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RESEARCH ARTICLE

EFFECTS OF PROTEIN ENERGY MALNUTRITION ON AUDITORY EVOKED POTENTIAL RESPONSES IN CHILDREN

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ABSTRACT

Aim: Protein energy malnutrition affects myelination and growth of the nervous system. The aim of this study is to determine the effects of protein energy malnutrition on auditory evoked potential response in children.

Materials and Methods: Study group includes 40 malnourished children of 5 – 10 years of age based on IAP and WHO classification for malnutrition. Control group consists of 40 normal children of same age group. Genetic and endocrine causes for short stature , children with ear pathology were excluded. Informed written consent from the parents / guardian was obtained. Brainstem auditory evoked potential was recorded. Results were analysed using unpaired student 't' test.

Result: There was a significant prolongation in wave I, II, III, IV latency , IPL I-III ,III-V in children with Grade III malnutrition and IPL I – III in Grade IandII malnutrition ($p < 0.05$).

Conclusion: The present study shows significant alteration in brainstem auditory evoked potential in children with malnutrition which may be due to nutritional deficiency affecting myelination of auditory brainstem pathways which depends on duration and severity of malnutrition. So brainstem auditory evoked potential can be used to detect malnutrition at its early stage.

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INTRODUCTION

Protein energy malnutrition may be defined as impaired growth mainly due to inadequate intake of food which may be both macronutrients and micronutrients. WHO defines protein energy malnutrition as a range of pathological conditions arising from coincidental lack in varying proportions of proteins and calories, frequently occurring in infants and young children usually associated with infection. About 60 – 70% of children have mild to moderate malnutrition and the remaining are severely malnourished (Swarna Rekha Bhat 2006). Protein energy malnutrition is known to be a major health and nutrition problem in India.(Parthasarathy *et al*., 2006). Children having birth order greater than or equal to 3 and those not immunised had higher prevalence of protein energy malnutrition (Sen P Mishra *et al*., 1996). Dietary proteins are the source of brain enzymes and neurotransmitters.

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The quality of dietary proteins determines the quantity of cerebral proteins and neurotransmitters. Thus the amino acid profile of cerebral extracellular milieu is a function of dietary proteins (Mohammad Ramadan *et al*., 2011). Malnutrition does not only risk the population for anemia and repeated infection, but it affects the developmental milestones and intellectual development. This persistent influence will lead to devastating effects in future.

This burden continues in generations, as malnourished young girls become mother, deliver a malnourished young offspring (Viresh Mahajan, Piyush gupta 2003). Undernutrition can cause developmental delays among the children and adolescents, leads to poor school performance and cause school dropouts (Bruno de Benoist *et al*., 1993-2005). Nervous system involvement in protein energy malnutrition results not only from deficiencies of protein and energy alone but also from deficiency of micronutrient needed for brain growth and development (Odebode and Odebode 2005). Iron deficiency alters myelination, neurotransmitter synthesis, hippocampal energy metabolism during neonatal period. Zinc deficiency alters autonomic nervous system

regulation, hippocampal and cerebellar development. Long chain fatty acids are essential for synaptogenesis, membrane function and myelination. (Michel K Georgieff 2007). Malnutrition causes structural and functional pathology of brain. Effect of chronic protein energy malnutrition causes stunting and wasting in children. It can also affect higher cognitive processes during childhood (> 5 yrs of age) (Bhoomika R Kar 2008).

Malnutrition leads to permanent suboptimal physical and mental development results in mental retardation (Neil Mclnish *et al*., 2008, David A.Levitsky, Barbara J. Strupp 1995). CNS injuries caused by severe malnutrition can be shown clinically and electrophysiologically (El-Khayat H.A 2004). Auditory evoked potentials (AEP) are sensitive measures related to brain functions. Protein energy malnutrition (PEM) and iron deficiency anemia affect myelination and neural maturation of auditory brainstem pathway (Mohammad Ramadan *et al*., 2011). Early onset malnutrition causes more abnormalities in AEP. These could be due to defect in myelination that ends in decreased synaptic efficiency in the auditory system. PEM slows the process of myelination, thus preventing the increase in caliber of myelinated nerve fibers (Juraci Goncalves de lima 2008).

MATERIALS AND METHODS

This study was conducted in Research Laboratory, Department of Physiology, Thanjavur Medical College, Thanjavur. This Case control study period extended betweenAugust 2013 to July 2014. The children were recruited from Raja Mirasudar Hospital, Thanjavur. Study group consists of 40 malnourished children. Out of 40, 20 children (13 males, 7 females) had Grade III malnutrition according to IAP and WHO Classification for Malnutrition. They had Weight for age , 51 - 60% of expected weight and Height for age < 85% of expected height . Remaining 20 children (10 males, 10 females) had Grade I and II malnutrition as they had weight of 61 –80 % of expected weight with normal height appropriate for their age. Control group consists of 40 normal children (20 males , 20 females) with weight > 80 % of expected with normal height for their age.

Inclusion criteria

Malnourished children with the age group of 5 – 10 years based on anthropometric measurements like weight for age and height for age according to IAP and WHO Classification for malnutrition were included in this study.

Exclusion criteria

Genetic causes and endocrine causes for short stature, children with ear pathology were excluded from the study. Ethical committee approval was obtained from Institution before commensing the study.

The aim, nature of the study was explained to the subjects and Parents / Guardian. An informed written consent was obtained from the Parent / Guardian of the child prior to the test. A detailed clinical, anthropometry and neurological examination was done. Brainstem auditory evoked potential was measured using eight channel digital polygraph (Neuro perfectplus).

Procedure

Electrodes were placed according to 10-20 International system of EEG electrode placement. Channel 1: Ai-Cz (Active recording electrodes over ipsilateral ear)

Channel 2: Ac-Cz (Contralateral ear). Ground electrode was placed 20% from the nasion (Fz) . Headphone was placed over the ear which delivers auditory stimulus at a rate of 8 – 10/sec. Intensity of stimulus is set at 30 db. An average of about 100 were recorded using auditory click stimulus. Absolute peak latency of wave I,II,III,IV,V and interpeak latencies of I-III, III-V,I-V were recorded.

RESULTS

Statistical analysis was done by using SPSS version 20.The results were analysed using unpaired student 't' test. Values were expressed as mean with standard deviation. The control group was compared with grade III and grade I,II malnourished group. p value < 0.05 was considered as statistically significant.

Table 1. Anthropometric measurements of case and control group

Group	Height for age (cm) Mean ± SD	Weight for age (kg) Mean ± SD	Age (years) Mean ± SD
Grade I & II	123.05 ± 9.67076	21.51 ± 3.75708	8.45 ± 1.820208
Grade III	103.4 ± 7.56307	15.325 ± 2.95704	
Control	124.1 ± 1.58252	26.755 ± 4.50538	7.575 ± 1.73777

Table 2. BAEP findings in study (Grade III malnutrition) group

Parameter (ms)	Study group(Grade III)	Control	P value
Wave I	1.48±0.34	1.09±0.26	0.00*
Wave II	2.77±0.46	2.29±0.48	0.00*
Wave III	4.12±0.53	3.61±0.74	0.00*
Wave IV	5.35±0.62	4.79±0.84	0.01*
Wave V	6.12±0.69	6.07±0.94	0.83
IPL I – III	2.69±0.47	2.40±0.48	0.02*
IPL III – V	2.50±0.56	2.21±0.47	0.03*
IPL I – V	5.12±0.67	4.98±0.87	0.52

*p <0.05 Significant

Table 3. BAEP findings in study (Grade I and II malnutrition) group

Parameter (ms)	Study group (Grade I& II)	Control	P value
Wave I	1.18 ±0.30	1.09±0.26	0.19
Wave II	2.22 ±0.32	2.29±0.48	0.58
Wave III	3.25 ±0.49	3.61±0.74	0.05
Wave IV	4.47 ±0.60	4.79±0.84	0.12
Wave V	5.63 ±0.81	6.07±0.94	0.07
IPL I – III	2.09 ±0.44	2.40±0.48	0.02*
IPL III – V	2.34 ±0.71	2.21±0.47	0.42
IPL I – V	5.12 ±0.88	4.98±0.87	0.56

*p < 0.05 significant

DISCUSSION

Malnutrition is widely prevalent in all developing countries and children are the worst sufferers. Early development of malnutrition during the critical period of brain development has devasating effect on brain growth. This period extends from prenatal to early postnatal life. Active synthesis of myelin occurs in this period (Janina R.Galler 1967). Myelin is composed of protein and phospholipid derived from cell membrane of oligodendrocytes in central nervous system and from Schwann cells in peripheral nervous system(Jagjit S.Chopra 1986). Malnutrition results in physical, chemical, and functional changes in brain. All changes occurring in this period are likely to be irreversible that has a longlasting effect mainly due to delay in myelination. Malnutrition results in poor learning abilities, impaired cognitive functions and school dropouts (Bruno de Benoist 1993-2005).

The present study observed prolongation of Wave I, II, III, IV and Prolonged inter peak latency I – III , III – V with p value < 0.05 in Grade III group. In Grade I, II group prolongation of Interpeak latency I – III was observed. This may be due to imperfect growth and development of myelin producing initial abnormalities in an increase in interpeak latency particularly I – III (Michel J Aminoff 2005). Vandana and O.P.Tandon (2006) measured auditory evoked potential responses in 20 chronic malnourished children of 3 – 6 years of age and found that there is significant prolongation in peak latencies of waves I, II, III, IV. Interpeak latencies of I – III and III – V were also prolonged as malnutrition affects the peripheral developmental process of auditory pathways in brainstem.

They found that longer duration of continuous protein energy malnutrition slows or arrest the process of myelination and preventing the increase in caliber of myelinated nerve fibre. The results were consistent with the result of present study. Allen counter.S *et al*., (2012) have shown the association of decreased haemoglobin level and anemia with abnormal brainstem auditory evoked responses in children with 2 – 15years of age. Significantly prolonged absolute latencies of waves I, II, III, IV, V were observed when compared to children with normal haemoglobin levels. The reason suggested was low haemoglobin levels may have subtle effects on the sensory – neural auditory brainstem system that are manifested as altered BAEP latencies. The results of present study is consistent with this result. Dursun odabas, Mesud ekisli (2005) studied the auditory brainstem potentials in children with protein energy malnutrition to determine the effects of PEM on developing brain in children. Significant differences were recorded in mean latencies of the waves I, II, III, IV, V on both ears and in the mean interpeak latencies of waves III – V and I – V on right ear between study and control group, suggesting the defect in myelination of auditory brainstem pathways in children with moderate / severe PEM. The present study results agreed with this result.

Cecila Algrain *et al.* (2003) studied the longlasting effects of iron deficiency anemia on auditory and visual system functioning in infants. Absolute latencies of all auditory brainstem response waves and interpeak latencies (except I – III interval) were significantly longer in children with iron deficiency anemia. They showed the evidence that iron deficiency anemia in infancy alters myelination and affects the transmission through auditory system. The result of this study is similar with the present study result.

Conclusion

The present study shows significant alteration in brainstem auditory evoked potential responses in children with malnutrition which may be due to nutritional deficiency affecting myelination of auditory brainstem pathways. These abnormalities depends on duration and severity of malnutrition. Severe and chronic malnutrition affects BAEP – I, II, III, IV and IPL I – III, III – V findings. Mild to moderate malnutrition alters BAEP – IPL I – III. Thus there is strong association between duration and severity of malnutrition with BAEP abnormalities. So this electrophysiological test can be used to detect malnutrition at its early stage. Nutritional deficiency during development of brain has longlasting effect on learning abilities, psychomotor development , but whether it is reversible or irreversible after nutritional rehabilitation needs to be evaluated. With the help of advanced electrophysiological methods , the need for screening , early diagnosis , health education and initiating nutritional support at appropriate time will help the children to improve their academic performance and to become a successful achiever in future.

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