Electroencephalography in Neuropsychiatry

April 01, 2006 | ADHD [1], Bipolar Disorder [2], Schizophrenia [3], Antisocial Personality Disorder [4], Sleep Deprivation [5], Neuropsychiatry [6], Addiction [7], Alcohol Abuse [8]
By Nash N. Boutros, MD [9] and Kerry Coburn, PhD [10]

The recent evolution of neuropsychiatry/behavioral neurology as a subspecialty represents a paradigmatic shift regarding the responsibility of psychiatrists in diagnosing and managing behavioral disorders with concomitant and demonstrable brain pathology such as dementia or head injury. This authors define the clinical usefulness of electroencephalography in evaluating neuropsychiatric disorders.

Special Report: Neuropsychiatry

Electroencephalography (EEG) is a noninvasive, widely available, and relatively inexpensive test that can help exclude or identify structural or functional factors contributing to psychiatric syndromes. This article defines the clinical usefulness of EEG in evaluating neuropsychiatric disorders, emphasizing the complementary nature of the visually inspected standard EEG (SEEG) and the computeranalyzed quantified EEG (QEEG).

The recent evolution of neuropsychiatry/behavioral neurology as a subspecialty linking these formerly disparate fields represents a paradigmatic shift regarding the responsibility of psychiatrists in diagnosing and managing behavioral disorders with concomitant and demonstrable brain pathology such as dementia or head injury. In addition, the biologic underpinnings of many mental illnesses, including bipolar disorder and depression, are now described in terms of their anatomy and physiology. QEEG analysis increases the sensitivity of EEG to physiologic or pathologic changes associated with such disorders.

Standard EEG

SEEG refers to the visual analysis of ongoing voltage recordings from multiple scalp locations. Two types of EEG deviations are usually indicative of significant cerebral pathology. The first is paroxysmal activity, including sharp waves, spikes, and episodic slow waves, indicating episodic abnormal neuronal discharges. These can be focal, suggesting structural pathology, or bilateral and more suggestive of functional pathology. The second type of EEG deviation is sustained slowing of normal brain rhythms. Slowing also can be diffuse, indicating more generalized pathology, or focal, indicating a localized pathology.

The most frequent reason for an EEG referral is to exclude a general medical condition, such as delirium, or a specific neurologic problem, such as epilepsy, as a cause of or a contributing factor to the presenting symptoms. Since the use of routine test batteries to exclude medical conditions is costly, clinicians must rely primarily on 2 red flags to trigger organic workups: unusual presentations and atypical age at onset. The yield is consistently low when using neuroevaluative tests to uncover causes such as tumors or aneurysms for syndromes presenting without manifest neurologic disturbances. It is much more likely that an EEG will uncover a factor that may be contributing to, but does not necessarily fully explain, the syndrome. It may also be helpful in revealing a factor that could help guide treatment, such as temporal lobe spiking in panic disorder.\(^1\)

Quantified EEG

After the EEG has been recorded and visually interpreted by the electroencephalographer, it may be analyzed further using quantitative means.\(^2\) QEEG analysis is always a post hoc procedure done after visual interpretation of the SEEG by a qualified electroencephalographer. It is specifically not recommended for use clinically as a stand-alone procedure. At its most basic level, QEEG provides a method of calling the electroencephalographer's attention to aspects of the original EEG record that may have been overlooked. QEEG's quantitative nature makes it exquisitely sensitive to subtle frequency changes and to abnormalities in the coherence of activity within and among brain regions. Brain activity varies among healthy people, and normal variability must be distinguished from that outside the normal range. An underlying assumption is that the more unusual the patient's brain activity compared with that of normal persons, the more likely it is that the statistical abnormality represents pathology. The establishment of normal limits is greatly aided by quantitative analysis comparing the patient's QEEG with those derived from large groups of healthy persons. Brain activity also changes with age, and QEEG tracks the moving window of normal limits across the entire life span.
In addition, QEEG can help the physician arrive at a specific diagnosis. Patients who have known neuropsychiatric disorders often show characteristic QEEG profiles, distinguishing them from patients who have similar disorders. When facing a difficult diagnostic question, the physician can compare the patient’s QEEG with the profiles characteristic of the different diagnostic possibilities, looking for the best fit. An extensive body of research shows that the accuracy of such computerized diagnostic classifications on the basis of QEEG alone typically exceeds 80%, although in an actual clinical setting the physician always makes the diagnosis, informed by other sources of information in addition to QEEG. Well-replicated studies have demonstrated QEEG classification accuracies high enough to be useful in diagnosing learning and attention disorders in children, and mood disorders (including bipolar disorder) and dementia among adults. Clinical Indications

The relative usefulness of SEEG and QEEG depends on the clinical indications for testing. Mental status changes, unusual presentations, personality changes, episodic behavior, and attention problems are situations that often prompt testing. Acute or gradual mental status change Patients with advanced dementia rarely have normal SEEG results, so a normal EEG is important in diagnosing pseudodementia secondary to depression or psychosis. When dementia and depression coexist, it becomes important to assess the relative contribution of each disorder to the overall clinical presentation; and SEEG has been shown to be helpful in this situation. SEEG is insensitive to the early stages of dementia, however, and cannot be relied on in diagnosing frontotemporal dementia (FTD). One reason for SEEG insensitivity to early dementia is that EEG changes in most dementing disorders are exaggerations of those found in normal aging. QEEG controls for healthy aging, however, and is sensitive even to subtle changes beyond normal limits. QEEG detects significant abnormalities at the earliest stages of dementia, which increase in parallel with increasing dementia severity. Figure 1 shows an example of a QEEG obtained from a demented patient. In addition to the more easily identified dementia types, QEEG may facilitate the difficult diagnosis of FTD. Perhaps of more importance, QEEG has been shown to distinguish accurately between dementia and pseudodementia.

The differential diagnosis of acutely disturbed and disorganized demented or psychotic patients often includes delirium. SEEG may be helpful in revealing whether altered consciousness is the result of a diffuse encephalopathic process, a focal brain lesion, or continued epileptic activity without motor manifestations. Usually, delirious patients have a toxic-metabolic encephalopathy with diffuse slowing of the background rhythms. Figure 2 shows an SEEG obtained from an acutely confused patient. Limited published research, however, suggests that QEEG adds little to standard visual analysis for the detection of delirium. Unusual presentation

An atypical clinical presentation is the most important factor for initiating an SEEG evaluation. However, patients with a nonatypical rapid-cycling bipolar disorder also may exhibit epileptiform EEG discharges. This may explain the reported effectiveness of anticonvulsants for rapid-cycling bipolar disorders.

Himmelhoch described the clinical characteristics of subictal mood disorders, including brief euphorias, mixed bipolar episodes, brief severe depressive dips with impulsive suicide attempts, compulsive symptoms, irritability and hostile outbursts, and marked premenstrual worsening. Patients with these disorders may also have paradoxical reactions to lithium and antidepressants, with better response to anticonvulsants.

QEEG is very sensitive for the detection of depression and for the discrimination between depression and dementia. A limited number of articles in the literature further suggest that QEEG accurately discriminates between unipolar depression and bipolar disorder, but this finding awaits independent replication. Recent personality change

An obvious recent personality change should always be viewed as a danger sign, and a full evaluation should be performed. Chronic postconcussive syndrome deserves special mention. QEEG is more helpful than SEEG in such cases. Even mild concussions in which the patient experiences either no loss of consciousness or less than 20 minutes of unconsciousness can cause reduced attention span, reduced shortterm memory capacity, depression, mood disorders, word-finding problems, and slowness of thought. EEG changes that often accompany mild head injury include reduced beta and/or alpha activity and increased theta activity. One commercially available QEEG system is tailored to detect brain damage secondary to closed head injuries and has been demonstrated to do so with greater than 95% accuracy. Episodic behavior

Case reports have described patients in whom borderline personality disorder (BPD) was diagnosed but who were subsequently found to have complex partial seizures documented by epileptic discharges over temporal regions. The prevalence of abnormal EEGs among clinic populations...
ranges from 6.6% in patients with rage attacks and episodic violent behavior to 53% in patients with antisocial personality disorder. \(^{11, 12}\) A flowchart for evaluation of patients presenting with episodic aggressive behavior is shown in Figure 3.

Whether an abnormal EEG predicts a favorable therapeutic response to anticonvulsants is currently unknown. Anticonvulsants can block epileptiform discharges and can lead to dramatic clinical improvement in persons exhibiting repeated and frequent aggression.\(^{13}\) The addition of carbamazepine to the treatment regimen of patients with schizophrenia who also exhibit EEG temporal lobe abnormalities but no history of seizure disorder can be beneficial.\(^{14}\) Anticonvulsants also may reduce aggressive tendencies irrespective of EEG abnormalities.\(^{15}\) Finally, panic symptoms resemble symptoms induced by temporolimbic epileptic activity, particularly that originating from the sylvian fissure. Panic disorder is the most common psychiatric disorder that must be differentiated from temporal lobe epilepsy.\(^{16}\)

**Attention and learning disorders**

Frank\(^ {17}\) reported that 21 (31%) of a sample of 64 children with attention-deficit/hyperactivity disorder had abnormal SEEG. Of these, 84% had spikes or spike-wave discharges. Hughes and associates\(^ {18}\) found “definite noncontroversial epileptiform activity” in 53 (30.1%) of 176 children with ADHD. Mainly focal and usually occipital or temporal, the epileptiform activity was less often generalized, with bilaterally synchronous spike and wave complexes seen in 7% of children. Several large, independently replicated studies have shown that QEEG distinguishes between healthy children and those who have a variety of attention or learning disorders, with accuracies typically exceeding 80%. While autism cannot be diagnosed based on EEG findings, an EEG can help rule out the presence of epileptic activity that is relatively common in this group. **Adequate SEEG evaluation**

For an adequate SEEG evaluation, the clinical reason for the referral must be considered. If a slow-wave abnormality is suspected, an awake recording is sufficient. The most important caveat is to make absolutely sure that the patient is alert during the procedure. In patients with borderline results, the inclusion of hyperventilation could enhance the abnormality.

If the purpose of SEEG is to rule out epileptiform discharges, an awake EEG is inadequate, and the inclusion of a sleep tracing is important. The EEG report should clearly indicate the stage of sleep during the recording. Serial recordings enhance the likelihood of finding abnormalities, particularly epileptiform abnormalities.\(^ {19}\) In our experience, the yield of more than 2 recordings does not justify the added expense. The second recording may be performed following sleep deprivation. **Adequate QEEG evaluation**

As a post hoc analytic procedure, QEEG is supplementary and complementary to SEEG. No special recording procedures are required other than ensuring that filters and sampling rates are set at specified levels. Virtually all modern EEG machines can provide a digitized record suitable for computerized analysis. Because QEEG analysis is easily biased by artifacts, the electroencephalographer begins by selecting artifact-free samples of the alert eyes-closed SEEG, which then are analyzed mathematically using commercial software. Abnormalities detected by QEEG are traced back to the original SEEG and interpreted by the electroencephalographer. When using QEEG to assist in diagnosis, the physician again plays the central role of narrowing the diagnostic possibilities to a small number (usually 2). The more the physician knows about the patient, the more alternative diagnoses can be excluded, increasing the accuracy of the classification. QEEG is not used as a diagnostic filter, running the patient's data through all possible classifiers. Such misuse nearly always produces spurious results.

Problems encountered in QEEG generally reflect user error. Incorrectly set filters, unrecognized patient drowsiness or artifacts, and other recording or screening errors can be prevented by thorough training and the maintenance of high laboratory standards. Specific training is required to correctly use QEEG software and to interpret the results. All use of QEEG must be supervised by an electroencephalographer, and its application to psychiatric diagnosis requires additional expertise in the DSM differential diagnostic criteria.

SEEG and QEEG are complementary techniques, and modern digital equipment facilitates and tends to lower the cost of QEEG. Specialized training is necessary to interpret both SEEG and QEEG, and the interpreter must be proficient in psychiatric differential diagnosis. Dr Boutros is professor of psychiatry and neurology at the Wayne State University School of Medicine in Detroit, as well as director of the neuropsychiatry division and clinical electrophysiology laboratories. He reports that he has no conflicts of interest regarding the subject matter of this article.
References

Source URL: [http://www.psychiatrictimes.com/articles/electroencephalography-neuropsychiatry](http://www.psychiatrictimes.com/articles/electroencephalography-neuropsychiatry)

Links:
[1] [http://www.psychiatrictimes.com/adhd](http://www.psychiatrictimes.com/adhd)
[3] [http://www.psychiatrictimes.com/schizophrenia](http://www.psychiatrictimes.com/schizophrenia)
[9] [http://www.psychiatrictimes.com/authors/nash-n-boutros-md](http://www.psychiatrictimes.com/authors/nash-n-boutros-md)