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Results of cranial electrotherapy stimulation to children with mixed anxiety and depressive disorder

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【**Abstract**】 **Objective**：To analyze the effectiveness of cranial electrotherapy stimulation (CES) on children with mixed anxiety and depressive disorder (MAD). **Methods:** There are two groups participating in the research, each of which included 30 subjects at the age of 8 to 16 who met MAD criteria of ICD-10 and whose SDS and SAS scores were more than 40. The experimental group was treated with CES, and the control group was treated with pseudo-CES．Comparison of SDS, SAS and α wave of occipital lobe between before and after the treatment was taken between the two groups. **Results:** On SDS, there are 49.60±7.03 in the experimental group and 47.23±5.86 in the control group before the treatment, but there are 34.08±7.79 in the experimental group and 46.83±10.35 in the control group on SDS after the treatment. On SAS, there are 48.27±7.01 in the experimental group and 46.03±6.24 in the control group before the treatment, but there are 29.67±6.03 in the experimental group and 39.17±12.73 in the control group on SDS after the treatment. ANOVA indicated that the treatment was significantly effective. The α_1 and α_2 of occipital lobe improved more in the experimental group. **Conclusion**: CES is effective for treating children with MAD. CES can affect brain electrical activity mapping of occipital lobe.
【**Key words**】 Cranial electrotherapy stimulation; Children; Mixed anxiety and depressive disorder; Brain electrical activity mapping

ICD-10 puts forward the concept of diagnostic category of mixed anxiety and depressive disorder (MAD), but no definite diagnostic criteria have been made. According to the descriptive definition of MAD in ICD-10, the category of children's MAD should be used when symptoms of both anxiety and depression are present, but neither set of symptoms, considered separately, is sufficiently severe to justify a diagnosis; some autonomic symptoms (tremor, dry mouth, palpitations, stomach churning, etc.) must be present, even if intermittently. It is found by studies that MAD can severely impair social functions, result in high suicide rate and greatly harm children' metal health, while its treatment efficacy is poor; parents often concern a lot about the adverse reaction to drug therapy, so we apply cranial electrotherapy stimulation (CES) to treat children with MAD. The results are reported as follows.

1 Subjects and Methods

1.1 Subjects

Experimental group: Children at the age of 8 to 16 who initially came to the children's psychological health clinic of our hospital because of emotional problems in the period of 2004~2006 and who satisfied the following conditions: Zung Self-Rating Depression Scale (SDS) and Zung Self-Rating Anxiety Scale (SAS) scores were more than 40; diagnostic criteria for anxiety disorder or depressive disorder were not satisfied; some autonomic symptoms (tremor, dry mouth,

palpitations, stomach churning, etc.) were present; the descriptive definition of MAD in ICD-10 was met. 30 cases were randomly selected, including 25 males and 5 females, and the average age was 12±2.6.

Control group: Students with emotional problems at the age of 8 to 16 who were recommended by teachers in elementary and middle schools in the city of Nanjing and who satisfied the following conditions: SDS and SAS scores were more than 40; diagnostic criteria for anxiety disorder or depressive disorder were not satisfied; some autonomic symptoms (tremor, dry mouth, palpitations, stomach churning, etc.) were present; the descriptive definition of MAD in ICD-10 was met. 30 cases were randomly selected, including 19 males and 11 females, and the average age was 11±3.6.

The result of chi-square test showed that there was no significant difference in gender and age between the two groups. Anxiety and depression state caused by schizophrenia or other diseases was excluded; all of the subjects had not received any drug therapy.

1.2 Methods

The Alpha-Stim 100 instrument developed and produced by EPI in the U.S. was used as the treatment device.

Its main working principle is that the cerebrum, hypothalamus, limbic system and reticular activating system that control mental and emotional activities are directly recuperated by application of micro-current bioelectricity which simulates brain electricity to the brain through the temporal skull [1-3]; it can adjust abnormal brain waves to make them resemble normal biological waves, and can stimulate the release of tranquilizing enkephalins [4], thus to effectively control anxiety and depression. Under stress, this device can excite the parasympathetic nervous system and correspondingly inhabit the sympathetic nervous system [5], thus to realize relaxedness, good moods and clear thinking.

Brain electrical activity mapping (BEAM): The SM2000 biological amplifier from the U.S. is linked with the quantitative EEG analyzer produced by Nicolet in the U.S, and according to the International 10/20 system, 16 electrodes were placed respectively on left frontal lobe, left postfrontal lobe, left central lobe, left parietal lobe, left occipital lobe, right frontal lobe, right postfrontal lobe, right central lobe, right parietal lobe, right occipital lobe, left anterior temporal lobe, left medial temporal lobe, left posterior temporal lobe, right anterior temporal lobe, right medial temporal lobe, and right posterior temporal lobe; reference electrode was placed on two earlobes; ground electrode was placed on the medial aspect of the frontal lobe; electrode impedance was <2KQ; sensitivity of the amplifier was 5mm/50μV; band-pass was l-30Hz; after collection of EEG data for 120s, 30s of data without artifacts were captured and were used for spectral analysis after 0.5～35Hz digital filtering. Power spectrum map was drawn after the signals went through Fast Fourier Transform (FFT), and the corresponding power spectrum map and digital map were printed out and data were saved to disk. Power values of three frequency bands – α_1 (8~8.9Hz), α_2 (9~10.9Hz), and α3 (11~12.8Hz) of occipital lobe were calculated and compared.

SAS and SDS were used for efficacy evaluation [6] which was conducted before the treatment and when the three courses of treatment with CES were completed. The treatment observation tables were filled in uniformly.

Treatment method: All cases were clinically diagnosed by specialist physicians and grouped after evaluation with SAS and SDS. In the context of informed consent of the children themselves and their parents, the experimental group received the treatment with CES; the current intensity was adjusted to 100~500μA and the frequency 0.5Hz, depending on the comfortableness of the children. A course of treatment lasted 5 days, 1 time/day, 10~15min/time; there was a rest period of 2 days

between two courses; each child received 3 courses of treatment. As to the control group, the power supply for CES would be disconnected after each child had cutaneous sensation of treatment with CES and the comfort degree was adjusted, which meant that 10~15min of pseudo treatment with CES was carried out.

1.3 Statistical Analysis

SPSS11.0 software was used for ANOVA of repeated variables of the data of the two groups; comparison was made for the SAS and SDS scores of the children in these two groups and the α-band power values of BEAM before and after the treatment.

2 Results

2.1 Efficacy

See Table 1 for the SDS and SAS scores of the experimental group and the control group before and after the treatment.

Table 1 SDS and SAS scores of the experimental group and the control group before and after the treatment ($\bar{x} \pm s$)

Time	SDS		SAS	
	Experimental group	Control group	Experimental group	Control group
Before treatment	49.60±7.03	47.23±5.86	48.27±7.01	46.03±6.24
After treatment	34.08±7.79	46.83±10.35	29.67±6.03	39.17±12.73

The ANOVA showed that: on SDS, the main effect of treatment was significant (F=36.56，P<0.01), the main effect of group was significant (F=11.01，P<0.01), and the interaction between treatment and group had statistical significance (F=32.98，P<0.01); on SAS, the main effect of treatment was significant (F=83.21，P<0.01), the main effect of group was significant (F=4.60，P<0.05), and the interaction between treatment and group had statistical significance (F=17.68，P<0.01). The results indicated that the treatment method was obviously effective, and the effect was significant in the experimental group.

2.2 Changes in EEG of Occipital Lobes of the Experimental Group and the Control Group

See Table 2 for the α_1, α_2 and α_3 of the left and right occipital lobes of the experimental group and the control group before and after the treatment.

Table 2 α-band power values of the experimental group and the control group before and after the treatment ($\bar{x} \pm s$)

Item	Before treatment		After treatment		Main effect of treatment	Main effect of group	Interaction
	Experimental group	Control group	Experimental group	Control group	F	F	F
Left α_1	23.09±30.13	43.63±39.73	19.46±28.37	45.14±37.99	0.56	5.98*	0.33
Left α_2	44.61±77.54	114.93±156.49	29.70±39.87	99.38±103.34	0.56	7.54**	0.00
Left α_3	9.84±10.09	23.81±34.55	8.23±4.98	26.82±66.65	0.02	1.92	0.24
Right α_1	24.87±1.07	42.69±40.18	17.41±21.54	47.42±41.62	0.08	6.39*	1.58
Right α_2	56.09±70.14	96.31±113.14	34.67±33.04	111.67±105.47	0.04	6.72*	1.29
Right α_3	9.94±5.94	20.93±24.74	10.69±8.90	26.21±51.84	0.59	2.24	0.34

Note: *P<0.05, **P<0.01

Set the left and right α_1, α_2 and α_3 before and after the treatment as repeated variables and the groups as group variables to carry out ANOVA. The results showed that: on α_1, α_2 and α_3, the main effects of treatment and interaction were both insignificant; on left and right α_1, the main effect of group was significant (F=5.98, P<0.05; F=6.39, P<0.05); on left and right α_2, the main effect of group was also significant (F=7.54, P<0.01; F=6.72, P<0.05); on left and right α_3, the main effect of group was insignificant. This indicated that the treatment with CES was significantly effective for α_1 and α_2 waves.

3 Discussion

It is common to find children with both anxiety and depressive disorder in children's psychological health clinics. According to clinical studies, about 25~50% of teenagers in depressive state have anxiety, and about 10~15% of teenagers in anxiety state have depressive disorder; most of them can be found in elementary and middle schools, and they would see doctors only when serious interpersonal conflicts occur or they refuse to go to school or even commit suicide because of despairing of the wearisome world. Previously, drug therapy was most common for treating depression and anxiety; such method was effective, but could result in significant adverse reactions [7]. Some studies at abroad report that CES can fast and effectively control and relieve psychosomatic disorders such as depression, anxiety, insomnia and pain, which is safe without toxic and side effects that may be caused by drugs [4, 5]. The research finding of the Capital Medical University in China shows that CES is safe and effective to treat children with emotional disorders [8]. The outcome of this study indicates that CES is also effective to treat children with MAD, which is in consistence with the findings of similar studies at home and abroad.

Some studies suggest that the anxiety and depressive state is often caused by the abnormality in central neurons and in electrophysiological activities among the neurons. Therefore, the patient's EEG shows disorderly waves and abnormal distribution, which is obviously manifested as a kind of dysfunction of nervous bioelectricity [9]. According to the study of BEAM when symptoms of both anxiety and depression are present by Yuan Yonggui et al [10], the α_1 and α_2 power values of left occipital lobe both decrease. The outcome of this study shows that the α_1 and α_2 power values of left and right occipital lobes of children with MAD are relatively high; the main effects of group before and after the treatment show significant difference, which means that the treatment with CES affects the EEG of the experimental group. Seen from numeric values, the α_1 and α_2 power values both decrease after the treatment, while α_2 decreases more significantly; this is consistent with the mechanism that CES can turn the wave crests of the EEG of patients with anxiety and depressive disorder to be low and smooth, slow down the wave velocity, present the "Alpha State" called by physiological psychologists, and thus effectively relieve emotional disorders and realize relaxedness and delightfulness [5]. As to α_3 power value, the main effect of group is insignificant after comparison between before and after the treatment, the reason for which may be that the influence of treatment on α_3 with high frequency is small since children's EEG mainly features slow frequency. The findings of electrophysiologic studies further support the treatment effect of CES on patients with MAD.

The α_1, α_2 and α_3 power values of left and right occipital lobes of the children in the two groups before and after the treatment, the main effect of treatment, and the interaction between treatment and group all have no statistical significance. That is to say, the experiment group after the treatment does not have more significant changes when compared with the control group. Therefore, it is temporarily impossible to state that the EEG of the experimental group after treated

with CES has significant improvement when compared with the control group; this may be related to big individual difference in brain waves and insufficient quantity of samples; hence, further study is required.

In the whole process of this study, all cases had no serious adverse reaction; there were only some minor discomfort such as transient dizziness, nausea and irritation of skin where electrodes were placed, which could be relieved after adjustment of current intensity or some rest. This result indicates that CES is worthwhile for attention and spread in clinical practice since it produces little adverse reaction with good compliance.

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