Bull Yamaguchi Med Sch 28 : 127-134, 1981

Computerized Transverse Axial Tomography in Epilepsy

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(Received March 24, 1981)

Abstract During a period from December 1976 to December 1980 a total of 233 epileptic patients underwent brain CT at the Department of Neuropsychiatry, Yamaguchi University Hospital, with 108 (46.4%) of these 233 having been found to have abnormal findings. No more than 6.3% of patients with primary generalized epilepsy had an abnormal brain CT. In contrast, approximately a half of patients with each of the other types of epilepsy showed abnormalities on brain CT: secondary generalized epilepsy, 50.0% ; partial epilepsy, 50.6% (with elementary symptomatology: 53.8% ; with complex symptomatology: 47.6% ; with secondarily generalized seizures: 54.5%). The incidence of brain CT abnormalities in epileptic patients was found to vary depending not only upon the type of seizure but also upon the patient's age at onset and at the time of examination, the degree of seizure control, and the presence or absence of a history of brain damage as well as of interictal neuropsychiatric symptoms. However, the site of organic changes disclosed by CT was not necessarily coincident with or in the proximity of the epileptic focus as identified by EEG.

Key Words: Epilesy; Computerized tomography (CT scan), EEG

Introduction

Epilepsy is essentially a functional disease of the brain and electroencephalography has held a leading position in the exploration and evaluation of this pathologic condition prior to its treatment.

However, it must be emphasized that an investigation of morphological abnormalities underlying the functional disturbance of the brain will certainly serve the following purposes: (1) early detection of brain tumors and other surgical diseases, (2) diagnosis and formulation of therapeutic scheme, (3) evaluation of prognosis and (4) early detection of changes in the brain caused by epileptic seizures.

Computerized transverse axial tomography (CT) was introduced into clinical practice by Ambrose, J.[1] in 1973; subsequently, in 1976, Gastaut, H. and associates[2] gave a comprehensive account of the usefulness of brain CT in the management of epilepsy.

Brain CT permits to visualize anatomical structures of the brain easily while imposing much lesser burden, both mental and physical, upon the patient than the conventionally used neuroradiologic diagnostic procedures (plain skull X-ray, pneumoencephalography, cerebral angiography and scintigraphy).

This advantage is more than counterbalancing its drawback that the images it affords are rather coarse so that small lesions might not be clearly distinguished. At the present time it is thus agreed upon that CT is best suited for the morphological evaluation of the brain of epileptic patients.

We have performed brain CT on 233 patients with epilepsy at the Department of Neuropsychiatry, Yamaguchi University Hospital during a period of 4 years and 1 month. The purpose of this paper is threefold: to document the findings thus obtained, to investigate into their correlation with clinical findings of epilepsy and to make a comparative study of the results with those reported by other authors.

Materials and Methods

The subjects used in this study were a total of 233 patients (134 males and 99 females) who were diagnosed of epilepsy and received treatment at the Department of Neuropsychiatry, Yamaguchi University Hospital and who were also subjected to brain CT during a period from December 1976 through December 1980.

These patients ranged in age from 6 to 68 years (average 26.3 years) and their ages at onset were between 2 months and 63 years (average 15.1 years).

The types of epilepsy in this series were classified in Table 1.

CT scans of the brain were made initially with EMI 1000 (from December 1976 through October 1977; 50 cases) and later with EMI 1010 (from November 1977 through December 1980; 183 cases).

Results

Of the entire 233 patients, 108(46.4%) had abnormal findings on brain CT.

Proportions of patients having CT abnormalities in individual types of epilepsy were summarized in Table 2.

In an overwhelming majority of cases CT abnormalities were accounted for by atrophic changes (including porencephaly). Space-occupying lesions (e.g., tumor and arteriovenous malformation), calcification, cyst of septum pellucidum and cavum Vergae were disclosed in occasional patients (Table 3).

A study of the incidence of CT abnormalities in relation to the age at seizure onset showed that the overall incidence of CT abnormalities tended to increase with advancing age at onset, although the incidence value for those patients whose age at onset was between 11 and 20 years was definitely low (30.9%). The incidence of CT abnormalities among patients in whom the onset of seizure occurred at the age of less than 20 years was 38.5% as against a corresponding value of 74.5% for those having the onset of seizure at 21 years or above (Table 4).

No correlation was noted to exist between the duration of illness and the incidence of CT abnormalities (Table 5). It was also found that the incidence of CT abnormalities became higher with increasing age at the time of CT scanning (Table 6).

The patients were divided into 4 groups

Table 1 Types of Epilepsy in the Patients

Types of epilepsy	No. of patients
Primary generalized epilepsy	32
Secondary generalized epilepsy	16
Partial epilepsy	158
with elementary symptomatology	53
with complex symptomatology	83
with secondarily generalized seizures	22
Unclassifiable cases	27
Total	233

Table 2 Proportion of Patients having CT Abnormalities in Individual Types of Epilepsy

Types of epilepsy	No. of patients with CT abnormalities (%)
Primary generalized epilepsy	2 (6.3)
Secondary generalized epilepsy	8(50.0)
Partial epilepsy	80(50.6)
with elementary symptomatology	28(53.8)
with complex symptomatology	40(47.6)
with secondarily generalized seizures	12(54.5)
Unclassifiable cases	18(66.7)
Total	108(46.4)

Table 3 CT Findings of the Patients

CT findings	No. of patients
Abnormal CT	108
Atrophic change	91(11)*
Diffuse atrophy	52(16)*
Cerebral hemiatrophy	15 (4)*
Porencephaly	13 (4)*
Localized low density area	14 (7)*
Other localized atrophy	8 (2)*
Tumor	6
Arteriovenous malformation	2
Calcification	14(10)*
Cyst of septum pellucidum and cavum Vergae	10 (5)*
Normal CT	125
Total	233

( )*: Number of cases showing other abnormal findings simultaneously.

Table 4 Age at Seizure Onset and Incidence of CT Abnormalities

Age at onset (years)	No. of patients with CT abnormalities (%)		Total	
under 4	15(41.7)		36	
4-10	30(46.2)	70(38.5)	65	182
11-20	25(30.9)		81	
21-30	17(73.9)		23	
31-40	13(72.2)	38(74.5)	18	51
41 or above	8(80.0)		10	
Total	108(46.4)		233	

Table 5 Duration of Illness and Incidence of CT Abnormalities

Duration of illness (years)	No. of patients with CT abnormalities (%)	Total
under 5	26(36.6)	71
5-9	21(52.0)	50
10-14	26(57.8)	45
15-19	14(58.3)	24
20-29	12(41.4)	29
30 or above	9(64.3)	14
Total	108(46.4)	233

Table 6 Incidence of CT Abnormalities and Age at the Time of CT Scanning

Age at the time of CT scanning (years)	No. of patients with CT abnormalities (%)	Total
6-10	7(31.8)	22
11-20	33(39.3)	87
21-30	20(45.5)	44
31-40	15(57.1)	35
41-50	16(72.7)	22
51 or above	17(73.9)	23
Total	108(46.4)	233

Table 7 Degree of Seizure Control and Incidence of CT Abnormalities

Degree of seizure control	No. of patients with CT abnormalities (%)	Total
"complete" group	10(25.6)	39
"well" group	48(42.5)	113
"poor" group	44(62.0)	71
"uncertain" group	6(60.0)	10
Total	108(46.4)	233

Table 8 Clinical History and Incidence of CT Abnormalities

Past history	No. of patients with CT abnormalities (%)	Total
Relevant antecedent history	70 (57.9)	121
Perinatal trauma or anoxia	24* (47.1)	51*
Head injury	16* (55.2)	29*
Meningoencephalitis	23* (76.7)	30*
Febrile convulsion	4* (22.2)	18*
Cerebrovascular attack	5 (100.0)	5
Metabolic toxicosis	4*(100.0)	4*
No history	38 (33.9)	112
Total	108 (46.4)	233

*: Cases showing two or more history were counted separately under the section for each history concerned.

Table 9 Interictal Neuropsychiatric Symptoms and Incidence of CT Abnormalities

Interictal symptoms	No. of patients with CT abnormalities (%)	Total
With any symptoms	67 (62.6)	107
Disturbance of socio-educational adjustment	42* (63.6)	66*
Mental retardation	38* (55.1)	69*
Characteristic disorder	34* (66.7)	51*
Hemiparesis	15* (93.8)	16*
Dementia	4*(100.0)	4*
Disturbance of consciousness	4*(100.0)	4*
Hemianopsia	3*(100.0)	3*
Strabismus	2* (66.7)	3*
With no symptom	41 (32.5)	126
Total	108 (46.4)	233

*: Cases showing two or more symptoms were counted separately under the section for each symptom concerned.

Table 10 Relationship between the Site of Electroencephalographic Epileptic Focus and the Site of Abnormal CT Findings

Site of electroencephalographic epileptic focus	Site of abnormal CT findings			Total
	Left hemisphere dominant	Right hemisphere dominant	Diffuse	
Left hemisphere	12	4	8	24
Right hemisphere	6	16	17	39
Total	18	20	25	63

according to the degree of seizure control, i.e., (1) "complete" group (entirely free from epileptic seizures for more than 3 years prior to CT scanning), (2) "well" group (with no more than several episodes of seizure occurring only when failing to take drugs during the 3-year period), (3) "poor" group (with seizures controlled inadequately by antiepileptic medication) and (4) "uncertain" group (uncertain as to what extent seizures were controlled by the therapy). When the incidence of CT abnormalities among these groups were compared, it became obvious that the incidence of CT abnormalities was low in "complete" group and high in "poor" group (Table 7).

The incidence of CT abnormalities, when studied in relation to relevant antecedent history, was also found to be higher in patients with a history of brain damage than in those without it. An exceedingly high incidence value was noted in patients with a history of cerebrovascular attack, metabolic toxicosis or meningoencephalitis, while a very low incidence value was associated with a positive history of febrile convulsion (Table 8).

On the other hand, patients with interictal neuropsychiatric symptoms had CT abnormalities more frequently than those without such symptoms (Table 9).

Lastly, the site of electroencephalographic

epileptic focus and the site of abnormal CT findings were examined for their anatomical relationship in 63 patients with partial epilepsy who demonstrated a single epileptic focus consistently on repeated EEG and abnormalities on brain CT. The two sites were coincident in 28 cases and contralateral to each other in 10 cases (Table 10).

Discussion

The incidence of abnormal findings on brain CT among epileptic patients reportedly varies from 34.0% to 71.4%[2-10], hence with a difference of about 38% between the two extreme values. One can therefore expect that approximately a half of epileptic patients in a given series have an abnormal brain CT. Reported incidence values of CT abnormalities in individual types of epilepsy are: 0%–20.0% for primary generalized epilepsy[2,3,11,12], 61.0%–72.2% for secondary generalized epilepsy[2,13] and 34.0%–70.0% for partial epilepsy[2,3,13-15]. Further, incidence values of CT abnormalities reported by various authors were 27.0%–59.5% for partial epilepsy with complex symptomatology and 43.0%–66.7% for partial epilepsy with elementary symptomatology[2,16]. Our results were in fairly good agreement with these figures.

An overwhelming majority of CT abnormalities are said to be accounted for by atrophic changes. According to reports available so far, the proportion of atrophic changes to entire CT abnormalities varies between 51.0% and 90.7%[4-7,15-17]. In agreement with these figures the corresponding value for our series was 84.3% (91 out of 108 cases).

Space-occupying lesions were disclosed by CT in 8 cases (7.4%) in our series (brain tumor: 6 cases; arteriovenous malformation: 2 cases); of these 6 brain tumors, 4 were associated with partial epilepsy and the remaining 2 were detected in unclassifiable epilepsy. Reported values of the incidence of brain tumor in epileptic patients range from 2.0% to 20.0%[2,4-11,16,18,19]. Gastaut, H. et al.[2] point out a high incidence of tumor in partial epilepsy of late onset; Masuhr, K. et al.[20] state that the incidence of brain tumor is high among epileptic patients having onset between 20 and 39 years of age and is on the decrease in those with disease onset later than 40 years of age. These are consistent with the results of our study which indicate that, of 6 cases with a brain tumor demonstrated by CT, 4 were of partial epilepsy and all these 6 had the onset of seizure at the age of 29 to 41 years, a finding which is really worthy of note.

Patients with the onset of disease occurring between 11 and 20 years of age were found to have a low incidence of CT abnormalities. This might be adequately explained by assuming that many of patients with primary generalized epilepsy had the onset of disease at these age levels. When the entire cases are considered as a whole, it was recognized that the incidence of CT abnormalities became statistically significantly higher with advancing age at onset ($P<0.05$); thus, patients having disease onset at 21 years or above of age had a significantly higher incidence of CT abnormalities than those with the onset at the age of 20 years or less ($P<0.001$). This fact can not be explained solely by the increase in proportion of partial epilepsy with advancing age at onset, but should rather be considered attributable, at least partly, to that the frequency with which organic brain damage, e.g., severe head injury, tumor, alcoholic encephalopathy and cerebrovascular attack, plays an epileptogenic role increases with advancing age.

When the incidence of CT abnormalities was studied in relation to the duration of illness, no statistically significant correlation was observed between these two features of epileptic patients. From this fact alone, however, there is no denying the possibility

that organic damage of the brain caused by epileptic seizures becomes increasingly severe with the elapse of time after the onset of disease.

It was recognized further that the incidence of CT abnormalities increased markedly with advancing age at the time of CT scanning ($P<0.01$). It would seem that this finding is related not only to the cause, type and age at onset of epileptic seizure but also to the cumulative effect of seizures on brain structures.

The incidence of CT abnormalities, when studied in relation to the degree of seizure control, was found to be significantly different between "well" group and "poor" group ($P<0.02$). This finding supports the hypothesis that the lesser the organic damage of the brain, the more amenable is the seizure to treatment.

The incidence of CT abnormalities was also recognized to be significantly higher in the presence of a history of brain damage than in its absence ($P<0.001$). A positive history of those pathological processes which are very much likely to produce a serious damage to the brain, e. g., cerebrovascular attack, metabolic toxicosis and meningoencephalitis, was associated with an exceedingly high incidence value of abnormal findings on CT. In contrast, the incidence of CT abnormalities was definitely low in febrile convulsions in which case functional factors and/or disposition play a predominant pathogenetic role.

Patients with interictal neuropsychiatric manifestations had a significantly higher incidence of CT abnormalities than those without such symptoms ($P<0.001$).

As regards the anatomical relationship between the epileptic focus identified electroencephalographically and the site of CT abnormality a majority of patients in the present series were found to have CT abnormality located in the same hemisphere as epileptic focus, while in the remainder the two sites were located on contralateral sides. This finding is of great importance since it may be interpreted as indicating that the epileptic focus might often exist near organic lesions demonstrable by CT, on the one hand, but on the other hand, as suggesting that the pathogenetic mechanism of epilepsy (which is a functional disorder of the brain) is not necessarily going on in the proximity of severe organic lesions of the brain.

As obvious from the above-mentioned, the information provided by brain CT proves of salient use in the diagnosis and treatment of epilepsy as well as in the evaluation of its prognosis. It should be clearly recognized, however, that electroencephalography and brain CT as they stand now are not competent enough to permit exact visualization of the sites of functional and morphological abnormalities and their anatomical relationship. Further technical advances in this field of medical science are earnestly hoped for.

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