Evaluation of intracranial space-occupying lesions by computed tomography and electroencephalography

A comparison

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Until recently, the diagnosis or exclusion of intracranial space-occupying lesions required hospitalization of the patient and the utilization of several diagnostic techniques, some of them invasive, potentially harmful, and costly in time and effort. With the recent advent of computed tomography (CT), a noninvasive technique is now available.[1,2] CT has been generally accepted as a revolutionary method for the investigation of central nervous system diseases and, in particular, for the detection of intracranial tumors.[3,4] We have undertaken this study to compare the results of CT and electroencephalography (EEG) and determine their respective values and limitations in the noninvasive diagnosis of space-occupying lesions within the skull.

Materials and methods

One hundred sixteen patients with intracranial space-occupying lesions were studied. The data were obtained from log sheets containing information on all patients studied by CT and EEG, starting with the installation of the EMI scanner at the Cleveland Clinic in early 1974 and continuing for some months into 1975. The two procedures were almost always accomplished within the same week, often on the same day. All patients with the diagnosis of a space-occupying lesion confirmed by contrast neuroradiological procedures, craniotomy, or necropsy were included in this study. Patients with incomplete information or in whom the diagnosis was uncertain were excluded.

CT scans were made with an EMI scanner displaying an image in a matrix of 160 × 160 elements. Tomographic cuts were separated by 2.5-cm intervals and obtained at an angle of 20° to 30° in relation to the orbitomeatal line. In each study four scans were done resulting in eight tomographic pictures. Intravenous contrast medium was used in most patients.

EEGs were recorded with 16- to 18-channel instruments using the 10 to 20 electrode placement system. Bipolar and reference montages were used in every record. All patients underwent hyperventilation and photic stimulation and many were studied during sleep. In addition to the classic features of local polymorphic slow activity, particular attention was given to any disturbance of background rhythms and the results of activation procedures.

The diagnosis of a space-occupying lesion was assured in most cases by craniotomy or necropsy verification. Some patients who had refused surgical intervention or whose condition ruled out surgery had diagnosis confirmed by contrast neuroradiological procedures and/or radionuclide brain scanning. One postcraniotomy study in a patient suspected of having recurrence of a parasagittal meningioma was also included. A few nonneoplastic conditions such as subdural hematoma and hygroma, subarachnoid cyst, and brain abscess were likewise incorporated into the study. Special emphasis was given to localization and a clear distinction was made between localizing and nonlocalizing abnormal results. Inconclusive or nonspecific abnormalities obtained by either procedure were rated as failures.

Results

CT alone was diagnostic in 104 patients (90%) and EEG alone in 79 (68%). The results of both procedures were simultaneously diagnostic in 72 patients (62%) and both failed in only two (1.7%). In combination, both methods provided sufficient information to suspect or suggest a space-occupying lesion in 114 of 116 individuals (*Table 1*).

CT and EEG results were reasonably

Table 1. CT versus EEG findings in 116 patients with an intracranial mass

	EEG					
	Highly diagnostic		Abnormal, not localizing		Normal or nonspecific	
CT	No.	(%)	No.	(%)	No.	(%)
Highly diagnostic	72	(62)	16	(13.8)	16	(13.8)
Abnormal, not localizing	0	(0)	3	(2.6)	0	(0)
Normal or nonspecific	7	(6)	0	(0)	2	(1.7)

comparable in supratentorial parenchymatous tumors (*Table 2*). All 37 supratentorial malignant gliomas, astrocytomas, and oligodendrogliomas were correctly localized by CT. The EEG studies gave a precise localization in 11 of 12 malignant gliomas, in 19 of 22 astrocytomas, and in two of three oligodendrogliomas. The EEG failed to detect a left frontal glioma and a grade II parasagittal astrocytoma, and was rated abnormal without localizing value in two patients with right parietal astrocytoma and in one with left frontal oligodendroglioma (*Figure*).

Supratentorial metastases (*Table 3*), including bilateral and multiple lesions, were localized by CT in 27 of 31 patients. Although the EEG was less efficient in the detection of multiple sites of implantation, it did give a correct localization on the four cases missed by CT. The EEG failed in only three individuals.

Twelve of 13 supratentorial meningiomas (*Table 4*) were correctly localized by CT, the exception being a probable postcraniotomy parasagittal recurrence, whereas the EEG failed in a tuberculum sella and a sphenoid wing meningioma, and was rated abnormal but without localizing value in a left frontal meningioma and a falx meningioma. Incongruent results were obtained with other supratentorial extra-axial tumors due to EEG failures (*Table 5*). CT localized all but one, being partially diagnostic for a chromophobe adenoma. The EEG was abnormal without clear localizing value in two chromophobe adenomas, a pituitary adenoma, and an acoustic neurinoma. It was negative or nonspecific in six instances (craniopharyngioma (2), chromophobe adenoma (1), pituitary adenoma (1), acoustic neurinoma (1), cholesteatoma (1).

Table 2. Supratentorial gliomas, 37 patients

CT	EEG: Highly diagnostic	EEG: Abnormal, not localizing	EEG: Normal or nonspecific
Highly diagnostic			
Gliomas Gr IV (12)	11	0	1
Astrocytomas (22)	19	2	1
Oligodendrogliomas (3)	2	1	0

In supratentorial nonneoplastic space-occupying lesions both CT and EEG produced localizing results in five of seven individuals (*Table 6*). The EEG was abnormal, but not localizing in a subarachnoid cyst detected by CT, and the CT failed in a subdural hematoma where the EEG was abnormal. In a small group of supratentorial miscellaneous tumors (lymphomas, dermoid cyst, tuberous sclerosis, and a tumor of unknown histology), CT results were localized in seven patients and the EEG in six, failing to detect a right frontal lymphoma (*Table 7*).

In the investigation of infratentorial tumors, CT failed to diagnose two brain stem gliomas and one cerebellar tonsillar tumor, and the EEG failed in three brain stem gliomas and one posterior fossa meningioma. CT and EEG were rated abnormal, but not localizing in a brain stem glioma and an ependymoma of the fourth ventricle; the EEG alone was abnormal and nonlocalizing in a left cerebellar metastasis and two brain stem gliomas (*Table 8*). The outstanding fact about this group is that both procedures failed simultaneously in two brain stem gliomas.

Discussion

Largely congruent results were obtained by CT and EEG in this series of

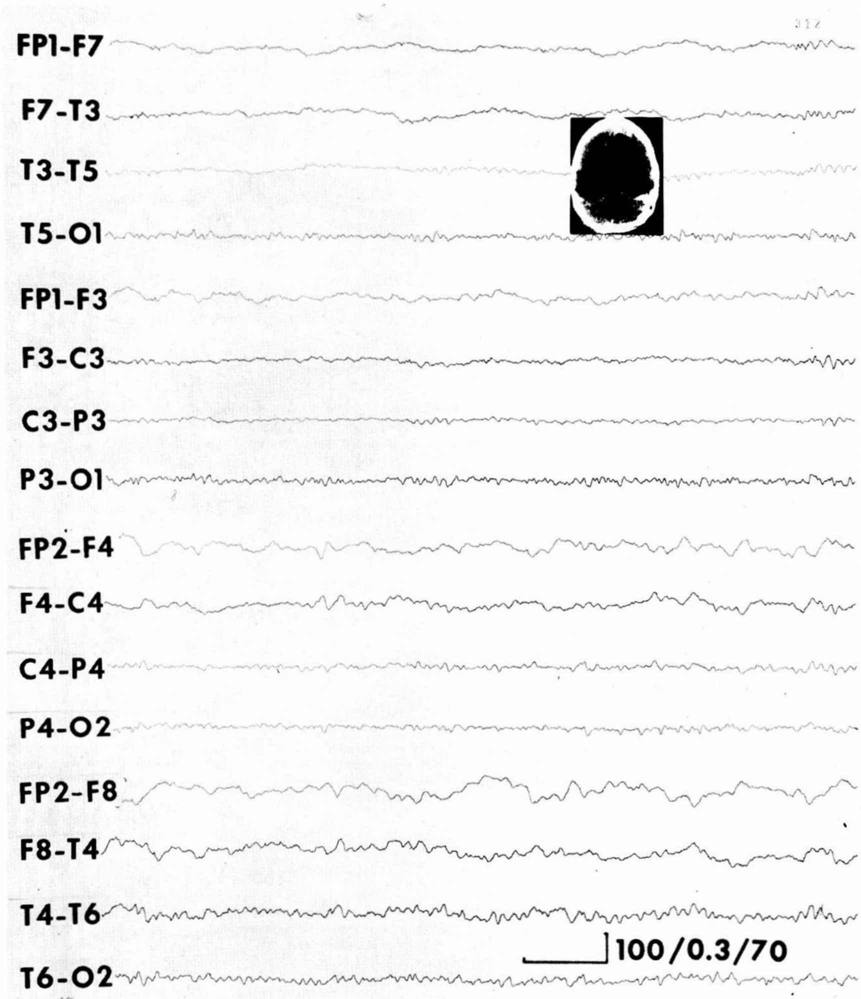

Figure. Example of concordant CT and EEG study of a patient with a right frontal grade IV glioblastoma.

Table 3. Supratentorial metastases, 31 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or non-specific
Highly diagnostic	20	4	3
Abnormal, not localizing	0	0	0
Normal or non-specific	4	0	0

Table 4. Supratentorial meningiomas, 13 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or non-specific
Highly diagnostic	8	2	.
Abnormal, not localizing	0	0	0
Normal or non-specific	1	0	0

116 intracranial space-occupying lesions. Supratentorial parenchymatous tumors were accurately located by both procedures in most patients. Supratentorial extra-axial tumors were better diagnosed by CT, although in many instances the EEG gave enough information to suspect a space-occupying lesion. Infratentorial tumors provided the highest incidence of failures. Cerebellar tumors were well diagnosed by CT and only indirectly suggested by EEG. Brain-stem tumors were poorly detected by either method. Although CT was more accurate in localizing intracranial masses, there were instances in which the EEG disclosed an abnormality in the absence of CT abnormality. Such were the cases of a cerebellar tonsillar tumor, a subdural hematoma, and four brain metastases.

Table 5. Supratentorial extra-axial tumors (other than meningioma), 10 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or nonspecific
Highly diagnostic	0	3	6
Abnormal, not localizing	0	1	0
Normal or nonspecific	0	0	0

Table 6. Supratentorial nonneoplastic space-occupying lesions, 7 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or nonspecific
Highly diagnostic	5	1	0
Abnormal, not localizing	0	0	0
Normal or nonspecific	1	0	0

Table 7. Supratentorial miscellaneous tumors, 7 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or nonspecific
Highly diagnostic	6	0	1

Table 8. Infratentorial tumors, 11 patients

	EEG		
CT	Highly diagnostic	Abnormal, not localizing	Normal or nonspecific
Highly diagnostic	1	3	2
Abnormal, not localizing	0	2	0
Normal or nonspecific	1	0	2

A brief comment about negative or nonspecific results is appropriate. Excluding subtentorial and extra-axial lesions, where the EEG in particular tended to fail or be nonlocalizing, CT failed in only six of 97 lesions. EEG failed in ten, with another ten instances in which the record was abnormal, but without clear localizing significance. Nevertheless, taken together, definite diagnostic findings were obtained on all 97 patients when the CT and EEG data were combined.

CT provides excellent information on the location of mass lesions, structural distortion of neighboring regions and the extension of edema. It also distinguishes between more than one independent lesion, as in metastases. The EEG may suggest the location of the tumor, but in most cases it cannot discern among several masses and does not give direct information on the presence of perilesional edema. On the other hand, the EEG shows the amount and extension of functional distortion, which in many instances is larger than the strictly anatomic involvement. It also furnishes knowledge on certain functional peculiarities of the space-occupying lesion, most important of all its paroxysmal activity. Judiciously used, each of these noninvasive procedures complement one another in the initial evaluation of the patient suspected of harboring an intracranial space-occupying lesion.[5] It is anticipated that with new developments in CT scanning, some of the above-reported failures will be averted.

References

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