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Research Article

Brainstem auditory evoked responses in severely malnourished children

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ABSTRACT

Background: Severe malnutrition is a common morbidity among children living in slums. The malnutrition affects the development of neural pathways depending on its duration and severity. The effects on both the peripheral and central nervous system by severe malnutrition can be shown using Brainstem Auditory Evoked Response (BAER). The objective of the study was to provide an electrophysiological evidence of effect of severe malnutrition specifically on auditory pathways in brain.
Methods: This study was an observational case control study done in Physiology department of a Government Medical College in north India. This study was done over a period of six months. Thirty children each in the age group of 2-5 years having severe malnutrition (as per WHO classification, Z-score cut-off point of <-3 SD) were taken as cases and thirty age matched children without malnutrition were taken as controls. BAER was done using standard procedures.
Results: Thirty cases and controls each were taken for the study. The mean age of the children in months was 3.18 ± 0.85 and 3.20 ± 0.85 in cases and controls respectively The latencies of all the waves of BAER were found to be significantly increased in children with severe malnutrition as compared to controls (p value <0.05 in all of them). The interpeak latencies of wave I-III and I-V were also found to be increased significantly.
Conclusions: The severe malnutrition leads to the auditory function changes detectable by delayed brainstem auditory evoked responses. These changes could be attributed to defects in myelination in the neural tissue of the auditory pathway.

Keywords: Severe Malnutrition, Brainstem auditory evoked response

INTRODUCTION

Severe malnutrition is a common morbidity among children living in slums. The WHO Global Database on Child Growth and Malnutrition uses a Z-score cut-off point of <-3 SD to classify low weight-for-age, low height-for-age and low weight-for-height as severe malnutrition.[1] Various nutritional deficiencies associated with it affect functioning of all the systems of the body. The malnutrition affects the development of neural pathways depending on its duration and severity. The auditory pathway can also get influenced by the nutritional status. The effects on both the peripheral and central nervous system by severe malnutrition can be shown electro physiologically using brainstem auditory evoked responses. BAER is the potential recorded from the ear and vertex in response to a brief auditory stimulation to assess the conduction through the auditory pathway up to midbrain.[2] The brainstem auditory evoked response is an effective and non-invasive means of assessing the functional status of the auditory nerve and the brain stem auditory sensory pathway in a child.[3] It is not significantly altered by state of consciousness, drugs and variety of environmental factors including other sensory input to the cortex.[4]

There is paucity of data on the relation of malnutrition and the BAER changes. So we designed this study to

provide an electrophysiological evidence of effect of severe malnutrition specifically on auditory pathways in brain.

METHODS

This study was an observational case control study done in Physiology department of a Government Medical College in north India. This study was done over a period of six months. Thirty children in the age group of 2-5 years having severe malnutrition (as per WHO classification, Z-score cut-off point of <-3 SD) were taken as cases and thirty age matched children without malnutrition were taken as controls. The height for weight, weight and height for age were calculated and classified from the WHO growth standards. The subjects were recruited from urban slums of the city where malnutrition was common. The controls were also taken from the same area to remove the demographic bias.

Exclusion criteria

All the subjects underwent a complete ENT examination and the children with abnormal hearing, otological disorder, family history of deafness and/or phenotypical markers (like low set ears, ear tags, facial dysmorphism and otic deformity) suggesting ear involvement were excluded from the study. Those subjects' whose parents or guardians refused to give consent were also excluded.

Experimental design

Each subject underwent detailed physical examination. Children were sedated using trichlophos if required under the supervision of a paediatrician. BAER was done using Data Acquisition and Analysis System, Neurostim (NS4), Medicaid systems, Chandigarh, India in an electrically and acoustically shielded air conditioned room. The recordings were taken by placing electrodes on the scalp: the reference electrode at the vertex, ground electrode on the forehead and active electrodes at the left and right ear lobe.[2] The impedance of skin to electrode was kept below 5 kilo ohms. The 2000 click stimuli having intensity of 7dB above the normal hearing threshold were given to each ear independently using headphones at the rate of 11.1/sec and for a duration of 0.1 ms. Latencies in waveforms were displayed on the monitor after filtration (at 100Hz and 3000Hz), amplification and averaging of the waves in the first 10 ms. The sweep speed was 1ms/division and the sensitivity was 0.5µV/division. The peak latencies of the waves I, II, III, IV and V, the inter peak latencies of I-V, I-III and III-V, the amplitudes of waves I (I-Ia) and V (V-Va) were recorded and statistically analysed. Both ears of each subject were taken as independent reading because of anatomical difference. We took average of the mean value of latencies of both ears as there is insignificant difference between the latencies of both ears.[5]

Data was collected by the investigators, compiled and analysed using descriptive analysis using Microsoft Excel ™ and statistical tests. Student t test was used for analysis. P value of less than 0.05 was considered significant.

Informed consent

Written informed consent was taken from one of the enrolled subject's parents or guardians. They were provided with written and verbal information including the questions involved in the research. Confidentiality of the subjects was maintained.

RESULTS

Table 1: Baseline variables.

Variable		Cases (n=30)	Controls (n=30)
Age in years		3.18 ± 0.85	3.20 ± 0.85
Height in cm		84.3 ± 5.27	92.56 ± 4.95
Weight in kg		6.99 ± 0.86	14.6 ±1.73
Body Mass index		9.81 ± 0.37	17.01 ± 1.24
Body surface area in m^2		0.36 ± 0.03	0.62 ± 0.05
Gender	Male	16 (53%)	15 (50%)
	Female	14 (47%)	15 (50%)
Religion	Hindu	21 (70)	20 (67%)
	Sikh	9 (30%)	10 (33%)

A total of 39 severely malnourished children were enrolled during the study period out of them seven children were excluded because of otological problems and two for not giving consent. Remaining 30 children were taken as cases. Age matched normally nourished next child in examination was taken as control. The mean age of the children in years was 3.18 ± 0.85 and 3.20 ± 0.85 in cases and controls respectively and was similar in both groups. Percentage of males in the cases and controls was 53% and 50% respectively. The baseline variables viz. height, weight, body surface area, body mass index of cases and controls are shown in the Table1. The mean peak latencies of wave I-V mean interpeak latencies I-III, I-V and III-V and mean amplitude I-Ia, V-Va of BAER and the comparison of above parameters in the cases and controls using student t-test are shown in Table 2.

The latencies of all the waves of BAER were found to be significantly increased in children with severe malnutrition as compared to controls (p value <0.05 in all of them). The interpeak latencies of wave I-III and I-V were also found to be increased significantly. There was statistically insignificant difference in the amplitude of waves I and V and interpeak latency III- V between the two groups.

DISCUSSION

This study was undertaken to see the effect of severe malnutrition on various parameters of BAER. The results of the study did show significant difference in the latencies and interpeak latencies. The severity of malnutrition has been shown to have correlation with the BAER abnormalities. Both the peripheral and central pathways do get affected by the malnutrition. As per our study increase in the latencies of wave's I-IV and interpeak latencies I-III indicates that peripheral portion of the auditory pathway is being affected. Similar finding has also been reported earlier in various studies.[6,7] Conduction through the neural pathways has also been seen to be affected by the nutritional status as shown by Chopra and Sharma.[8] Central pathways also get affected by the nutritional status of the child as shown by other studies. Our study has also reported the increase in the latency of wave V and interpeak latency I-V which reflect central portion of the auditory pathway. Similar results have also been documented earlier.[9-11] Odobas et al found increase in the absolute latencies of wave I-V and interpeak latency I-V and III-V indicating the involvement of peripheral as well as the central pathways in malnourished children.[12] Very little data is available regarding the variation in the amplitude of the waves of BAER in relation to malnutrition.

The nutritional status of the baby affects both the peripheral and central auditory pathways. The effect of malnutrition on the brainstem auditory responses can be attributed to defective myelination of the neural tissues and subsequent decrease in the diameter of myelinated nerves.[13] The decrease in the number of neurons, synthesis of structural proteins and myelination due to the nutritional deficiencies can be related to the delayed central responses of BAER.[14,15]

Although different classifications are used to classify the severity of malnutrition in previous studies but the conduction has been shown to be slower in all of them thus reinforcing the finding in our study that the malnourished children do have deranged BAER.

Table 2: Comparison of BAER parameters in the cases and control groups.

Group	Wave	Cases (n=30)	Controls (n=30)	t value	p value	Sig
Duration (ms)	I	1.71± 0.01	1.68± 0.08	1.81	0.04	S
	II	2.81± 0.04	2.77± 0.06	3.09	0.002	S
	III	3.95± 0.10	3.88± 0.07	3.20	0.001	HS
	IV	4.92 ± 0.09	4.86± 0.14	2.02	0.02	S
	V	5.99 ± 0.04	5.91± 0.11	3.43	0.001	HS
Interpeak Latency (ms)	I – III	2.24 ± 0.09	2.19± 0.10	1.84	0.04	S
	I – V	4.28± 0.04	4.23± 0.1	1.91	0.03	S
	III – V	2.04± 0.10	2.04± 0.14	0.03	0.49	S
Amplitude	I-Ia	0.92± 0.30	0.91± 0.09	0.23	0.41	S
	V-Va	1.15± 0.45	1.13± 0.46	0.17	0.43	S

Limitations

The limitations of the study include its small sample size. The BAER was done only at a single point of time. Only the severely malnourished children were taken as subjects. Cortical auditory evoked potentials were not used to assess the auditory pathways.

Future prospects

Further studies are required with adequate sample size along with stratification of various degrees of severity of malnutrition. The BAER can also be done during rehabilitation phase so as to ascertain the reversibility of the BAER changes acquired during the malnourished phase. Long latency potentials can also be included in the analysis of BAER to get more knowledge about the cortical pathways.

CONCLUSION

The severe malnutrition leads to the functional changes in the auditory system detectable by delayed brainstem auditory evoked responses. BAER is an easy, non-invasive and feasible method of detecting the auditory impairment in children. These changes could be attributed to defects in myelination in the neural tissue of the auditory pathway.

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