

QEEG Neurometrics and Differential Diagnosis of ADHD

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Quantitative EEG (QEEG) can help reveal the underlying neurophysiology associated with the symptoms of Attention Deficit Hyperactivity Disorder (ADHD) and learning disorders, and help differentiate these disorders from other comorbidities. Excess slow wave activity is the most common abnormal finding in children with attention disorders with the thalamocortical and/or septal-hippocampal pathways most likely to be dysfunctional. The QEEG can play an important role in the evaluation and treatment of these children and adolescents by providing information that leads to better diagnosis and design of Neurotherapy treatment protocols and medication choices. QEEG Neurometrics has been shown in a number of large studies to have high sensitivity and specificity for distinguishing children with attention disorders and/or learning disorders from children without these disorders.

Background

Children and adults with ADHD form a heterogeneous population, with multifaceted aetiologies. After the introduction of the Attention Deficit Disorder (ADD) categories in the Diagnostic and Statistical Manual of Mental Disorders (DSM-III) in 1980, ADD and ADHD may have been used as acronyms for a range of separate dysfunctions or disabilities . A screening of 211 studies of ADHD revealed that the authors of these studies attributed 69 different characteristics to children labeled ADHD, and 38 different possible causes .

At a recent summit on ADHD, the Surgeon General of the USA, David Satcher, M.D., stated, " We believe that more than 4% of the children in this country (USA) suffer from ADHD. We want to know how to better identify and refer children for treatment". The presenters at the conference agreed that no single assessment method of ADHD was definitive. Satcher indicated that once the disorder was better understood, using procedures like QEEG, the ability to diagnose would improve .

Initially presented in the journal "Science" in 1988, the QEEG neurometric system was developed by Drs. Leslie Prichep and Roy John at the New York University Medical School . The database now contains the QEEGS of about 20,000 carefully screened normal subjects and various patient groups. The purpose of a QEEG neurometric assessment is to determine how various areas of the brain functionally differ from the age and gender appropriate database under eyes closed conditions.

The means and standard deviations of the normative distributions in the database having been established, individual patient's electrophysiological data can be evaluated objectively and expressed in standard deviations from the means. The basic assumption is that QEEG features exceeding two Standard deviations from the means are likely to reflect abnormality. Mathematical discriminant equations with multivariate features that characterize the EEG of normal individuals and various clinical groups have been constructed and independently replicated . Neurometrics are used to objectively assess the statistical similarity between the individual patient and various statistically-defined distinctive group profiles .

Research indicate that ADHD children can be differentiated from non ADHD in over 96% of cases on the basis of their QEEG signatures . QEEG helps to differentiate the

neurological underpinning of attention deficits arising from ADHD, from the neurological underpinning arising from attention deficits associated with other primary psychiatric disorders: depression, anxiety, obsessive compulsive disorder, oppositional defiant disorder or psychosis.

Chabot and colleagues found that the patterns of QEEG abnormality of children with ADHD and attentional problems represented deviations from normal development rather than maturational lag or a delay in normal development.

QEEG Discriminant Findings in ADHD

Chabot and colleagues used stepwise discriminant analysis to compare the normal population of children with the children with attention problems and normal IQ scores. A discriminant function utilising nine QEEG variables resulted in 94.8% correct classification of normal children and 93.1% correct classification of the normal IQ children with attention problems. Split-half replication resulted in a specificity of 88% (normal children called normal and a sensitivity of 93.7% (ADHD, ADD and ATT children called abnormal). A total of 95.4% of the low-IQ group of children with attention problems was classified as abnormal .

Using QEEG measures, it has been possible to discriminate replicably ADD/ADHD versus normal children, with a sensitivity of 90% and a specificity of 94% and ADD versus specific learning disorders with a sensitivity of 97% and a specificity of 84.2% .

Usefulness of QEEG neurometrics in a clinical setting.

Chabot and colleagues found that generalized or focal theta/alpha excess was present in 76.2% of their sample of ADD, ADHD, and children with attentional problems. These theta and alpha excess children can be divided into two distinct neurophysiological subgroups .

* The first and most common group consisting of 46.4% of the sample was characterised by theta and/or alpha excess, mostly at frontal and/or central regions with normal alpha mean frequency.

Excessively high output of thalamocortical alpha generators can result from (a) overactivation of the thalamus. The primary dopamine pathways originate in the substantia nigra in the brainstem and innervate the caudate nucleus and putamen and are largely responsible for sensorimotor integration. Down-regulation of nigrostriatal dopaminergic neurons results in overstimulation of the midbrain reticular formation and the production of excess alpha (b) underactivation of the prefrontal cortex resulting from disinhibition from nucleus reticularis.

Excess theta may be generated in the septal-hippocampal pathways. Dopaminergic neurons from the ventral tegmental bundle provide the septal nucleus and the nucleus accumbens with inhibitory modulation; and dopaminergic down-regulation is likely to result in excess theta .

This subtype of ADHD characterised by excess theta and alpha is therefore likely to result from under-activation of the frontal lobes due to down regulation of dopamine levels. Chabot's QEEG findings, Amen's SPECT studies as well as other neuroimaging studies support Levy's dopaminergic theory of ADHD which proposes a dysregulation

of prefrontal dopaminergic circuits .

However this QEEG profile was also reported to occur in depression and this subgroup of children has been shown to respond to the anti depressant Bupropion . A variant of this pattern is the presence of increased beta activity. Beta excess has been reported in several studies of adults with major affective disorders, and has been associated with anxiety.

* The second group of theta/alpha excess children in Chabot's studies showed evidence of a slowing of the alpha generator. This group included 29.8% of the total sample and involved theta/alpha excess accompanied by decreased alpha mean frequency.

Consequently ADHD children may have co-morbidities of depression and anxiety, and furthermore if the ADHD discriminant functions are not triggered, it is likely that depression and/or anxiety may be the primary diagnosis. The QEEG can tease out the underlying neurophysiology and help in the formulation of testable hypotheses that can be used to treat individual cases based on evidence of their neurophysiology. The choice of medication and of Neurotherapy frequency and training sites can be derived with the help of the QEEG, rather than be based on symptoms that are unrelated to the underlying neurophysiology.