Brain Mapping of Mentally Retarded Children in High-Fluoride Regions

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Abstract: On the basis of routine EEG, this article used mapping technologies to conduct research on the brain electrical activities of mentally retarded children in high-fluoride regions. Results showed that the θ energy percentages in the central, parietal, occipital, and left temporal areas of the mentally retarded group were significantly higher than those of the normal control group. The α energy percentages in the central and occipital areas were significantly lower than those of the control group. These abnormal changes in brain electrical [activities] were closely related to the high-fluoride environment. The degree of fluoride's damage to brain functions can be intuitively and visually understood via brain mapping.

Ziyang, Shaanxi is an area of chronic endemic fluorosis, with a high incidence of endemic cretinism in the past. Since systematic iodine supplement plans were put in place, typical endemic cretinism is no longer prevalent. However, there are still a great number of mentally retarded children of unknown cause, and the danger as a result is very significant. In order to further understand the impact of high fluoride on brain functions, this article conducted research on brain mapping of mentally retarded children in high-fluoride regions.

Materials and Methods

I Subjects

Students from a certain school in Haoping District, Ziyang County, Shaanxi were randomly selected. After analysis of cranial X-ray, auditory evoked potentials and karyotype, and other pediatric clinical examinations, no critical abnormality was found. Then intelligence screening and social adaptability tests were conducted and 14 children with mental retardation of unknown cause were found, whose ages ranged from 9 to 13 years old, IQ was between 55 and 69, and average urinary fluoride amount was 4.05mg/L (reaching the amount of fluorosis); this was the experimental group. The 12 healthy students of the same age range with all normal indicators and an average urinary fluoride level of 1.26 mg/L were the control group.

II Analysis of Records and Data

Needle electrodes were selected to take unipolar lead records according to the international 10-20 system; at the same time a 14-track tape recorder was used for recording. The recorded analog electroencephalogram (EEG) signals were input into a 7T17S signal processor by replaying the tape. Power spectral values of all leads in all frequency bands were calculated and eventually displayed on brain diagrams in the form of pixels.

III Indicator Analysis

Total energy: the total size of all frequency bands under the power spectral density curve; energy percentage: the energy in each frequency band as a percentage (%) of total energy.

Results

I In viewing the mapping intuitively, the gray scale of the α frequency band of the control group was the highest and formed a distinct dominance in the occipital area; the gray scales of θ and δ frequency bands were relatively low. The gray scale of the α frequency band of the experimental group was relatively low and no distinct dominance was formed; the gray scales of θ and δ frequency bands were relatively high. The gray scales of θ frequency bands were also seen to significantly increase in the central and parietal areas. Comparing the abnormal rates of the mappings of these two groups, $\chi 2 = 9.758$, $P < 0.01$, indicates that the abnormal rate of the experimental group is higher than that of the control group (see Table 1).

II Comparison of energy percentages of different analyzed frequency bands of the two groups (see Table 2), according to t-test, indicated that the energy percentages of the two groups had significant differences only in the θ and α frequency bands, i.e. the θ energy percentage of the experimental group was higher than that of the control group, or the α energy percentage of the experimental group was lower than that of the control group.

Table 1: Comparison of abnormal rates of brain mappings of the two groups				
Group	**Number of abnormal people**	**Number of normal people**	**Total**	**Abnormal rate (%)**
Experimental group	12	2	14	85.71
Control group	3	9	12	25.00
Total	15	11	26	57.69

Table 2: Comparison of energy percentages of different analyzed frequency bands of the two groups (× ± s,%)			
Analyzed frequency band	**Experimental group (n = 14)**	**Control group (n = 16)**	**t**
DELTA(δ)	27.76 ± 4.57	25.94 ± 5.54	0.972
THETA (θ)	24.04 ± 2.90	21 40 ± 3.10	2.657*
ALPHA (α)	31.86 ± 6.31	38.65 ± 9.25	2.182*
BETA(β)	15.84 ± 2.90	14.07 ± 2.41	1.545

*p < 0.05

III Comparison of energy percentages at different sites of α frequency bands of the two groups (see Table 3), according to t-test, indicated that the α energy percentages of the experimental group were lower than those of the control group in the dual central area and occipital area; p < 0.05 or < 0.01.

IV Comparison of energy percentages at different sites of θ frequency bands of the two groups (see Table 3), t-test indicated that the θ energy percentages of the experimental group were significantly higher than those of the control group in the dual central, parietal, occipital, and left temporal areas, P < 0.05 or < 0.01.

Discussion

I The structure and functions of the cerebral cortex are still at a continually growing and developing stage in children, and thus determine certain characteristics of their brain electrical activities. According to research, the growth of children's brain electrical activities has a strict sequence. The occipital area is the area of earliest development, followed by the temporal lobe; the frontal and central areas develop relatively late[1,2]. From the standpoint of the composition of brain electrical activities, as one ages, the α energy percentage gradually increases and the dominance gradually moves from the central area to the occipital area; the energy level starts to decrease at the age of 13. The α energy percentages of the experimental group were significantly lower than those of the normal control group in the central and occipital areas; wherein that of the right occipital area was significantly lower, indicating that the brain excitability of the experimental group had declined, the α energy dominance had not moved to the occipital area, and brain development lagged behind.

θ energy percentage gradually declines as one ages. The rate of decline of the occipital area is double that of the central area. Energy in the central area is always higher than in the occipital area, and energy declines to a very low level at the age of ten. As reported, θ energy is negatively correlated to IQ for children between 5 and 12 years old; this is even more prominent in the parieto-occipital area of the mapping[3,4]. Gasser et al.[5] believed that the change in the correlation between mapping and IQ has a biological basis; concerning mapping, the central area and the parietal area were subject to the least interference of public and most dangerous factors, and could best reflect the correlation to IQ; and θ energy and IQ of mentally retarded children

Table 3: Comparison of energy percentages of different sites of α and θ frequency bands of the two groups (× ± s, %)						
Anatomic Site	α frequency band			θ frequency band		
	Experimental Group	Control Group	*t*	Experimental Group	Control Group	*t*
FP1	27.32 ± 1.26	29.54 ± 2.34	0.846	27.47 ± 0.66	23.65 ± 0.83	1.875
FP2	27.53 ± 1.44	31.55 ± 1.98	1.725	25.35 ± 0.70	23.86 ± 0.72	1.450
F7	27.30 ± 1.21	30.83 ± 2.04	1.529	24.75 ± 0.58	22.44 ± 0.89	2.258*
F8	28.64 ± 1.37	32.65 ± 2.24	1.613	24.34 ± 0.78	22.54 ± 0.93	1.580
C3	31.79 ± 1.67	39.26 ± 3.29	2.145*	25.85 ± 0.83	22.54 ± 1.13	2.357*
C4	32.14 ± 1.61	38.94 ± 2.72	2.102*	25.65 ± 0.87	22.11 ± 0.92	2.958**
T5	31.15 ± 1.97	36.95 ± 2.90	1.701	24.54 ± 0.88	21.75 ± 0.93	2.173*
T6	31.86 ± 1.84	37.82 ± 2.65	1.901	24.32 ± 0.89	21.12 ± 1.03	2.060
O1	38.02 ± 2.65	48.15 ± 3.40	2.405	21.31 ± 1.05	17.51 ± 1.06	2.511*
O2	39.06 ± 2.44	48.90 ± 3.39	2.895**	21.29 ± 1.05	17.33 ± 1.03	2.683*
Fz	28.43 ± 1.32	37.72 ± 5.69	1.722	26.85 ± 0.78	24.79 ± 0.84	1.795
Pz	32.73 ± 1.74	38.30 ± 2.57	1.850	26.50 ± 0.41	22.90 ± 0.95	2.571*
*p < 0.05; **p < 0.01						

were more closely related than those of normal children. The θ energy percentages of the experimental group were significantly higher than those of the control group in the central, parietal, occipital, and left temporal areas. The impairment sites matched the aforementioned sites, indicating that the development of cerebral cortex in these regions was slowed, excitability had declined, and functions were in a suppressed or fatigued state, which further proved that θ energy was closely related to IQ.

Research indicates that the temporal lobe is related to memory functions and its pathological changes usually result in mental retardation, which is more prominent when the pathological changes are on the dominant side. The frontal lobe is the major functional area of mental intelligence; developmental disorders in the frontal lobe and temporal lobe directly affect intelligence development. In the mapping of the mentally retarded group from the high-fluoride regions, the impairment areas included the frontal lobe, the central area and the left temporal lobe, which further demonstrated that there was a certain pathological basis for the abnormal changes in brain electrical activities of mentally retarded children.

II Endemic fluorosis is a disease that severely endangers human health. For a long time, clinical attention has been focused on fluoride poisoning of teeth and bones. Animal experiments prove that developing brain tissue is also one of the target tissues of fluoride toxicity. Fluoride stored in the brain can cause loss in its weight and retarded development, and directly damage nerve cells. Fluoride also affects multiple enzyme functions. In particular, it can damage acetylcholinesterase and thus damage the transmission of cholinergic neurotransmitters and reduce the excitability of cerebral cortex. At the same time fluoride can also induce lipid peroxidation of neuron membranes and thus damage the integrity of membranes and intracellular components. The product of lipid peroxidation—lipofuscin—in the brain is deposited in the frontal lobe, central gyrus, and temporal lobe, in the order of amount deposited from largest to smallest; there is a relatively small amount in the occipital lobe, which therefore can cause intelligence development disorder.

EEG reflects the electrical activities of cerebral cortex nerve cell dendrites and synapses. When fluoride cause reduced metabolism of nerve cells, neurotransmitter conduction block, and loss of cortical function, mapping reflects declined brain bioelectrical activities and reduced sensitivity to stimulation.

To summarize: the abnormal changes in brain electrical activities of mentally retarded children in high-fluoride areas have a certain biological and pathological basis, and are closely related to the high-fluoride environment. The degree of fluoride's damage to brain functions can be more intuitively and visually understood via brain mapping.

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