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PROXIMAL CONDUCTION VELOCITY OVER H-REFLEX ARC IN MALNOURISHED CHILDREN UNDER FIVE YEARS OF AGE.

Physiology

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ABSTRACT

INTRODUCTION: Malnutrition in children affects the development and function of every organ system including the peripheral and central nervous systems. Hoffmann reflex (H-reflex) is an important neurological screening tool, especially in the paediatric population. Conduction velocity over the H-reflex arc has been used to assess proximal motor and sensory pathways. The present study attempted to demonstrate slowed conduction over H-reflex arc in malnourished children below five years of age.

MATERIAL AND METHODS We studied 82 under-five children with protein-energy malnutrition. 60 age-matched healthy children served as control subjects. As proximal conduction velocity over H-reflex arc changes with age, study subjects were divided into four groups on the basis of age. Based on the degree of malnutrition, the patients were further divided into two groups. The H-reflex was recorded from soleus muscle by stimulating posterior tibial using Neuro perfect EMG/NCV/EP SYSTEM (Medicaid systems, Chandigarh,160002, India).

RESULTS The conduction velocity over the soleus H-reflex arc was significantly decreased in severely malnourished children. However, conduction velocity over the soleus H-reflex arc in the children suffering from mild-to-moderate malnutrition was comparable with normal children.

CONCLUSION The findings suggest that severely malnourished children demonstrate slowed postnatal peripheral neural maturation. Conduction over the soleus H-reflex arc was significantly decreased in severely malnourished children.

KEYWORDS

Children, Malnutrition, Hoffman reflex (H-reflex), Proximal Conduction Velocity

INTRODUCTION:

The term "malnutrition" has been used to characterize energy and/or nutritional deficits, excesses, or imbalances in a person's diet that have a measurable harmful effect on body composition and function[1,2]. However, this study has dealt with the under-five children suffering from Protein-Energy Malnutrition (PEM).

PEM in children continues to be a scourge in developing countries even in the 21st century. Undernutrition is responsible for around 45 percent of mortality among children under the age of five, with low- and middle-income countries being the most affected[2]. In 2015-16, 35.7 percent of Indian children below five years were underweight[3].

Malnutrition in children affects the development and function of every organ system including the peripheral and central nervous systems. In the developing child, myelination begins in the motor roots of the peripheral nerves and continues through the central nervous system. The larger part of myelin is formed in the first few years after birth[4].

Malnutrition in under-five children may slow down this myelination process. As a result, conduction in demyelinated axons may be delayed or blocked.

The Hoffmann reflex (H-reflex) is an electrical analog of the spinal stretch reflex. The H-reflex is evoked by low-intensity electrical stimulation of the afferent nerve, rather than a mechanical stretch of the muscle spindle, that results in monosynaptic excitation of alpha motoneurons (αMN)[5]. Advantages of recording H-reflexes lie in the low stimulation intensity required to elicit them and, in their ability, to convey information about the proximal sensory and motor pathways. Conduction velocity over the H-reflex arc has been used to assess nervous system myelination as well as the sensory (Ia) and motor components of the reflex arc[6].

MATERIAL AND METHODS:

This study was a case-control study. It was conducted at Neurophysiology Laboratory, Aligarh Muslim University, Aligarh. Ethical clearance was obtained from the Institutional Ethical Committee and well explained informed written consent was obtained from parents/guardians of all the participants. Cases were comprised of eighty-two under-five children with protein-energy malnutrition. Sixty age-matched healthy children served as control subjects. Participants with demyelination disorders, motor neuron disease, diabetes mellitus, thyroid dysfunction, myopathies, and neuromuscular junctional disorder were excluded from the study. The sample size was estimated at convenience. Assessment of the nutritional status of the study subjects was done as per the guidelines of the Nutrition Subcommittee of the Indian Academy of Paediatrics[7].

Hoffmann – Reflex (H-reflex) study:

The H-reflex was recorded from soleus muscle by stimulating posterior tibial using Neuroperfect EMG/NCV/EP SYSTEM (Medicaid systems, Chandigarh,160002, India). The active surface electrode was placed at the distal edge of the calf muscle and the reference electrode on the Achilles tendon. The ground electrode was placed between the stimulating and the recording electrodes. The cathode was kept proximal to the anode to avoid the anodal block. The tibial nerve was stimulated in the popliteal fossa by applying a square wave pulse of 0.5 milliseconds (ms) duration at a frequency of 1/sec. The filter setting was 20Hz-5 kilohertz and sweep speed was 5 ms/ division.

Calculation of Conduction velocity over H-reflex arc:

After obtaining a maximal H-reflex, a maximal M-response was then elicited by supramaximal excitation of the tibial nerve from the same site of stimulation used for the H-reflex, i.e., the anode was rotated proximally. Length of soleus H-reflex arc is estimated as 80% of body height, an estimate based on studies of adult cadavers[8] and knowledge of the respective development of the femur and the trunk during the first year of life[9,10]. With due consideration of synaptic delay[11], the conduction velocity over H- reflex arc was calculated by the formula[12]: - H-reflex CV (m/s) = (80% Height) / (H-reflex latency – M latency – 1 ms)

Statistical Analysis:

The Statistical analysis has been done using the statistical package for social science (SPSS 17.0) for Windows Software. One-way analysis of variance (ANOVA) and Tukey-Kramer post hoc test was used to compare the means of comparison groups.

RESULTS:

Since proximal conduction velocity over the H-reflex arc varies with age, study subjects were divided into 4 age groups for statistical analysis. Within each age group, the cases were further divided into 2 groups based on the degree of malnutrition, first as suffering from mild-to-moderate malnutrition (PEM grades I and II) and second as suffering from severe malnutrition (PEM grades III and IV).

Table 1: Age And Gender Distribution Of Study Subjects

Groups	Age (months)	Gender (controls)		Gender PEM (I & II)		Gender (PEM III & IV)	
		Male	Female	Male	Female	Male	Female
Group I	6-12	9	6	7	4	6	4
Group II	>12-24	9	6	7	5	5	8
Group III	>24-36	9	6	6	4	6	3
Group IV	>36-48	9	6	5	4	5	3

PEM= protein-energy malnutrition.

Table 1 shows the age and gender distribution of controls and cases in different age groups. 15 healthy children served as control subjects in each age group.

Table 2: Comparison Of Mean Proximal Velocity Over H-reflex Arc (m/s) (one-way Anova)

Age groups	Control	PEM grade (I & II)	PEM grade (III & IV)	p-value (one way ANOVA)
	Mean (SD)	Mean (SD)	Mean (SD)	
Group I	48.75 (2.62)	48.04 (2.24)	45.14 (1.77)	0.002†
Group II	54.61 (1.47)	53.79 (1.67)	48.34 (1.02)	<0.001†
Group III	57.68 (1.10)	56.65 (1.76)	49.24 (1.46)	<0.001†
Group IV	59.50 (0.67)	58.91 (0.94)	51.12 (1.92)	<0.001†

PEM= protein-energy malnutrition, †Significant

Table 2 shows the statistical analysis of the results using One-Way ANOVA. In all four age groups, the comparison of mean proximal velocity over H-reflex arc between the control group and PEM groups was statistically significant.

TABLE 3: Post Hoc Analysis (Tukey- Kramer test)

Age groups	Groups compared	p-value
Group I	Control- PEM grade (I&II)	0.702*
	Control - PEM grade (III&IV)	<0.001†
	PEM grade (I&II)- PEM grade (III&IV)	0.019†
Group II	Control- PEM grade (I&II)	0.298*
	Control- PEM grade (III&IV)	<0.001†
	PEM grade (I&II) - PEM grade (III&IV)	<0.001†
Group III	Control- PEM grade (I&II)	0.190*
	Control- PEM grade (III&IV)	<0.001†
	PEM grade (I&II)- PEM grade (III&IV)	<0.001†
Group IV	Control- PEM grade (I&II)	0.458*
	Control- PEM grade (III&IV)	<0.001†
	PEM grade (I&II)- PEM grade (III&IV)	<0.001†

* Not Significant, † Significant, PEM= protein-energy malnutrition

Table 3 shows the statistical analysis of the results by the Tukey-Kramer post-hoc test. In all the age groups, the mean proximal velocities over the H-reflex arc were significantly lower in the PEM grade III and IV groups than in the control groups. However, there was no statistically significant difference in mean proximal velocities over H-reflex arc between PEM grade I & II groups and control groups.

DISCUSSION:

The present study focussed on the effects of malnutrition on conduction over the soleus H-reflex arc during the first years of postnatal life. Proximal conduction velocity over the H-reflex arc conveys information about both the sensory and motor segment of this spinal monosynaptic reflex arc. Other nerve conduction studies such as F waves have been used to study conduction in the proximal segment of the motor nerves only[13]. Delayed distal motor and sensory nerve conduction velocity in malnourished children has been shown in previous studies[14,15].

From the above result, it appeared that across all the age groups, the conduction velocity over the soleus H-reflex arc was significantly decreased in the PEM grade III and IV groups than in the control groups, while there was no statistically significant difference between PEM grade I & II groups and control groups. Freitas-Silva SR et al[16] (2008) have reported similar findings showing a significant reduction of velocity index in rats submitted to neonatal malnutrition. Krishnamurthy N et al[17] (1993) have reported that H-reflex latency remains unaffected in children with grade I & grade II malnutrition.

Conduction velocity over soleus H-reflex arc increase with age, the increase is more rapid during the first two years of life[12]. Cai F et al [18] (1997) demonstrated that the conduction velocities of the H reflex do not reach adult values until 6 years of age. Myelination of the peripheral nerves also occurs during this period. It starts at the fifteenth week of gestation[19] and lasts for the first two to five years of life[20,21]. The quick integration of radioactive precursors into myelin and a large increase in enzymes involved in the production of myelin components have been proven biochemically early in development[4]. The axons also mature during the prenatal and postnatal periods, starting at twenty weeks of pregnancy and peaking between the ages of two and five years[22]. Malnourishment in children can impair this ongoing maturation of peripheral nerves. Among children with severe PEM, this could be the cause of a significant reduction in conduction velocity over the soleus H-reflex arc.

CONCLUSION:

The present study aimed to study the effect of malnutrition on proximal conduction velocity over H-reflex arc in under-five children. The findings of our study suggest that malnutrition affects nerve conduction even proximally. Further studies should evaluate long-term neurological sequelae of malnutrition in children.

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