ORIGINAL RESEARCH PAPER

Physiology

STUDY ON CHANGES OF EEG POSTERIOR ALPHA RHYTHM AND DELTA WAVE IN HEALTHY NEWBORN DURING ONE YEAR OF LIFE AT TERTIARY CARE HOSPITAL

KEY WORDS: EEG, Alfa & Delta Rhythm

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ABSTRACT

Background: Normal electroencephalographic pattern varies with age and level of Alfa and delta activity. Sleep assessment during infancy presents an opportunity to study the impact of sleep on the maturation of the central nervous system.

Objectives: - To study the changes of Posterior Alpha rhythm and slow activity delta wave in healthy newborn during one year of life.

Methodology : -This longitudinal follow-up study was conducted on 50 healthy, normal, full-term newborn up to age of one year.

Result :- Out of 50 newborn posterior Alpha rhythm was seen in none of the newborns at the time of 0-2 week which increased to (40/45) 88.9 % at 3 month, 88.1% (37/42) at 6 month, 94.7% (36/38) at 9 month. Slow activity delta was observed in 43/50 (86%) of newborns at 0-2 weeks, then in 40/45 (88.9 %) at 3 months and 85.7 %, 85 % and 86.8 % at 6, 9 and 12 months respectively.

Conclusion: - the emerging pattern of the present study depicts the development of cerebral maturation in EEG and a marked conspicuous change in Alpha and Delta rhythm in EEG.

INTRODUCTION

Normally, electroencephalographic (EEG) varies with age and level of vigilance. Infants spend most of their time in the sleeping state. Sleep assessment during infancy presents an opportunity to study the impact of sleep on the maturation of the central nervous system (CNS), overall functioning of the physiological systems, and psychomotor development. (1)Thus, the 1st year of life is a time of substantial change in the development of the human brain, establishment of sleep patterns, and the concurrent EEG wave pattern. Thus, the relationship between the two is vital, as the control of sleep–wake cycles are regulated by the CNS. (2)

The absence of SWC after birth has been associated with a poor neurodevelopment outcome. (3) By the end of first year of life this gradual evolution of posterior basic alpha rhythm arises. This slower frequency response demonstrated more clearly during the photic stimulation and crying due to hyperventilation.(4) The slow activity delta of .75-1.75 Hz was noted at the age of 3 months over the occipital region, which represents the transition of sleep into deeper stages.

Research employing electroencephalographic (EEG) techniques with infants has flourished in recent years due to increased interest in understanding the neural processes involved in early social and cognitive development. (5)Thus, the internal structure of the sleep cycle also changes with age, because of the increase in the proportion of quiet sleep (QS)/non-rapid eye movement (NREM). The slow wave sleeps/NREM which establishes from the 21st week onward is proved by the appearance of of posterior basic alpha rhythm EEG wave pattern. However, the proportion of total sleep time remains stable throughout the 1st year of age. (6)

Our findings highlight the importance of maturational aspects of sleep and paediatric EEG can only be determined to be normal by assessing whether the EEG patterns are appropriate for maturational age. Sleep in infants at term can be called as Active sleep (AS) to Rapid Eye movement (REM) and Quiet sleep (QS) to Non- rapid eye movement (NREM) sleep.(7)

In order to better explain developmental phenomena, there remains great interest in integrating behavioural and neuro-physiological measures to capture not only aspects of cognitive development but also social and emotional development. Our focus here is on the electroencephalogram (EEG) which has a rich history and a bright future in terms of its continuing utility in the study of behavioral and neuro-physiological development in infants.(8,9)

METHODOLOGY

This is longitudinal observational study. Subjects Sample consisting of 50 healthy vaginally delivered full term infants (27 male and 23 female) was recruited from the Department of Obstetrics and Gynaecology in Netaji Subhash Chandra Bose, Medical College and Hospital, Jabalpur (M.P.). At birth, physical developmental screening was normal and also later assessed by TDSC scale. (10) Written informed consent was obtained from all parents after detailed explanation of the method and aim of the study, and the approval by the Ethical Committee was obtained.

Infants were enrolled as healthy, if they met the following criteria: - Gestation age >37 weeks, no requirement for resuscitation following delivery and Apgar scores of ≥7 at 5 min.(11)

Anthropometric Assessment :- Birth weight range (2.4–4 kg), length at birth (45.6–53.4 cm), head circumference (HC) (31.7–36.9 cm).

Methods EEG recording: - EEG data were recorded using the Neurograph 16-Channel. EEG system with EEG surface electrodes. All the infants were in the supine position in the lap of mother during each recording. All recordings commenced as soon as possible after birth and were continued for 1 h. (3) EEG was recorded from eleven scalp electrodes positioned using the 10–20 system of electrode placement, (Reduced montage/IV-montage) modified for infants (FP1, FP2, C3, C4, O1, O2, T7, T8, Cz, A1, and A2). Reference electrodes were placed at Cz, A1, and A2. Scalp electrodes were attached to the baby's scalp using a conductive water-soluble fixative paste. Electrode impedance was maintained below 5 k Ohm [Figure 1]. Respiratory movements were observed during recording. (3)

Of the original 50 infants, 8 infants did not allow application of the EEG electrodes and 4 dropped out. Thus, statistical analyses included 38 infants who contributed EEG data. Only infants with artifact-free EEG data were included in this analysis. This study particularly focuses on unique features of sleep changes which arise from birth to 1st year of age along with an assessment of psychomotor development with using following parameters:

a. Apgar score,
b. Weight and HC,
c. Posterior basic alpha rhythm
d. Slow activity delta wave

RESULTS :-

This longitudinal observational study was conducted in 50 newborn and followed up to age of one year.

APGAR score

Fig 1. At the time of birth most of the newborns 30 (60%) had APGAR score of 7, eighteen (36%) had score of 8 and only two (4%) had that of 9.

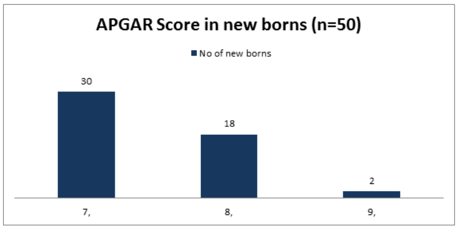

Fig 1 .X-axis showing Apgar score and Y-axis showing number of Infants.

Fig -2 - Mean weight and head circumference at the time of birth was 2.78 kg and 33.3cm,which increased to 5.6 kg and 39.1cm at the age of 3month, 7.1kg & 41cm, 8 kg & 43.6 cm, and 8.8 kg , 45.5 cm at 6, 9 and 12 months respectively.

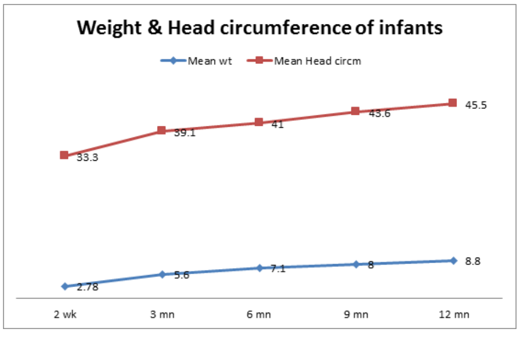

Fig 2. X-axis represents ages in week (wks) and months (mn), and on Y-axis showing growth of weight and head circumference in number of infants.

Table 1 shows that Posterior Alpha rhythm was seen in none of the newborns at the time of 0-2 week which increased to (40/45) 88.9 % which was all 4 hz at 3 month then at 6 months 88.1% (37/42) had Post Alpha rhythm of 4.1-4.9 hz and only 11.9% (5/42) had that of 4 hz, at 9 months 92.5% (37/40) had Post Alpha rhythm of 5-5.9 hz remaining 7.5% (3/40) had that of 4.1-4.9 hz and finally at 12 months 94.7% (36/38) had Post Alpha rhythm of 6-8 hz and remaining 5.3 % (2/38) had that of 5-5.9 hz.

Table -1 Posterior Alpha rhythm in no of infants with respect to follow up

Follow up	Absent	4 hz	4.1-4.9	5-5.9	6-8 hz	Total tested
0-2 wk	50	0	0	0	0	50
3 month	5	40	0	0	0	45
6 month	0	5	37	0	0	42
9 month	0	0	3	37	0	40
12 month	0	0	0	2	36	38

Table -2 Posterior Delta rhythm in no of infants with respect to follow up

Follow up	Present	Absent	Total tested
0-2 wk	43 (86%)	7	50
3 month	40 (88.9%)	5	45
6 month	36 (85.7%)	6	42
9 month	34 (85%)	6	40
12 month	33 (86.8%)	5	38

Table -2 Slow activity delta was observed in 43/50 (86%) of newborns at 0-2 weeks, then in 40/45 (88.9 %) at 3 months and 85.7 %, 85 % and 86.8 % at 6 , 9 and 12 months respective Slow activity delta

DISCUSSION

In anthropometric measurement the mean increment of weight from the time of birth was 2.78 kg, which progressively increased to 8.8 kg at the 12 months of age respectively, by comparing with the expected weight for the age. In the same way head circumference also increases i.e. mean Head circumference (HC) in last visit i.e. at 12-month it increased to become 45.5 cm. As per following the normal criteria, in which HC increases 2cm/month in first three month, 1cm/month in next three month and in last 6 months of infancy it increases 0.5 cm /month. As HC growth proceeds, the various psychomotor changes seem to occur. As shown in fig.2 striking developmental anabolic growth of brain and body mass occurs during the first year of life for e.g. skilled eye-hand coordination at the age of 9 months. (12,13) Thus it is reasonable to assume that the different emerging patterns from birth to 12 months of age in the subsequent follow up visits depicts the development of cerebral maturation in EEG. Even so there was a wide variation from child to child.

The posterior basic alpha rhythm of 4 Hz emerged at 3 months in approximately 90 % (Table 2) by the time of 12 months of age it reached to 6-8 Hz in 95%, in remaining 5.3 % infants showed 5-6 Hz. This range was best seen during crying and sleepy condition usually over the occipital regions. Thus, the findings suggest that the alpha rhythm represent an inactive state of underlying cortical areas. (14,15,16) Dreyfus et al in 1975 demonstrated posterior basic rhythm by passive occlusion of eyes. The other authors also proved it by showing blocking effects with eye opening. The researchers also evaluated it in crying babies with forceful eye closure and in a quiet infant with open eyes. The authors mentioned it as a sign of impending drowsiness. (4) In 1972 Dumermuth studied the same rhythmic activity over central region. (17)

Smith et al in 1937 prompted the posterior basic alpha band has been the object of numerous studies. By the end of first year of life this rhythm reached around 6Hz, 6-7 Hz during the 2nd year and 7-8 Hz during the 3rd year of life. (16)Thus, this gradual evolution of posterior basic alpha rhythm arises from the upper limit of theta and merges into the lowest alpha range. (18) Dumermuth in 1972 reported the widely scattered slower frequencies of 2-5Hz range in the waking infants. The authors obtained this slower frequency response during the photic stimulation and crying due to hyperventilation. While, Koshino in 1975 demonstrated more clearly that blocking response of posterior basic alpha rhythm in children other than the first year of life. (15)

After the several studies, posterior basic alpha rhythm is considered highly variable. Hence, authors reported it may reach upto 10 Hz in the 2nd year of children. (15, 16)

As shown in TABLE -2 The slow activity delta of .75-1.75 Hz in 40/45 (88.9 %) was noted at the age of 3 months over the occipital region and then very little change was seen throughout the follow up visits, it maximally increased up to 3 Hz in 85 % at 9 month of age. This wave represents the transition of sleep into deeper stages. The stability achieved by delta activity at the age of 9- months, was needed to continue up to at least 3 year to determine similarity to the adult sleep pattern. During such recordings the respiratory rate and body movements were minimal, which characterizes slow wave sleep/ quiet sleep same as in adults; this once again emphasize that serial EEG studies should continue. This finding was found to be similar with the study of Samson-Dollfus et al in 1981. (15, 19)

CONCLUSION

In this study, we primarily targeted on the emergence of posterior basic alpha and delta bands developmental EEG patterns, since they had been the main bands of interest for developmental cognitive neuroscience. Then we also moved on to describe how EEG measures had influenced the study of early social and cognitive development along with the weight gain, HC changes. Thus, it is reasonable to assume that the different emerging patterns from birth to 12 months of age in the subsequent follow up visits depicts the development of cerebral maturation in EEG. Even so there was a wide variation from child to child.

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