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Serum Zinc Level in Children with Protein Energy Malnutrition and Its Correlation with Serum Albumin

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Abstract

Objectives: To estimate the serum zinc and albumin level in hospitalised children with protein energy malnutrition and to find out the correlation between serum zinc and albumin.

Methods: It is a case – control hospital based study comprising of 50 cases and 50 controls. Hospitalized children of 1-12 years of age with malnutrition were taken as cases and those without malnutrition were selected as controls. The nutritional status of the children was assessed. Serum zinc and albumin level were measured. Statistical analysis was done by calculating P-value and Pearson’s correlation coefficient.

Results: Mean serum zinc was 54.38 ± 10.33 µgm/dl in cases and 92.84 ± 22.31 µgm/dl in controls. The mean serum zinc was 59.5 ± 11.10 µgm/dl in grade I PEM, 55.6 ± 5.76 µgm/dl in grade II PEM, 50.14 ±10.96 µgm/dl in grade III PEM and 45.68 ± 10.15 µgm/dl in grade IV PEM. Mean serum albumin was 2.43 ± 0.68 gm/dl in cases and 3.6 ± 0.31 gm/dl in controls. The mean serum albumin level was 2.7 ± 0.62 gm/dl in grade 1 PEM, 2.5 ± 0.59 gm/dl in grade II PEM, 2.03 ± 0.47 gm/dl in grade III PEM and 2.0 ± 0.66 gm/dl in grade IV PEM.

Conclusion: Malnourished children were deficient in both zinc and albumin and deficiency increases as the severity of PEM increases. There was a moderate positive correlation between serum zinc and albumin level. Regular supplementation of zinc in form of zinc fortified food will decrease this deficiency in those children at risk.

Keywords: Serum zinc, Serum albumin, PEM, Children

Introduction

Protein energy malnutrition (PEM) is very common in children of developing countries. World Health Organisation (WHO) defines PEM as range of pathological conditions arising from coincidental lack in varying proportions of proteins and calories, occurring most frequently in infants and young children and commonly associated with infection [1]. About 6,600 under five children die every day of malnutrition in India (NFHS-3) [2].

Over the last few years, micronutrient deficiency has gained importance as a public health problem along with proteins, carbohydrates and fats. Zinc has been known to be an essential element since its discovery by Raulin in 1869 [3]. To date more than 200 zinc dependent enzymes have been identified in biochemical pathways. Because of zinc's central role in cellular growth and differentiation, the effects of its deficiency are especially pronounced in tissues and organs with rapid turnover (e.g. the immune system), and during periods of rapid growth. Meats and many plant sources like lentils and grains such as whole meal meat, maize and polished rice provide a high zinc concentration but the release and absorption of zinc is limited by the abundant phosphorus compound, phytate, which binds zinc[4]. The normal serum zinc level of healthy children is 60-100 ug/dl [5].

The best global indicator of children's well being is growth. Assessment of growth is the single measurement that best defines the nutritional and health status of children, and provides an indirect measurement of the quality of life of the entire population[6]. Causes of malnutrition include, inadequate intake as a result of insufficient or inappropriate supply of food, early cessation of breastfeeding, cultural and religious beliefs, poor sanitation and chronic diseases[7]. In India as per NFHS-3, 45% of Indian children are underweight [2]. Studies in children with PEM have documented decreased levels of various macro and micro nutrients viz. albumin, potassium, zinc, iron, magnesium, calcium, copper, folic Acid, vitamin A, K, E, D [8].

Zinc, a trace element-a metalloporphyrin is involved in numerous aspects of cellular metabolism. It is a constituent of over 100 enzymes and plays a role in immune function, protein and DNA synthesis. A daily intake of zinc is required to maintain a steady state because the body has no specialised zinc storage system. In protein energy malnutrition there is deficiency of zinc which affects the antioxidant properties and immune system of body. Supplementation of zinc helps to improve the immune system of body [9].

In human serum, zinc is primarily bound to albumin (80-85%), alpha 2 macroglobulin (10-15%) and retinol binding protein (2-3%). Further studies have shown levels of alpha 2 macroglobulin is relatively constant in disease states; so change in serum zinc level can be attributed to decrease in serum albumin level [8].

In protein energy malnutrition there is hypoalbuminaemia and the decrease in serum zinc level can be primary or secondary to decrease in serum albumin level. This study was planned with the objectives to estimate the serum zinc level in hospitalized children with protein energy malnutrition in this part of the country and to compare with that of healthy children and to find out the correlation between serum zinc and albumin level.

Materials and methods

Ethical clearance was taken from the Institutional Ethics committee before the study. The study was carried out in the Department of Pediatrics, Assam Medical College, Dibrugarh. Serum albumin and zinc level were estimated in the Department of Biochemistry. 50 hospitalized children with malnutrition (weight for age $\leq$ 80% of expected), of ages 1- 12 years, were taken as cases; and 50 children without malnutrition (weight for age >80% of expected) were taken as controls who were age, sex and socio-economic status matched with cases. Children with gastroenteritis, acute respiratory tract infection, persistent diarrhoea, kwashiorkor and history of intake of zinc in the past three months, were excluded. Outcome measures were anthropometric measurements (height, weight) and estimations of serum zinc and serum albumin level.

Verbal consents were taken from the parents/guardian of the children fulfilling the inclusion criteria. A detailed history was taken and thorough clinical examination, including height and weight, were done and recorded in a pre-structured proforma. The nutritional status of children were assessed in relation to weight for age (upto 10 years), height for age (for all), weight for height (upto 5 years) and BMI (above 5 years). WHO growth chart was used for interpretation. For grading of malnutrition IAP classification [10] was used. Blood samples were taken in clot activator vial for serum albumin and serum zinc estimations. Serum zinc was measured by colorimetric method and serum albumin was measured by Bromocresol green dye method.

Statistical analysis of data was done by calculating P-value with analysis of variance of serum zinc level in cases, serum zinc level for degree of malnutrition and using Pearson's correlation coefficient between serum zinc and albumin.

Results

Out of 50 cases, 16 cases (32%) were of grade I malnutrition, 17 cases (34%) of grade II, 10 cases (20%) of grade III and 7 cases (14%) were of grade IV malnutrition. Male:Female ratio was 26 (52%) : 24 (48%). Age distribution wise, 25 cases (50%) were between 1 – 5 years of age and 25 cases (50%) were between 5 – 12 years. Wasting was found in 47 cases (94 %). Stunting was found in 31 cases (62%). In 31 cases of stunting mean serum zinc level was 51µgm/dl and in 19 cases without stunting mean serum zinc level was 55 µgm/dl. So it has been seen that low serum zinc level is associated with stunting. The mean value of serum zinc was 54.38 ± 10.33 µgm/dl in cases and 92.84 ± 22.31 µgm/dl in controls.. The mean value of serum zinc was 59.5 ± 11.10 µgm/dl in grade I PEM, 55.6 ± 5.76 µgm/dl in grade II PEM, 50.14 ±10.96 µgm/dl in grade III PEM and 45.68 ± 10.15 µgm/dl in grade IV PEM. The mean value of serum albumin was 2.40 ± 0.64 gm/dl in cases and 3.5 ± 0.31 gm/dl in controls. The mean serum albumin level was 2.7 ± 0.62 gm/dl in grade 1 PEM, 2.5 ± 0.59 gm/dl in grade II PEM, 2.03 ± 0.47 gm/dl in grade III PEM and 2.01 ± 0.66gm/dl in grade IV PEM. There was a moderate positive correlation between serum zinc and albumin level in malnourished children (Pearson correlation co efficient was 0.58).

Table 1: showing age, sex distribution and presence of stunting in cases, and serum zinc and albumin in both cases and controls.

Sex distribution in cases	Male : 26 no (52 %)	Female : 24 no (48 %)
Age distribution in cases	1 – 5 years : 25 no (50 %)	5 – 12 years : 25 no (50 %)
Stunting in cases	Present : 31 no (62%)	Absent : 19 no (38%)
Serum Zinc level	Cases : 54.38 ± 10.33 µgm/dl	Control:92.84 ± 22.31 µgm/dl
P value	0.009	
Serum Albumin level	Cases : 2.4 ± 0.68 gm/dl	Control : 3.6 ± 0.31gm/dl
P value	0.002	

Table 2: showing serum zinc and albumin in various grades of PEM in cases.

Nutritional grade	Serum Zinc	Serum Albumin
Grade I (32%)	59.5 ± 11.10 µgm/dl	2.7 ± 0.62 gm/dl
Grade II (34%)	55.6 ± 5.76 µgm/dl	2.5 ± 0.59 gm/dl
Grade III (20%)	50.14 ±10.96 µgm/dl	2.03 ± 0.47 gm/dl
Grade IV (14%)	45.68 ± 10.15 µgm/dl	2.01 ± 0.66gm/dl
P value : < 0.001		

Discussion

In this study, mean value of serum zinc was low in children with PEM. This Result correlates well with previous studies done by Farhan et al (2009) [5], Khubchandani (2013) [13], Atinmo et al (1982) [14], Gautam (2008) [15], Khare et al (2012)[16] and Bates (1981) [17], Elizabeth et al (2000) [33]. The reasons for zinc deficiency in malnourished children are low dietary intake, poor bioavailability, mal-absorption, and/or increased losses due to diarrhoea[18]. Phytate in cereals, which constitute the most important sources of nutrients of children in our environment, may be responsible for zinc deficiency as a result of poor bio-availability [19].The deficiency is more common in regions with high consumption of rice and unleavened bread as dietary fibers and phytates inhibit zinc absorption. Malnourished children are found to have low serum zinc level all over the world including South America[21], Egypt[22], Turkey [23] India[25], Nigeria[26], Jamaica[27], Pakistan[28] & Bangladesh[29].

Serum zinc level in our study was normal in normally nourished children in this part of the country. This result was in concordance with study done by Javed et al[5], Kozielec et al[29] and Ahmed et al[30], Kholay et al[31]and Nakamaru et al[32]

We have observed a progressive decline in serum zinc level with increasing severity of PEM, which is in agreement with those reported by Atinmo (1982) et al [14], Elizabeth et al [33], Javed et al [5], Khubchandani et al [13]

We have found low serum albumin level in children with malnutrition and this is in conformity with the study done by Khubchandani et al [13], Ugwuja et al [12], Singla et al [18]. We observed that the degree of hypoalbuminemia increases as the severity of malnutrition increases like Khubchandani et al [13] observed in her study.

In our study a positive correlation between serum zinc and serum albumin level in children with malnutrition was observed (Correlation coefficient is 0.58) and this is in accordance with Khubchandani et al [13], Elizabeth et al (2000) [33], Singla et al [18]and Bates et al [17].

We have seen a positive correlation between serum zinc and height for age in children with malnutrition as seen in the study done by Singla et al [18]. So serum zinc has got a role in linear growth of a child. Stunting in zinc deficient children is due to long continued micronutrient deficiency along with chronic malnutrition and this is of concern as stunting tends to remain permanent [34]

Conclusion

Serum zinc and albumin are low in children with malnutrition in this part of the country. Poor bioavailability of zinc because of presence of phytates in the food, as rice and pulses are the staple foods in this region, and repeated episodes of diarrhoea in malnutrition are the major causes of zinc deficiency. On the other hand zinc deficiency increases the susceptibility to infection. Serum zinc also has a positive correlation with stunting. So measures should be taken to prevent zinc deficiency in children, to prevent malnutrition and permanent height loss. The best way to prevent zinc deficiency in those children at risk is by providing regular zinc fortified food along with zinc supplementation in each episode of diarrhoea and pneumonia.

Conflict of interest: None

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