Electroencephalographic Findings in a Case of Globoid Cell Leukodystrophy

KAZUIE IINUMA and AKIRA ONUMA
Department of Pediatrics, Tohoku University School of Medicine, Sendai

An increased slow wave pattern of the EEG basic waves without epileptogenic discharges was observed in an early stage of a case of Krabbe’s disease. In the later stage of the illness, spikes and sharp waves were mixed with. The peculiar runs of fast activity which were described by Kliemann et al. (1969) were not observed during the course of our patient. ——— globoid cell leukodystrophy; EEG; PEG; EEG basic waves

The present study consisted of serial observations of electroencephalograms of a Japanese male with antemortem diagnosis of Krabbe’s leukodystrophy (globoid cell leukodystrophy, GLD) at the age of 1 year and 2 months, because such a serial EEG observation of this illness from the beginning has been scarcely reported up to date.

SUBJECTS AND METHODS

Subject. A Japanese male, 1 year and 2 months old, was diagnosed as Krabbe’s disease on the basis of a marked decrease in the galactocerebroside β-galactosidase activity in leukocytes and serum by Wada et al. (1975).

Classification of clinical stages. According to evolution of clinical symptoms, clinical stages were classified into I, II and III stages on the basis of Hagberg’s description (1963).

Electroencephalograms (EEGs). Five EEG tracings were recorded at the age of 7, 13, 14, 16 and 18 months. All the EEGs were recorded with a uniform technique and the placement of electrodes was based on 10-20 International System using a 13-channel electroencephalograph (Toshiba model DSH-013 B).

The basic wave of EEGs derived from the monopolar right occipital lead was recorded in an awake state, and the frequency was analyzed by the frequency analyzers (Toshiba models DDA-002A and DDA-002B). The basic waves were devided into 5 bands according to following frequency ranges: δ, 2-4 c/s; θ, 4-8 c/s; α, 8-13 c/s; β₁, 13-20 c/s; β₂, 20-30 c/s, and also into 10 bands according to following frequency ranges: I band, 2.00-2.40 c/s; II, 2.40-2.88 c/s; III, 2.88-3.46 c/s; IV, 3.46-4.15 c/s; V, 4.15-4.98 c/s; VI, 4.98-5.97 c/s; VII, 5.97-7.17 c/s; VIII 7.17-8.60 c/s; IX, 8.60-10.3 c/s; X, 10.3-12.4 c/s.

An integrated voltage at each of the frequency bands was averaged over 12 epochs consisting of 5 sec of data. Energy % was calculated according to the following formula:

Energy % of the δ band = \( \frac{V_δ}{V_δ^2 + V_θ^2 + V_α^2 + V_β₁^2 + V_β₂^2} \times 100 \)

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Pneumoencephalography. Pneumoencephalography was performed at the age of 14 months. To estimate an apparent dilatation of lateral ventricles, Evans' ratio was calculated (Evans 1942). The width of the third ventricle on anteroposterior projection was measured. The presence of air accumulation in the cortical surface and cisterns was examined.

RESULTS

EEG findings. The EEG findings in our own case in relation to the child's age and clinical stage are tabulated in Table 1.

<table>
<thead>
<tr>
<th>No. of EEG</th>
<th>Age of patient (months)</th>
<th>Clinical stage (Hagberg)</th>
<th>Increased slow wave activity</th>
<th>Epileptic discharges</th>
<th>Sleep spindles</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>I</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>2</td>
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<td>3</td>
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The first EEG was recorded at the age of 7 months, when he was evaluated as being in Hagberg's stage I. At that time, the patient could scarcely smile and the rigidity of the extremities, anorexia, vomiting and intermittent fever of unknown origin were complained of. Fundoscopic examination could not reveal an apparent optic atrophy. The first EEG showed an irregular slow activity but no asymmetry between the two hemispheres. Sleep spindles at about 16 c/s appeared in the central region. No seizure discharges were present.

The second EEG was recorded at the age of 13 months, when he was estimated as being in Hagberg's stage II. At that time, the patient was unable to move his extremities because of severe rigidity, or suck milk by himself. Pale papillae were observed by fundoscopy. The second EEG showed more irregular pattern than the previous one and were mixed with spikes in the fronto-central regions. Sleep spindles were not observed.

The third EEG was recorded at the age of 14 months, Hagberg's stage II. At that time, the presence of optic atrophy was revealed by fundoscopy. The EEG showed no changes compared with the second EEG.

The fifth EEG was recorded at the age of 18 months, Hagberg's stage III. At that time, the patient was unable to move his extremities at all and swallow any foods. He was scarcely able to cry against painful stimuli. Deep tendon reflexes were not elicited because of severe rigidity.

The EEG showed an increased slowing with frequent multifocal spike discharges and periodic bursts of slow waves. Diffuse 20-25 c/s fast waves were observed. Sleep spindles were never observed.

Frequency analyses. Frequency analyses of the EEG basic waves were performed at the age of 14 and 18 months. Distribution patterns of energy %
Fig. 1. Electroencephalograms of our case.
A: EEG taken at 7 months of age.
B: EEG taken at 14 months of age.
C: EEG taken at 18 months of age.

Fig. 2. Distribution patterns of energy percent of EEG basic waves.
A: Basic waves were analyzed by a conventional analyzer.
B: Basic waves were analyzed by a specially designed analyzer.
In both figures,
•—•, our own patient (S.H.) (14 months old);
○—○, our own patient (S.H.) (18 months old);
•••••, control infants (14 months old).
at each of the frequency bands of our patient were shown in Fig. 2 (A) and (B). Both frequency spectra at the age of 14 months and 18 months showed obvious slow patterns compared with those of normal infants of the same age group (Yamauchi 1972). Between the two data obtained at 14 and 18 months, there were no significant differences.

**Pneumoencephalography.** Pneumoencephalograms revealed a marked dilatation of the lateral ventricles with the Evans' ratio of 0.305 and a dilatation of the third ventricle of 18 mm in diameter. Air accumulation was observed in cortical surface of the right fronto-parietal region and in the chiasmatic cistern (Fig. 3).

**Discussion**

Blom and Hagberg (1967) reported EEG features in five patients with GLD and described that as a rule the EEG was normal in the beginning of the disease, whereas a general tendency to slowing occurred in later stage, sometimes asymmetrical, often mixed with paroxysmal or epileptogenic activity. But in their report, the EEG was not investigated in clinical stage I of Hagberg.

In 1969 Kliemann et al. reported EEG findings of 7 patients with Krabbe's disease and described that EEG changes occurred even at an early stage of the illness (Hagberg's stage I) and that they were characterized by an excess of irregular slow activity with occasional appearances of multifocal discharges and
peculiar runs of fast activities.

In our own case, the first EEG was taken at the age of 7 months, stage I, and showed slow pattern without seizure discharges. The EEG already showed a reminiscent of the irregular slow pattern. In the second EEG taken at the age of 13 months, stage II, spikes were observed. In the later records, the EEG abnormalities characterized by slow wave mixed with seizure discharges became progressively severe.

Frequency spectra of the basic waves at the age of 14 and 18 months were equally showing delta dominancy, revealing that the delta dominancy of the basic waves developed at the later stage of the stage II and remained not changed in its grade despite of further evolution of clinical symptoms.

In our case, peculiar runs of fast activities which were reported by Kliemann et al. (1969) were not observed.

By pneumoencephalography which was done at the age of 14 months, the presence of atrophy of the subcortical white matter was highly suspected. This suggested that demyelination was already severe at Hagberg’s stage II.

Blom and Hagberg (1967) also described that central and cortical atrophy of diffuse type was observed by pneumoencephalography of a patient with GLD.

References

6) Yamauchi, N. (1972) EEG basic wave patterns of healthy children under the age of 4 years. *Brain Develop. (Jap.)*, 4, 114-128.