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Serum zinc levels related to protein energy malnutrition of Anganwadi schools in Kuppam Mandal, Chittor District, Andhra Pradesh

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Abstract

Background: Malnutrition is globally an important risk factor for illness & death, contributing to more than half of deaths in children world-wide. Most common micronutrient deficiencies seen in malnutrition include iron, iodine, zinc & vitamin A.

Objectives: (1) To estimate total protein, albumin and zinc levels in serum in Protein-Enegry Malnutrition children and healthy age & sex matched controls (2) To find out whether there is any correlation between height and weight with serum zinc levels in cases.

Methods: 33 cases and 28 controls from 12 Anganwadi centers of age 3 – 5 years served as materials. Protein-energy malnutrition cases were identified as per IAP guidelines. 3 ml venous blood was collected and serum was analysed for total protein by Biuret method, albumin by BCG-dye binding method and zinc by Nitro-PAPS colorimetric method.

Results: Mean zinc level in serum was 96.71 mg/dl in controls and 72.82 mg/dl in cases ($p < 0.001$), serum albumin was 4.14 g/dl in control group and 3.53 g/dl in cases ($p < 0.001$), total protein level was 6.8 g/dl in controls and 5.85 g/dl in cases ($p < 0.01$).

Conclusion: Zinc deficiency does exist in malnourished children and has an impact on growth and development of the child.

Key Words: Albumin, protein-energy malnutrition, total protein, zinc

Introduction

Malnutrition is globally the most important risk factor for illness & death, contributing to more than half of deaths in children world-wide. The World Health Organisation defines malnutrition as "the cellular imbalance between the supply of nutrients & energy, and the body's demand for them to ensure growth, maintenance & specific functions" (1). In India, Protein-Energy Malnutrition (PEM) is estimated to be an underlying cause in 30% of deaths among children under the age of 5 years with a 53.4% prevalence of under-nutrition. Biochemical changes frequently observed in PEM includes: reduction in concentration of all proteins in the body, reduction in liver detoxifying mechanism, impairment in gluconeogenesis with the risk of hypoglycemia and marked decrease in plasma transferrin concentration. A decreased concentration of plasma triglycerides, cholesterol & β-lipoproteins was seen along with an altered anti-oxidant status in PEM. Several parameters like sodium, potassium, bicarbonate, β-carotene, retinol & uric acid levels were found to be significantly lower in the malnourished individuals (2).

In addition, PEM children may be frequently affected by micronutrient deficiencies, which also

have a detrimental effect on growth & development. The most common micronutrient deficiencies include iron, iodine, zinc & vitamin A. Zinc is an essential nutrient for life and is a component of over 100 metalloenzymes with catalytic, regulatory & structural role (3). Zinc deficiency associated with PEM contributes to anaemia, dwarfism, hepato-spleenomegaly, hyperpigmentation, hypogonadism, Acrodermatitis enteropathica, diminished immune response & poor wound healing.

Material and Methods

Twelve Anganwadi centers which come under Kuppam Mandal, located under Chittor District of Andhra Pradesh were visited. A preliminary survey was done of all children between 3 years & 5 years attending respective Anganwadi centres by taking the measurement of Height & Weight. Protein-Energy malnutrition cases and age & sex matched normal healthy controls were identified in each of these centre based on IAP guidelines. As per the ethical guidelines by the institution ethical committee, after taking an informed consent from the parent/guardian, a total of 33 PEM children and 28 healthy children served as the materials for the study. Children with recent history of fever, jaundice, liver disorders, bleeding diathesis or any such illness known to affect protein or zinc levels in serum were excluded from the study.

3 ml venous blood was collected from these children using 24 gauge needles from the median cubital vein after taking suitable aseptic precautions. The sample was transferred to a test tube & the blood was allowed to clot for about 15 minutes. The sample was then centrifuged at 3000 rpm for 10 minutes to separate the serum. Separated serum was carefully transferred to the labeled plastic vials. Analysis of serum was carried out in batches, with inclusion of Bio-rad internal quality control materials for each batch. Serum was analysed for total protein by Biuret method (4), albumin by BCG-dye binding method (5,6) & zinc by Nitro-PAPS colorimetric method (7,8) by using 'Chemwell' fully automated analyser at Clinical Biochemistry Laboratory, P.E.S. Institute of Medical Sciences & Research, Kuppam.

Analysis of results was done on the basis of mean values, standard deviation and Student 't'-test. The values are compared for the corresponding degree of freedom at 5% and 1% levels of significance. Partial correlation co-efficient was compared with a constant. The percentage of significance was obtained on the basis of 'r' values and 'p' values.

Results

In the present study, serum zinc, total protein and albumin levels were analysed in cases of Anganwadi school children, and compared with the healthy controls.

The age group of the cases and controls were between 3 & 5 years. The total number of cases included in the study was 33 with 28 age and gender matched controls. Age and gender wise distribution of cases and controls are depicted in Table 1.

Table 2 shows the nutrition status of the controls based on weight for age. 14.3% were between 81 – 85%, 25% were between 86 – 90%, 32.1% were between 91 – 95%, while 28.6% were > 96%. As per the IAP guidelines, gradation of PEM school children based on weight for age revealed that 54.4% of cases were under Grade I PEM and 45.5% of children were under Grade II PEM. The details of the same have been displayed in Table 3.

The mean & standard deviation of cases and controls of the parameters estimated namely total protein, albumin and zinc is shown in Table 4. Serum zinc levels and serum albumin levels showed highly significant decrease ($p < 0.001$) as compared to controls. Also serum total proteins showed a significant decrease ($p < 0.01$) when compared with controls. Table 5 displays the correlation coefficient of serum zinc levels with height and weight. There was a negative correlation of 80% significance with respect to height and a positive correlation of 81% with respect to weight.

Discussion

Protein Energy Malnutrition is still a problem of concern affecting the children in early infancy and childhood, especially in developing countries like

Table 1

Age and gender distribution of cases and controls

	GENDER	3 – 4 YEARS	4 – 5 YEARS
CASES (n = 33)	Males	11	5
	Females	9	8
CONTROLS (n = 28)	Males	7	10
	Females	6	5

Table 2

Nutrition status based on weight for age in controls

	81 – 85 %	86 – 90 %	91 – 95 %	96 – 100 %
CONTROLS (n = 28)	4	7	9	8
% Distribution	14.3	25	32.1	28.6

Table 3

Grades of malnutrition based on weight for age in cases

	GRADE I	GRADE II	GRADE III
	71 – 80%	61 – 70 %	< 60%
CASES (n = 33)	18	15	NIL
% of Distribution	54.5	45.5	0

Table 4

Total protein, albumin & zinc in cases aand controls

	TOTAL PROTEIN (g/dl)	ALBUMIN (g/dl)	ZINC (mg/dl)
	Mean ± SD	Mean ± SD	Mean ± SD
CONTROLS (n = 28)	6.87 ± 0.95	4.13 ± 0.46	96.71 ± 34.20
CASES (n = 33)	5.85 ± 1.40□	3.53 ± 0.84□	72.82 ± 26.36□

□ a Vs b : $p < 0.001$ † a Vs b : $p < 0.01$

Table 5

Correlation co-efficient between zinc levels with height & weight in cases

	HEIGHT	WEIGHT
r	- 0.0463	0.0430
p	0.801	0.815

India. Many biochemical parameters are known to contribute to the pathogenesis and outcome of malnutrition, which have been studied by various research workers.

In the present study, it was observed that among the 33 malnourished cases, 54.5 % came under the category of Grade I PEM and 45.5 % came under Grade II PEM in the present study. None of the children had Grade III PEM, which is considered as the severe form.

The mean zinc level in serum was 96.71 mg/dl (SD ± 24.20) in controls and 72.82 mg/dl (SD ± 26.36) in cases. Comparison between the control and case groups showed a highly statistically significant decrease ($p < 0.001$) in values in PEM cases. Similarly, serum albumin showed highly significant decrease in cases with mean value of 3.53 g/dl (SD ± 0.84) as compared to control group with mean value of 4.14 g/dl (SD ± 0.46), with a 'p' value < 0.001. But it was seen that the mean total protein level was 6.8 g/dl (SD ± 0.95) in controls and 5.85 g/dl (SD ± 1.40) in cases, which showed a significant decrease with 'p' < 0.01. Similar results were obtained by E.I. Ugwuja and his co-workers, who conducted a study on malnourished pre-school children in Central Nigeria (9). Another study done by K.E.Elizabeth et al (10) also showed that the serum zinc, protein and albumin levels were highly significantly decreased in cases of PEM as compared to the controls. 10 malnourished children studied by de Souza N M et al (11) also showed the presence of significant zinc deficiency when compared with controls. Singla P N and his investigators (12) similarly showed that the serum zinc levels were significantly decreased in malnourished subjects as compared to healthy controls along with a significant decrease in serum albumin and serum copper levels. In a study conducted by the Department of Pediatrics, King Edward Medical College & Mayo Hospital, Lahore, Tahir Masood Ahmad and his team (13) observed significantly lower zinc levels in children with Kwashiorkor. In a study comprising of 20 malnourished children by Shingwekar AG and his researchers (14) observed that serum zinc levels and retinol-binding protein were significantly lower as compared to controls.

The present study reveals that there exists a negative correlation with the zinc levels in serum when compared with height of malnourished children, keeping age factor as constant. However, a positive correlation existed when the comparison was made between serum zinc levels and weight

of malnourished children, age factor being kept constant. Such relationship between serum zinc levels and stunted growth has been supported by the observations made by K.E. Elizabeth et al (10). Several studies have indicated the existence of relationship between the stunted growths of children with low zinc levels in serum. Likewise, many studies have confirmed that zinc supplementation has an important role in the achievement of suitable height for the age in children (15,16,17).

Observations in various studies suggest strongly that micronutrient deficiencies are common and exist in various degrees along with protein energy malnutrition. Zinc is one of the important micronutrient which plays an important role in growth and development, immune response, neurological functions and reproduction (18). Several nutritional as well as socio-economic reasons can be postulated for the existence of zinc deficiency observed in the present study. These include – poor dietary intake, poor absorption due to worm infestations, socio-economic factors like poverty and ignorance, lack of attention towards prompt treatment of infection, decrease absorption due to causes like diarrhea, lack of personal hygiene.

Since zinc plays an important role in the growth and developmental process especially in children, stunting of malnourished children as observed in the present study can be attributed to its deficiency. Also there exists a risk of infection in these malnourished children due to poor immunity status, which is an important factor determining morbidity and mortality in them.

Conclusion

From our study, it can be concluded that zinc deficiency does exist in malnourished children and has an impact on growth & development of the child. Thus, micronutrient supplementation is necessary for these children along with protein and calorie rich foods. Health education of parents, especially of rural origin with regard to foods rich in proteins, calories as well as micronutrients will help in prevention of malnutrition and to overcome such deficiencies. Necessary protein and zinc supplementations in addition to the diet will be extremely helpful in maintaining the immunity and achieve optimal growth and development for their respective age. Since malnutrition is a condition involving multi-factorial etiology and consequences, there exists a wide scope of research in identifying their role in pathogenesis, treatment and prevention. Further studies may be undertaken to know more about the effects of zinc supplementation in malnourished children with respect to the immunity, growth & development process.

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