. Epilepsy is more common in children than in adults and is initially classified as generalized or partial. Accurate localization of the epileptic focus is necessary to ensure appropriate treatment. Electroencephalography (EEG) is still the most important method for diagnosing and assessing all types of epilepsy. However, the sensitivity of routine EEG is limited by restrictions in spatial and temporal sampling. About 50% of patients with epilepsy do not show paroxysmal epileptiform discharges on EEG recording [1]. In addition, EEG cannot provide accurate localization for surgical treatment, and usually cannot identify the leading focus in patients with multifocal epilepsy.

Dramatic improvements in neuroimaging techniques were made in the 1990's. For

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Address reprint requests to : Shung-Shung Sun, Department of Nuclear Medicine, China Medical College Hospital, No 2, Yuh-Der Road, Taichung 404, Taiwan, R.O.C.

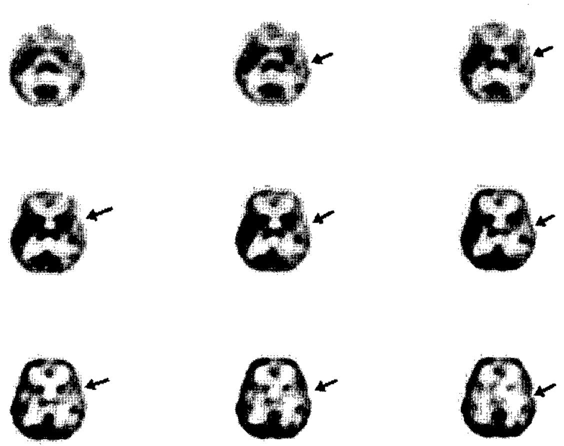

Fig. 1. Positive findings of Tc-99m ECD SPECT revealed hypoperfusion in the left frontal-temporal-parietal lobes and basal ganglions (arrows).

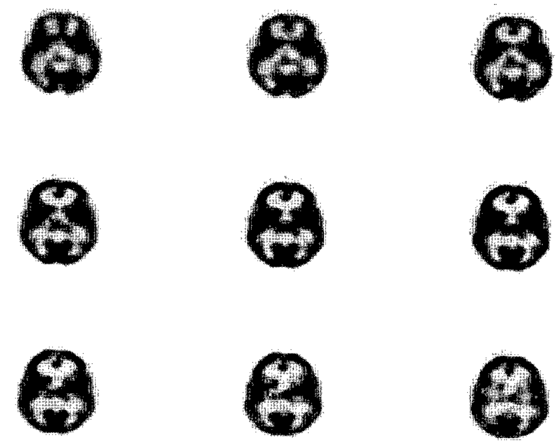

Fig. 2. Negative findings of Tc-99m ECD SPECT revealed symmetrical tracer uptake and no definite hypoperfusion in the brain cortex or basal ganglions.

example, brain magnetic resonance imaging (MRI) is effective in displaying structural brain lesions associated with clinical manifestations and detecting alterations possibly related to epilepsy, e.g. hippocampal sclerosis [2]. However, MRI is normal in up to 37% of patients suffering from epilepsy [3]. Single photon emission computed tomography (SPECT) is a functional neuroimaging technique with an established role in the detection of epileptic focus in patients with refractory epilepsy [4,5]. Tc-99m hexamethyl-propylene amine oxime (HMPAO) SPECT scan has been widely used to evaluate epilepsy [6-8]. Tc-99m ethyl cysteinate dimer (ECD) has similar kinetics to Tc-99m HMPAO in the brain [9]. The aim of this study was to evaluate the clinical value of Tc-99m ECD brain SPECT for localizing the epileptic focus in adult patients with medical refractory epilepsy undergoing evaluation for epilepsy surgery.

MATERIALS AND METHODS

Patients

A total of 54 adults (28 men and 26 women; age range, 21 to 45 yr) with a history of medical refractory epilepsy (from 5 to 30 yr) were enrolled in this study. All patients underwent Tc-99m ECD brain SPECT scan. Twenty-six patients presented with generalized tonic clonic seizure (GTCS), 27 with complex partial seizure (CPS) and one with both conditions (GTCS + CPS).

Imaging Procedures and Interpretation

Preparation of a commercially available Tc-99m ECD kit was carried out according to the manufacturer's instructions. Radiochemical purity was at least 90% in all studies using thin-layer chromatography. The interictal study was performed without EEG control. Patients were placed in a dark and quiet room, and Tc-99m ECD (740 MBq) was injected intravenously. Between 15 and 45 min after 99mTc-ECD injection, SPECT data were obtained using a dual-head gamma camera (ADAC, Vertex plus) equipped with fanbeam collimators. Data were collected from 64 projections in the 140 keV photopeak over 360° (180 for each head) in 128×128 matrices, with an acquisition time of 30 sec/view. A zoom factor of 1.46 was used. Transaxial, coronal and sagittal slices were reconstructed with attenuation correction using a Butterworth filter, with cutoff frequency of 0.2 per cm and an order of 20. All SPECT images were reviewed separately by at least two experienced nuclear medicine physicians blind to the clinical data. The findings were considered pathological if one or more areas of hypoperfusion in the regional brain flow were present on more than one view or slice. When interpretations differed, the final

Table 1. The detailed data of patients in this study

No. of patient	Sex	Age (yr)	Type of seizures	Time of seizures (yr)	SPECT results
1	M	31	GTCS	15	Left frontal and bilateral temporal lobes (hypoperfusion)
2	M	28	GTCS	16	Left frontal and left temporal lobes (hypoperfusion)
3	M	27	GTCS	10	Right temporal lobe (hypoperfusion)
4	F	21	GTCS	8	Negative
5	M	23	GTCS	7	Right frontal and right temporal lobes (hypoperfusion)
6	M	29	GTCS	11	Right parietal lobe (hypoperfusion)
7	M	22	GTCS	7	Negative
8	M	33	GTCS	15	Left frontal and left inferior temporal lobes (hypoperfusion)
9	M	28	GTCS	13	Negative
10	F	32	GTCS	12	Left parietal and left temporal lobes (hypoperfusion)
11	M	33	CPS + GTCS	17	Bilateral frontal, left temporal and left parietal lobes (hypoperfusion)
12	M	35	GTCS	25	Left frontal and left temporal lobes (hypoperfusion)
13	F	27	GTCS	9	Left frontal and left temporal lobes (hypoperfusion)
14	M	33	GTCS	15	Left frontal and left temporal lobes (hypoperfusion)
15	F	35	GTCS	14	Negative
16	M	22	GTCS	7	Negative
17	M	23	GTCS	5	Left inferior temporal and right parietal lobes (hypoperfusion)
18	M	28	GTCS	14	Right parietal lobe (hypoperfusion)
19	M	35	GTCS	20	Negative
20	F	30	GTCS	10	Left temporal lobe (hypoperfusion)
21	M	25	GTCS	8	Left temporal and left parietal lobes (hypoperfusion)
22	F	30	GTCS	13	Left frontal and left inferior temporal lobes (hypoperfusion)
23	M	36	GTCS	11	Left frontal and left inferior temporal lobes (hypoperfusion)
24	F	24	GTCS	7	Negative
25	F	45	GTCS	30	Left frontal, left inferior temporal and left parietal lobes (hypoperfusion)
26	F	33	GTCS	16	Negative
27	F	24	GTCS	10	Right temporal and right parietal lobes (hypoperfusion)
28	F	36	CPS	13	Right temporal lobe (hypoperfusion)
29	M	26	CPS	13	Left temporal lobe (hypoperfusion)
30	M	22	CPS	10	Left inferior temporal lobe (hypoperfusion)
31	F	26	CPS	8	Left inferior temporal lobe (hypoperfusion)
32	F	23	CPS	9	Left inferior temporal lobe (hypoperfusion)
33	F	26	CPS	10	Right temporal lobe (hypoperfusion)
34	M	35	CPS	18	Left inferior temporal lobe (hypoperfusion)
35	M	28	CPS	17	Right frontal lobe (hypoperfusion)
36	M	27	CPS	14	Right parietal lobe (hypoperfusion)
37	F	22	CPS	10	Left inferior temporal lobe (hypoperfusion)
38	M	29	CPS	15	Left inferior temporal lobe (hypoperfusion)

M = male; F = female.

Table 1. Continued

No. of patient	Sex	Age (yr)	Type of seizures	Time of seizures (yr)	SPECT results
39	F	25	CPS	13	Negative
40	F	33	CPS	10	Left inferior temporal lobe (hypoperfusion)
41	M	22	CPS	12	Left frontal lobe (hypoperfusion)
42	F	31	CPS	12	Negative
43	F	30	CPS	14	Right parietal lobe (hypoperfusion)
44	F	33	CPS	15	Left temporal lobe (hypoperfusion)
45	F	21	CPS	9	Left inferior temporal lobe (hypoperfusion)
46	M	33	CPS	20	Negative
47	M	23	CPS	12	Right temporal lobe (hypoperfusion)
48	F	32	CPS	15	Left temporal lobe (hypoperfusion)
49	F	23	CPS	10	Negative
50	F	34	CPS	15	Left temporal lobe (hypoperfusion)
51	M	27	CPS	10	Left inferior temporal lobe (hypoperfusion)
52	M	24	CPS	11	Left inferior temporal lobe (hypoperfusion)
53	F	36	CPS	20	Left inferior temporal lobe (hypoperfusion)
54	F	29	CPS	15	Left inferior temporal lobe (hypoperfusion)

diagnosis was made by consensus. The results of SPECT images were classified as positive (Fig. 1) or negative (Fig. 2).

RESULTS

Detailed patient data and study results are summarized in Table 1. In 18 of the 26 cases with GTCS (69%) and in 23 of the 27 cases with CPS (85%), SPECT demonstrated brain perfusion abnormalities. One patient with both GTCS and CPS had a positive SPECT. No SPECT-related discomfort or side effects were observed during the study. The left hemisphere was most frequently involved and the major perfusion abnormalities were found in the temporal, frontal and parietal lobes. Eight patients with CPS underwent epileptic surgery on the basis of preoperative Tc-99m ECD brain SPECT results and their conditions improved greatly after surgery (Table 2).

DISCUSSION

The management of patients with medical refractory epilepsy requires objective and precise localization of the epileptic focus. Tc-99m HMPAO brain SPECT imaging has been used to evaluate the interictal period in adults with intractable epilepsy [6,7,10]. However, there is little information regarding the use of interictal Tc-99m ECD brain SPECT for evaluation of adult medical refractory epilepsy, including GTCS and CPS, especially in comparison with postoperative results. ECD is a neutral lipophilic complex that can be labeled with Tc-99m to become a suitable tracer for evaluating regional cerebral blood flow [11]. Tc-99m ECD is an effective marker for cerebral perfusion imaging, showing rapid and good uptake in the brain [12]. No side effects related to Tc-99m ECD SPECT were observed in this study. Brain surgery in medical refractory epilepsy cases requires the most precise localization of the epileptic focus in order to restrict surgical intervention [13-15]. In our study, 8 CPS patients received surgery based on the preoperative Tc-99m ECD brain SPECT results and all conditions improved postoperatively. Overall, GTCS in 69% of the

Table 2. The results of the 8 patients who underwent epilepsy surgery

Case No.	Type of seizures (frequency)	SPECT results	Surgery	Post-op evaluation
Case 28	CPS (5-10/month)	Hypoperfusion in the right temporal lobe	Right anterior temporal lobectomy	No more seizures, DC of antiepilepsy
Case 29	CPS (7-10/month)	Hypoperfusion in the left temporal lobe	Left anterior temporal lobectomy	No more seizures, DC of antiepilepsy
Case 31	CPS (7-10/month)	Hypoperfusion in the left inferior temporal lobe	Left anterior temporal lobectomy	No more seizures, DC of antiepilepsy
Case 32	CPS (5-7/month)	Hypoperfusion in the left inferior temporal lobe	Left anterior temporal lobectomy	Improvement (0-1/month)
Case 34	CPS (5-10/month)	Hypoperfusion in the left inferior temporal lobe	Left anterior temporal lobectomy	No more seizures, DC of antiepilepsy
Case 35	CPS (7-10/month)	Hypoperfusion in the right frontal lobe	Right frontal lobectomy	Improvement (1-2/month)
Case 44	CPS (5-8/month)	Hypoperfusion in the left temporal lobe	Left anterior temporal lobectomy	No more seizures, DC of antiepilepsy
Case 53	CPS (6-10/month)	Hypoperfusion in the left inferior temporal lobe	Left anterior temporal lobectomy	No more seizures, DC of antiepilepsy

patients and CPS in 85% of the patients were detected by Tc-99m ECD brain SPECT in this study.

In conclusion, interictal Tc-99m ECD brain SPECT scan is a safe and valuable imaging method for detecting and localizing the epileptic focus in adults with medical refractory epilepsy, including GTCS and CPS. Follow-up studies of patients who undergo epilepsy surgery are needed for confirmation of these results. However, because some patients did not undergo brain CT/MRI and intraoperative EEG in this study, a further study including brain MRI/CT and intraoperative EEG is necessary.

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鎝-99m-ECD腦部單光子射出斷層掃描在成人頑固性癲癇症間期的評估

孫盛生　周德陽[1] 莊豐如

中國醫藥學院附設醫院　核子醫學科　神經外科[1]

背景　能正確診斷及定位癲癇發作的病灶是非常重要的，尤其是對於術前的定位，然而，核磁共振掃描及腦電圖都有其限制性。本篇研究的目的在於評估癲癇發作間期使用鎝-99m-ECD單光子射出斷層掃描對於引起成人癲癇病灶定位之臨床可用性及正確性。

方法　選擇54位頑強性癲癇症的病人來做鎝-99m-ECD單光子射出斷層掃描(28位是男性，而26位是女性，年齡從21到45歲)。有26位病人是全身陣攣間歇性癲癇(GTCS)，27位是複雜性局部癲癇(CPS)，且有一位是全身陣攣間歇性癲癇與複雜性局部癲癇(GTCS+CPS)二者都有。在27位複雜性局部癲癇病人中有8位接受了癲癇手術。

結果　二十六位全身陣攣間歇性癲癇的病人在癲癇間期所做的鎝-99m-ECD單光子射出斷層掃描的結果顯示出有18位病人有腦部血流不正常的降低(69%)；27位複雜性局部癲癇的病人則有23位(85%)，一位有全身陣攣間歇性癲癇及複雜性局部癲癇的病人也顯示有血流降低的情形。8位接受癲癇手術的病人在術後有很大的改善。

結論　癲癇間期以鎝-99m-ECD單光子射出斷層掃描來偵測成人頑固性癲癇病灶之定位是一個有用且正確性高的方法。(中台灣醫誌 2002;7:76-81)

關鍵詞

癲癇間期，鎝-99m-ECD單光子射出斷層掃描，頑強性癲癇

聯絡作者：孫盛生

地　　址：404台中市北區育德路2號

中國醫藥學院附設醫院　核子醫學科

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