QUANTITATIVE ELECTROENCEPHALOGRAPHY IN AUTISTIC CHILDREN

Thesis

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Abstract

Introduction: Autistic disorder has been defined as a neurodevelopmental disorder with associated deficits in executive function, emotional, language and social function. There are often regions of brain dysfunction associated with neural connectivity anomalies in autism. **Objectives:** The current study aimed to study the quantitative EEG findings in autistic children, and compare it to normal control.

Methods: The EEG recording was done for 21 autistic children between the ages of 4 and 12 years old compared to 21matched control group during an eyes-opened condition .Topographical differences in cerebral functioning were examined using estimates of absolute, relative power, asymmetry as well as theta beta ratio, delta alpha ratio and intrahemispheric and interhemispheric coherence.

Results: There were statistically significant differences in EEG power, symmetry, delta alpha ratio and coherence between autistic and control groups with excessive absolute of delta and theta power especially at frontal region. There was also global reduction in relative alpha and beta power especially in frontal, central and posterior regions in autistics. There was normal theta beta ratio but elevated alpha delta ratio in Fz and Pz midline sites (P= 0.02 and 0.05 respectively). Also there was a pattern of underconnectivity and over connectivity when measuring the intra and interhemispheric coherence in autistics compared to control group.

Conclusions: These results suggested regional dysfunction of brain in autistics along with a pattern of abnormal neural connectivity which could be the major deficit leading to autistic symptomatology.

Keywords: Autism; QEEG; power; Coherence

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List of Abbreviations

ACC	**Anterior cingulate cortex**
ADD	**Attention deficit disorders**
ADHD	**Attention-Deficit Hyperactivity Disorder**
APA	**American Psychiatric Association**
ASD	**Autistic spectrum disorder**
CAM	**Complementary and alternative medicine**
C.S	**Ceaserian section**
CDD	**Childhood Disintegrative Disorder**
CNS	**Central Nervous System**
Cps	**Cycle per second**
DSM	**Diagnostic and Statistical Manual of mental disorders**
EEG	**Electroencephalography**
EKG	**Electrocardiogram**
ERPs	**Event-related potentials**
FDA	**Food and drug administration**
FFT	**Fast Fourier Transform**
fMRI	**Functional magnetic resonance imaging**
GABA	**Gamma amino butyric acid**
GIT	**Gastrointestinal tract**
Hz	**Hertz**
ICA	**Independent Component Analysis**
ICD	**International classification of diseases**
LORETA	**low-resolution brain electromagnetic tomography**
MEG	**Magneto-encephalography**
MNS	**Mirror neuron system**
NEBA	**Neuropsychiatric EEG-Based Assessment Aid System.**

PDD	**pervasive developmental disorders**
PDD-NOS	**pervasive developmental disorders not otherwise specified**
PET	**positron emission tomography**
QEEG	**Quantitative electroencephalography**
RBS-R	**Repetitive Behavior Scale-Revised**
SD	**Standard deviation**
SPSS	**Statistical Package of social standard**
SMR	**Sensori- motor rhythm**
SPECT	**single-photon emission computed tomography**
SSRI	**Selective serotonin re-uptake inhibitor**

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INTRODUCTION

Autistic disorder (ASD) is a neurodevelopmental disorder that is clinically characterized by impaired social interaction, language impairments, behavioral stereotypes, and some cognitive deficits. These features appear in early childhood, tend to persist life-long, and often lead to poor outcome in adulthood ***(American Psychiatric Association., 2013).***

Recent epidemiological studies estimate the prevalence of ASD to be 1 in 88 children in the USA ***(Centers for Disease Control and Prevention, 2012).***

Given that an autistic disorder-identifying laboratory test is not available, diagnoses are primarily based on detailed clinical interview and behavioral observation, such as the Autism Diagnostic Interview, the Autism Diagnostic Observation Schedule, the Childhood Autism Rating Scale (CARS) and the Checklist for Autism in Toddlers (***McAlonen et al., 2005).***

Although behavioral observation remains the major diagnostic tool, it may be confounded by interrater bias. Thus, some efforts have been made to develop neurobiological measures including MRI measures and genetic testing that may provide more objective and sensitive diagnoses for autistic disorders. However, reliable and affordable neurobiological measures have not been established ***(Chan et al., 2007).***

Findings of a magnetic resonance imaging (MRI) study indicated that children with Autism had a significant reduction in total grey matter volume as well as fronto-striatal and parietal networks. In addition, white

matter was reduced in the cerebellum, left internal capsule, and fornices. Anomalies in brain metabolites have also been reported in the amygdala-hippocampal regions in autism ***(McAlonan et al., 2005).***

Despite an extensive research, there is still much debate about the morphological, functional, and neuropsychological characteristics of the "autistic" brain and thus the neural basis of altered behaviors in ASD remains largely unclear. Several neuroimaging and neurophysiological techniques have been used in order to understand the correlation between brain functionality and autistic behavior (***Narzisi et al., 2012).***

Among them, Quantitative Electroencephalography (QEEG) is currently receiving great interest and it is increasingly used in studies on neurodevelopmental disorders, especially the ASD. QEEG of resting-state data also has promise as an approach for monitoring treatment outcomes in autistic children through neurofeedback therapy and transcranial direct current stimulation therapy (tDCS) which depended on QEEG protocol ***(Sheikhani et al., 2012).***

QEEG is a type of electrophysiological assessment that applies computerized mathematical analysis to convert the raw waveform data into different frequency ranges including delta, theta, alpha, beta and gamma. EEG recordings may be performed at rest, in both closed and opened eye conditions, or while subjects perform specific tasks. The absolute power, relative power, asymmetry and brain connectivity or coherence in each frequency band can be calculated ***(Lucia et al., 2013).***

Given that the QEEG technique has the advantages of being less expensive, easier to perform, and noninvasive compared with some other neuroimaging techniques as fMRI. In this way, we are able to analyze the background activity of EEG with sophisticated statistical techniques to

reveal patterns invisible to the naked eye. Several groups of researchers have attempted to develop the QEEG technique as a screening assessment for neurodevelopmental disorders ***(Lucia et al., 2013).***

It is clinically significant to develop a biological screening test that is relatively easy and possible even for young children to perform. As previous research has suggested that as little as 1-min noise-free electroencephalographic (EEG) data would yield reliable and valid data it is possible to apply the EEG technique to children with special needs who may not be able to sit still for a long time or comply easily ***(Kropotove., 2009).***

There is emerging evidence that QEEG data can be used to assess regions of neural dysfunction associated with neural connectivity anomalies in autistic children. Assessment of regional brain dysfunction requires functional brain imaging techniques as static measures tend to find few abnormalities in autistic disorders. This would include techniques such as functional MRI, positron emission tomography (PET), single photon emission computed tomography (SPECT), magnoencephalography (MEG) and QEEG. Some of these techniques require sedation or injection of radioactive material so as to make participation difficult for a typical autistic child. EEG appears to be the most clinically available and least invasive of these techniques. ***(Coben and Myers., 2008).***

Coben et al ., (2008) have demonstrated that autistic children can be distinguished from typically developing children by their EEG alone at a rate in excess of 88%. They were also able to show that unique patterns of regional dysfunction could be discerned through the quantitative analysis of the EEG.