Development of sleep in normal infants during the first year of life (an EEG study)

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Introduction
In the first 15 weeks of life, the EEG of sleep changes in several aspects.

The most impressive changes are:
1. Discontinuity, REM sleep onset and frontal sharp waves disappear.
2. Sleep spindles appear (1).

The present study was undertaken to describe the further development of the sleep EEG during the first year of life, focussing on: how drowsiness and sleep start at this age and description of the course in time of grapho-elements as sleep spindles, sharp vertex waves and K-complexes.

Methods and Subjects
The study concerned all EEG’s that were recorded in our paediatric EEG laboratory from 1993 through 1997.

Children in the first year of life were included. As we did already a study in children in the first 15 weeks of life, this age category was excluded. Thus 105 children (49 girls) with a chronological age (time since birth) of 15 to 55 weeks (mean and median of 35 weeks) participated.
The diagnoses were Breath Holding Spells (9), ALTE (12), Febrile Convulsions (48), Strange Movements but no Epilepsy (36).
Children that were born pre-term, or had congenital, neurological or mental disorders were excluded. All infants were clinically normal at the time of recording of the EEG and had completely normal results at follow-up (duration of follow-up 2-6 years).
The EEG’s were recorded for at least 40 minutes per recording using the ten-twenty system with all electrode positions in various derivations. The record-
ings were assessed according to the rules of the International Federation of Clinical Neurophysiology (2).

Results
Fifty-six of the children actually slept during the recording (duration of sleep; 40 – 2420 sec.; median 690 sec.) Another 12 children had periods of drowsiness only.
In these 68 children drowsiness was characterised by high amplitude theta over all cerebral regions.
The EEG background patterns during sleep were always continuous. This means that patterns as tracé alternant did not occur at this age.
Sleep started as NREM sleep in all 56 children that actually slept.
Sleep spindles were found in all sleep records. The amount of spindles per unit of sleep time was independent from age. This in contrast to the maximum duration of these grapho-elements, that declined with age. Long lasting sleep spindles were predominantly seen in the first few month of life (fig. 1a, table 1).
Sharp vertex waves occurred in all sleep records. The number of these waves per unit of sleep time increased with age (see fig. 1b and table 1.)
K-complexes were found in only 30 of the children studied. Most K-complexes were seen in the age category from 30 weeks and older, but in three children they already occurred at the age of 15-18 weeks.
There was no correlation with age regarding the number of K-complexes per unit of time.

<table>
<thead>
<tr>
<th>Age (weeks)</th>
<th>Duration of sleep spindles(s.) (mean)</th>
<th>Sharp vertex waves (mean/1000 s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15w. - 24w</td>
<td>6.1</td>
<td>24.7</td>
</tr>
<tr>
<td>25w. - 44w.</td>
<td>4.8</td>
<td>30.1</td>
</tr>
<tr>
<td>45w. - 55w.</td>
<td>3.5</td>
<td>66.5</td>
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</tbody>
</table>

*Table 1: Relation between duration of sleep spindles and sharp vertex waves versus age during the first year of life.*
Figure 1: a) correlation between maximal spindle duration (msd in s.) and age after birth (aab in weeks). Regression equation: \( msd = -0.07 \ aab + 7.397 \). \( P<0.000 \)

b) correlation between amount of sharp vertex waves (svw in N/1000s.) and age after birth (aab). Regression equation: \( svw = 0.468 \ aab -0.6 \). \( P<0.001 \)

Discussion
In infants sleep develops rapidly. In essence, sleep has already many features of mature sleep in an early stage of life.
The results of our study give evidence that the trends that are already visible in the first 15 weeks of life, continue. Discontinuity of the background patterns does not reoccur. Sleep spindles, that are present in all sleep EEG’s after a chronological age of 11 weeks, remain. However they are not fixed and develop further with increasing age.

The same holds for sharp vertex waves. These grapho-elements occur later, but show a correlation with age as well.

In particular the age dependant changes that occur for sleep spindles and sharp vertex waves are new information. The other results of our study are – in broad outlines – similar to previous studies as summarised in (3).

The results of our study provide normal values to the electro-encephalographer for recognising normal and abnormal sleep EEG features in the first year of life.

Acknowledgement

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References