

Value of EEG in acute confusional states

RUTH OBRECHT, F. O. A. OKHOMINA, AND D. F. SCOTT

From the EEG Department, Section of Neurological Sciences, The London Hospital, London

SUMMARY Electroencephalograms of 95 patients with an acute confusional state, referred over three years, were studied to determine their usefulness. The majority were abnormal, and those from patients with intracranial pathology often showed asymmetry of delta activity and paroxysmal discharges. These, and other features, suggested that the EEG was a helpful investigation.

The importance of the EEG in acute confusional states was noted by Engel and Romano (1959), while Bickford and Butt (1955) reported findings in hepatic encephalopathy which were re-emphasised by Silverman (1962). Subsequently there have been communications on particular aspects—for example, Schwartz and Scott (1971) on confusion associated with spike and wave discharges in the EEG, and Swash and Rowan (1972) in relation to calcium disorders. However, recent overall evaluation of the use of the EEG is lacking although published reports have been reviewed (Dongier, 1974).

The purpose of the present investigation was to study a series of consecutive referrals with acute confusional state to a general hospital, and particular attention was paid to the value of the EEG in distinguishing between those patients with an intracranial cause for the condition and those in whom the primary disorder was located elsewhere.

Subjects and method

Over three years 103 patients were referred to us with an acute confusional state, approximately 1.2% of the total number of EEGs undertaken in our department. Details of the patients were obtained from the EEG computer file in which patient identification, diagnosis, and EEG information are stored (Krauthammer *et al.*, 1966; Scott, 1976). There were 63 men and 40 women.

The ages ranged from 20 to 88 years, and 70 of the patients were over 50 years of age. The majority (56) were referred by general physicians, and approximately equal numbers from neurologists, psychiatrists, and the cardiac surgeon. Ninety

were inpatients and 13 were attending the outpatient department.

The patients were divided according to the site of the primary disturbance, whether intracranial or extracranial—for example, metabolic or electrolyte disorder. Classification was based on all the information available in the EEG request forms and the case notes (Table 1). There were 48 patients with intracranial pathology. Forty-two patients had primary extracranial pathology. Eight

Table 1 Classification of study patients according to type of disorder

Category of disorder	Number of patients	Total in group
Disorders within the cranium		
Diffuse cerebrovascular disease	14	
Vascular lesions	9	
Degenerative conditions of brain (dementias, multiple sclerosis)	7	
Brain tumours	6	
Abscess, venous thrombosis	3	
Diffuse inflammatory conditions	3	
Head injury	2	
Hydrocephalus	2	
Temporal lobe epilepsy	2	
		48
Extracranial disorders		
Metabolic and electrolyte disturbance (secondary to hepatic failure, gastrointestinal disorders, endocrinal diseases)	18	
Cardiac surgery	9	
Tumour in other systems	8	
Alcoholism	5	
Neurological abnormalities at spinal cord level	2	
		42
Mixed pathology		
Dementia and acute respiratory infection	3	
Cardiopathy, electrolyte disturbance, and suspected vascular accident	2	
Metastatic carcinoma (also suspected in brain) and severe electrolyte disturbance	2	
Diabetes mellitus, hypertension, cerebral vascular disease	1	
		8
No organic basis		5
		103

Address for correspondence and reprint requests: Dr D. Scott, EEG Department, Section of Neurological Sciences, The London Hospital, Whitechapel, London E1 1BB.

Accepted 11 July 1978

patients in whom no definite decision could be made on whether the cause for their confusion was intra- or extracranial were omitted from further consideration. In five patients no organic basis was found for their confusional state; three had a previous history of psychiatric disorder. Ten out of the 95 patients now being considered had seizures, six had known intracranial pathology, three of them had temporal lobe epilepsy, and a further three, presenting as late onset epilepsy with major seizures, had diffuse cerebrovascular disease. In the remainder, epilepsy complicated a variety of systemic disorders. None of the patients had idiopathic epilepsy.

Nine of the 95 patients had undergone cardiopulmonary bypass, after which a confusional state developed. In the majority the primary disorder was considered to be outside the central nervous system. Consideration was given to the behavioural state of the patients (Victor and Adams, 1953) who had an extracranial cause for confusion. Fourteen were agitated and eight unreactive. Four of the 22 were alcoholics. In the remainder there was no predominant pattern to their behaviour.

The EEGs were performed in a routine way with Elema Schönander machines, using either pad or stick-on electrodes placed according to the 10/20 system. Only the EEG at the time of the confusional episode was included in this study, although previous and subsequent tracings were examined in relation to patients with epilepsy. The recordings were assessed at the time of reporting, using a transcription sheet which allows qualitative and semiquantitative ratings of EEG features (Krauthammer *et al.*, 1966; Scott, 1976). The dominant rhythm was noted and each activity was then considered in detail and coded for amplitude, distribution, and amount. Asymmetries of any of these characteristics were also determined. Generalised or focal sharp waves, spikes, and spike and wave were also assessed, as well as the presence or absence of various features such as bifrontal delta, paradoxical delta (Schwartz and Scott, 1978), and triphasic waves. Finally, an overall assessment was made on whether the EEG was normal or abnormal, and the degree of abnormality found.

Results

Eighty-three of the 95 patients had abnormal EEGs: 52 showed marked and 31 mild disturbance (Table 2). Twelve patients had normal recordings. The degree of abnormality was very little different whether there was definite intracranial pathology or the disturbance was primarily extracranial. Patients with known psychiatric disturbance showed only mild EEG abnormality.

Table 2 EEG results in 95 patients with acute confusional states

Category of disorder	EEG		Degree of abnormality	
	Normal	Abnormal	Mild	Marked
Disorder within the cranium	4	44	16	28
Extracranial disorder	5	37	13	24
No organic basis	3	2	2	0
Total	12	83	31	52

Alpha activity was dominant in 56 of the 95 records, fast frequencies in five, and theta activity in most of the remainder. Sixty-six of the 95 records showed delta activity. Marked amounts appeared in 17 out of 48 with intracranial pathology, and in six of the 42 where the pathology was located elsewhere. Asymmetries of the delta activity occurred in 11 of 37 patients with intracranial disturbance compared with two out of 28 where the disturbance was outside the cranium.

Spikes, sharp waves, and spike and wave complexes appeared in the EEGs of 17 of the 95 patients. Most of these (14) were from the group with intracranial pathology. The paroxysmal features were localised in 11, and generalised in three records. The other three were from the patients with extracranial pathology. Two of these had febrile respiratory infections with electrolyte disturbance, and their EEGs showed bilateral sharp waves. The third patient had previously had a lung excision for carcinoma and, though he showed no localising neurological signs, the EEG showed lateralised spikes and sharp waves.

Bifrontal delta activity was seen in 31 patients, and it was equally common in those with intracranial and extracranial disorders. Pathological stimulus-related slow wave arousal responses, often called paradoxical delta activity (Schwartz and Scott, 1978), occurred in only three records, all from patients with intracranial pathology. Similarly, periodic lateralised epileptiform discharges which recur at a repetition rate of more than one a second over a particular area and are associated usually with seizures (Chatrian *et al.*, 1964), were observed in three patients. On the other hand, triphasic waves, delta waves with a specific sharpened configuration and three definite components (Bickford and Butt, 1955) were noted in five patients, of whom three had a systemic disorder.

PARTICULAR GROUPS OF PATIENTS

Of the 10 patients with epilepsy, all had abnormal EEGs, more than half being markedly disturbed, but only two showed spikes and sharp waves. Of

the three patients who had seizures of temporal lobe type, two showed improvement in their EEG abnormality at the time of confusion compared with their previous records, and the third showed an increase in abnormality in the form of a sharp wave focus and bilateral slow activity. The EEG of the three patients who had late onset epilepsy showed diffuse disturbance but only one had sharp waves and spikes. In the remaining four, in whom seizures and confusion were related to an extracranial cause, diffuse EEG abnormality with delta activity was seen, both in a widespread and bifrontal fashion. Diffuse spikes and sharp waves were noted in only one such patient.

In the nine patients who had cardiopulmonary bypass the EEG abnormality was diffuse with intermittent bifrontal delta activity. Spikes and sharp waves were noted in the EEG of one patient and triphasic forms in another. The other patients of the whole series who had triphasic EEG waves had respectively, electrolyte disturbance, mitral valve disease, myxoedema, and venous sinus thrombosis.

Of the 22 patients with marked behavioural change and an extracranial cause for their confusion, 14 were agitated and eight underactive. The majority in both groups had marked EEG disturbance. Considering only the four alcoholic patients, the two who were agitated showed only mild non-specific changes in their EEG tracings, while the underactive pair had markedly abnormal records with generalised slowing of cerebral rhythms.

Discussion

Although confusional states currently provide a small number of referrals to neurophysiology departments, our clinical impression was that the EEG was of value, in particular for deciding whether confusion was primarily due to intracranial causes or secondary to a systemic disturbance. Bearing in mind the well-known non-specificity of the EEG in this condition (Dongier, 1974), a group of confused patients were studied who had been referred consecutively to our department.

Almost half of the 48 patients with primary intracerebral disease showed abnormality such as asymmetries of delta activity and localised paroxysmal features. In the group of 42 patients in whom the disturbance was primarily in other systems, abnormalities of this type were seen in only three. On the other hand, the small group of patient with no organic disturbance showed normal or very mildly abnormal records, whereas in most patients with pathology either in the brain or elsewhere the EEGs were abnormal, and in most instances

markedly so.

Other phenomena such as bifrontal delta activity and triphasic waves were seen in both intracranial and extracranial conditions while none of the patients without organic basis for the confusional state showed these features. The findings are similar to those in another study (Rowan *et al.*, 1974) on intracranial metastases. The EEG, therefore, does appear to have a use in acute confusional states, and it is of interest that in a small number of patients the investigation gave the first clue that the cause of the mental state was intracranial.

We are grateful to the physicians and surgeons of the London Hospital who allowed us to study their patients.

References

- Bickford, R. G., and Butt, H. R. (1955). Hepatic coma: the EEG pattern. *Journal of Clinical Investigation*, **34**, 790-799.
- Chatrian, G. E., Shaw, C-M., and Leffman, H. (1964). The significance of periodic lateralised epileptical discharges in the EEG: electrographic, clinical and pathological study. *Electroencephalography and Clinical Neurophysiology*, **17**, 177-193.
- Dongier, M. (1974). In *Handbook of EEG and Clinical Neurophysiology*, Vol. 13, Clinical EEG III, pp. 22-59. Edited by A. Rémond. Elsevier: Amsterdam.
- Engel, G. L., and Romano, J. (1959). Delirium, a syndrome of cerebral insufficiency. *Journal of Chronic Diseases*, **4**, 260-276.
- Krauthammer, W., Last, S. L., Morgan, M. H., and Prior, P. F. (1966). EEG reports—the storage of data in a computer. *Electroencephalography and Clinical Neurophysiology*, **21**, 616.
- Rowan, A. J., Rudolf, N. de M., and Scott, D. F. (1974). EEG prediction of brain metastases. *Journal of Neurology, Neurosurgery, and Psychiatry*, **37**, 888-893.
- Schwartz, M. S., and Scott, D. F. (1971). Isolated petit mal status presenting de novo in middle age. *Lancet*, **2**, 3-8.
- Schwartz, M. S., and Scott, D. F. (1978). Pathological stimulus related slow wave arousal responses in the EEG. *Acta Neurologica Scandinavica*, **57**, 300-304.
- Scott, D. F. (1976). *Understanding EEG*. Duckworth: London.
- Silvermann, D. (1962). Some observations of the EEG in hepatic coma. *Electroencephalography and Clinical Neurophysiology*, **14**, 53-59.
- Swash, M., and Rowan, J. (1972). EEG criteria of hypocalcemia and hypercalcemia. *Archives of Neurology (Chicago)*, **26**, 218-228.
- Victor, M., and Adams, R. A. (1953). *The Effect of Alcohol on the Nervous System*. Association for Research in Nervous and Mental Diseases. Williams and Wilkins: Baltimore.