ELECTROENCEPHALOGRAPHY

EDWARD M. ZUCKER, M.D.
Department of Neuropsychiatry

Electroencephalography, or the recording of action potentials of the brain, is being utilized increasingly as a laboratory aid in studying a variety of cerebral dysfunctions.

Hans Berger[1] first reported in 1929 that he had recorded spontaneous electric discharges from the human brain and established that this electric activity originates in the neurons.

Satisfactory amplification of the extremely small potential changes depends upon a very sensitive and delicate instrument capable of responding to minute potential changes. The instrument consists of a preamplifier, an amplifier, and a recording pen. The most satisfactory instruments consist of several channels and are able to record voltage changes simultaneously from several points. The instrument can record frequencies of 1 to 40 per second and will respond to changes in potential from 5 to 300 microvolts. Each record is carefully standardized before and after the recording so that voltage of the waves can be determined, and the recording paper runs at a constant speed so that the frequency of the waves can be counted.

The usual record takes only thirty to sixty minutes to record and is taken without pain or discomfort to the patient. The patient is usually placed in a shielded room to exclude extraneous electrical impulses which might produce artifacts in the record. The record is made with

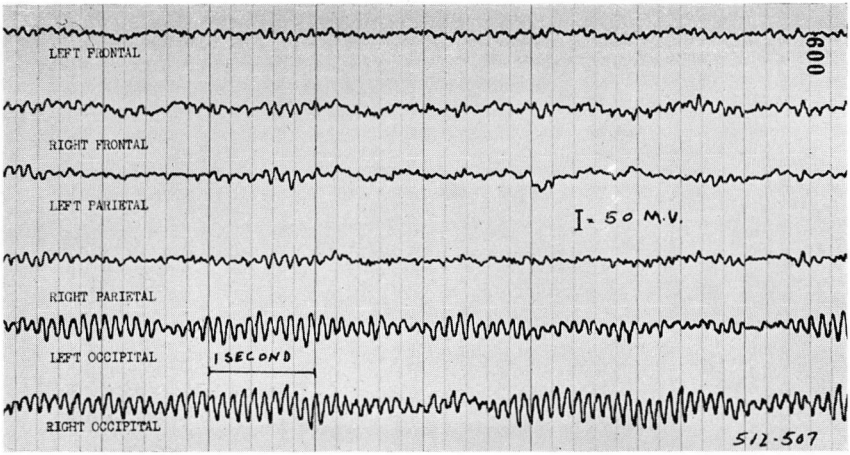

FIG. 1. Normal 10 per second alpha waves best seen in the occipital leads.

the patient relaxed but not asleep, as free from all sensory stimuli as possible, and within two hours after a meal. The patient should be free from the effect of medication before the record is made. Small electrodes are attached to the frontal, temporal, parietal, and occipital regions of both sides of the scalp in a routine examination. An indifferent electrode is attached to the lobe of the ear and is used as a point of reference. The patient is grounded by an electrode attached to the other lobe of the ear. Additional electrodes are used for cortical localization.

The normal pattern of the electroencephalogram consists of a series of sinusoidal waves with a frequency of 8 to 12 per second (average 10) and with an amplitude of 10 to 75 microvolts (fig. 1). These waves are most regular from the occipital and parietal regions with the patient's eyes closed. These are called alpha or Berger waves. About 85 to 90 per cent of the population in general show normal patterns; the other 10 to 15 per cent show irregularities in the electroencephalographic pattern.[2] The records are analyzed as to frequency, amplitude, wave forms, and in some cases the phase relationship of abnormal waves.

Convulsive disorders or the epilepsies show the most striking changes. Even in the interval between seizures the electroencephalogram will show a high percentage of abnormalities (80 to 85 per cent). Most cases show variations in frequencies, called dysrhythmias. The waves are either too fast or too slow. Gibbs[2] correlated the abnormal epileptic patterns and found that rapid spike waves were more often associated with grand mal seizures, a slow (four to six-second) wave (fig. 2) was found in psychomotor seizures, and a slow (three-second) wave (fig. 3), often with an alternating diphasic spike, was associated with petit mal activity. However, prediction of the clinical type from the record between seizures is not always possible. The voltage is usually abnormally

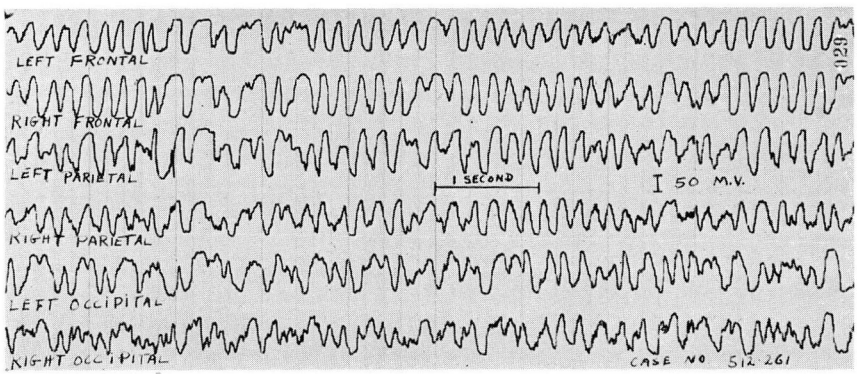

FIG. 2. Case of 16-year-old patient with grand mal, petit mal, and psychomotor seizures; the latter were dominant recently.

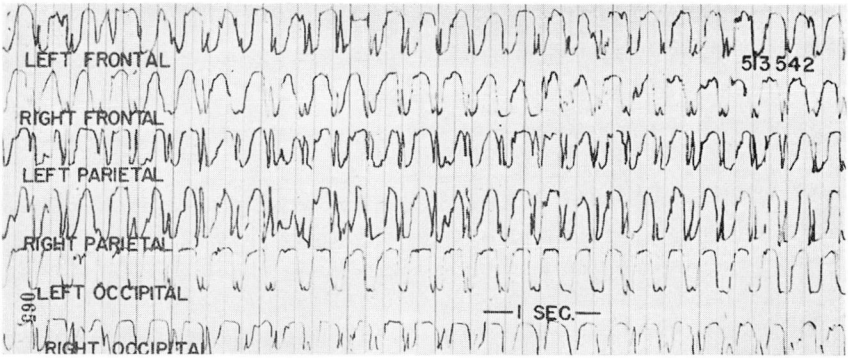

FIG. 3. Record of a clinical petit mal seizure which occurred during hyperventilation.

high in epileptic records, sometimes reaching 200 to 300 microvolts. During an actual seizure there is a tremendous energy output, indicating a massive neuronal discharge. Hyperventilation will often produce a disorganization of the normal pattern and an abnormal voltage build-up which otherwise might not appear. Clinical or subclinical seizure discharges are often produced in petit mal epilepsy by over breathing.

Focal organic lesions, such as tumors, abscesses, and cysts, when they involve the cortex, can often be localized by the focal abnormal electric activity produced by the lesion.[3] The lesion, itself, may be electrically inactive, but the surrounding compressed brain tissue usually gives rise to abnormal, slow waves. Amplitude asymmetry between homologous areas of the two hemispheres is also useful in cortical localization. An epileptogenic lesion may occasionally give rise to focal discharges of spike-like waves. A subdural hematoma may cause a depression of electrical activity over the area of the injury.

Electroencephalography is an aid in evaluating head trauma. As might be expected, posttraumatic epilepsy and cases with neurologic evidence of brain damage show the higher percentage of abnormal records. Walker[4] has used a subconclusive dose of metrazol to activate areas of abnormal irritability or epileptogenic foci, and this localization is utilized in the neurosurgical removal of these lesions.

A high percentage of abnormal records have been demonstrated in cases of psychopathic personalities and behavior disorders in children. Putnam and Merritt[5] reported a series of cases in which dullness, apathy, and mild mental confusion appeared as an epileptic variant. Electroencephalography furnishes valuable diagnostic information in many of these epileptoid conditions.

Conclusion

Electroencephalography is a valuable laboratory diagnostic instrument in the study of convulsive disorders, in the localization of gross lesions of the cortex, in the evaluation of head injuries, and in the diagnosis of other conditions which indicate a cerebral dysfunction. It is not intended that electroencephalography should displace other means of investigation such as a careful history, neurologic examination, x-ray examination, blood and spinal fluid studies, but rather that it should serve as a supplementary procedure to the proved methods of diagnosis in diseases of the nervous system.

References

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