Clinical Experience

qEEG Study on the Treatment of ADHD with CES

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Attention Deficit Hyperactivity Disorder (ADHD), “hyperactivity” for short, is one of the most common behavioral disorders of childhood, with a prevalence rate of 3-6% for school-age children. For 2/3 of the child patients, the symptoms will last until adolescence, while for the remaining 1/3, the symptoms will last a lifetime.[1] As a new technology of importing weak micro-bioelectric current directly into the brain through electrodes clipped to the ear lobes, Cranial Electrotherapy Stimulation (CES) has been applied in the treatment of ADHD. Quantitative Electroencephalogram (qEEG) is used to evaluate the clinical effects of CES on the treatment of ADHD, for the expectation of providing an objective conclusion and result analysis of changes in neuro-electrophysiology. The related information and data of 90 cases of ADHD treated with CES are reviewed and summarized here.

I. Information and Method

1. General information: 90 children were treated at the Psychological Clinic for Children Rehabilitation of the First Affiliated Hospital of the Medical College of Shihezi University whose hyperactivity diagnosis scales were compliant with the diagnostic criteria for ADHD published in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IVr), including 70 boys and 20 girls, 6-13 years old (average age 9.5 years old). With the informed consent of their parents, these patients were included and controlled to receive continuous and complete examination and treatment.

Inclusion criteria: patients were included who agreed to be hospitalized for a course of treatment of 14 consecutive days, having CES 20-30 minutes each day, and to cooperate for the data collection of two qEEG examinations.

Exclusion criteria: patients with a medication history of methylphenidate or any other similar medicine, with serious physical or neural dysfunction, or with mental retardation, affective disorder, autism, epilepsy or any other organic brain disorder were excluded.

2. Method: the digital 36-channel full-function EEG of Italian EB Neuro Sirius BB type was utilized in this study. 16 conducting electrodes were attached to Fp1, Fp2, F1, F2, C3, C4, P1, P2, 01, 02, F7, F8, T3, T4, T5 and T6, with A1 and A2 (for ears) acting as reference electrodes, according to the international 10/20 system. The unipolar and bipolar lead electroencephalography lasted at least 20 minutes. qEEG examinations were conducted before the CES treatment and 2 weeks after the CES treatment.

Using Alpha-Stim (manufactured by Electromedical Products International, Inc. in the

USA), the CES treatment was provided over 14 consecutive days, 20-30 minutes each day.

3. Observation indexes: a 30-second artifact-free segment from each qEEG examination based on the sampling method described by Xie Yanfeng was used as a sampling unit.[2] The power values at the frequency band θ (4.0-7.9 Hz), α (8.0-13.9 Hz) and β (14.0-32.0 Hz) in qEEG and the power ratio value θ/β as four value indexes was used for clinical effects.[3-6]

4. Statistics: the value observed is expressed in the standard deviation of the average ($\bar{x} \pm s$). A *t* test inspection of the qEEG values obtained before and after the CES treatment analyzed whether there were any differences. The SPSS 11.0 software was used for data analysis. P<0.05 was the difference determining statistical significance.

II. Result

All 90 patients received treatment as well as before-treatment and after-treatment qEEG examinations as planned. As for the before-treatment qEEG examination, 14 of 90 patients had normal results (16%) and the remaining 76 had abnormal results (84%). Among the 76 abnormal patients, 58 had increased band θ (76%), 10 had slower band α (13%) and 8 had poor amplitude modulation, synchronicity and photo-inhibition experiment (11%).

See Table 1 for the results of the power values at the frequency band θ, α and β in qEEG and the power ratio value θ/β before and after CES treatment.

Table 1. Results of Four qEEG Indexes Before and After CES Treatment ($\bar{x} \pm s$)

Item	θ (Hz)	α (Hz)	β (Hz)	θ/β
Before CES Treatment	40.2±7.3	22.7±4.5	9.6±5.6	4.03±1.77
After CES Treatment	21.5±9.7	43.1±5.5	15.8±1.9	2.56±0.89
t value	10.32	9.76	7.41	6.11
p value	p<0.05	p<0.05	p<0.05	p<0.05

III. Discussion

ADHD is one of the most common behavioral disorders of childhood. The pathogenesis analysis for ADHD is that it is mainly concentrated in the central nervous system and takes into account such viewpoints as brain development, dissection, biochemical reactions and functions.[7-9] ADHD is a metabolic neurotransmitter disorder in the parts of the brain that controls attention, wakefulness and inhibition processes such as the reticular structure, limbic system, thalamus and basal ganglia. It causes the wakefulness disorder, metabolism disorder and dysfunction of the cerebral cortex, lowers the orderliness and self-organization capacity of the brain, and thus results in ADHD.[10]

As a new technology of importing weak micro-bioelectric current directly to the brain via electrodes clipped onto the ear lobes, CES has a working mechanism of adjusting or reversing the abnormal brain waves helping them return to normal or close to normal. CES acts directly on the hypothalamus regulating mind, emotion and sleep, as well as the

limbic system and ascending reticular activating system which corrects the brain's bioelectricity dysfunction.

qEEG does a quantitative analysis based on the normal EEG and acts as a quantifiable scale of evaluating the brain's neuro-electrophysiology. With a sensitivity of 90%,[4] qEEG can reflect the brain's functional change in an objective, acute, accurate and reliable way, so currently the clinical effects of ADHD are usually evaluated based on qEEG results.

There has been no previous literature in China reporting on a qEEG study on the treatment of ADHD with CES. However, all the above 90 patients have received qEEG examinations before and after CES treatment. The qEEG examination before the CES treatment showed a qEEG abnormality rate of 84%, with the dominant abnormality of increased movements of band θ. Many domestic and foreign researches show that increased movements of band θ and higher power ratio value θ/β are the common features of ADHD; in addition, the movements and power values of band α and β decrease, which will cause a higher power ratio value θ/β.[11] We have obtained the same result, with an abnormality rate slightly lower than 90%, which is reflective of the total number of the patients involved. From Table 1, we can see that after the CES treatment, the power value at band θ decreases, the power values at band α and β increase, and the power ratio value θ/β decreases. The results show that the differences between the four values obtained before and after the CES treatment have statistical significance. Therefore, we believe that CES is a therapy which can effectively alleviate the brain's metabolism disorders and dysfunctions against the pathogenesis of ADHD.

This analysis for qEEG value indexes shows that CES is an effective therapy which can improve the brain's neurological function for the treatment of ADHD. Thus this study provides an objective experimental basis for the treatment of ADHD with CES.

DOI 10 38771 / cma. j issn 1674-0785 2011. 08. 063.

Foundation Program: Special Subject Research Program of the First Affiliated Hospital of the Medical College of Shihezi University (YJ2008-R061)

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(Received on: 28th Jan. 2011)
(Edited by: Qi Hongdan)

Liu Yanmin, Zhang Guiqing, qEEG Study on the Treatment of ADHD with CES [J/CD], C*hinese Journal of Clinicians* (Electronic Edition) 2011;5(8):2462-2463.