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Serum Zinc and Copper Levels In Severe Acute Malnutrition In Indian Children

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Abstract

Background – Severe acute malnutrition is one of the commonest cause of mortality and morbidity in under five year of children in India. Most of the complications of SAM are due to deficiency of proteins, vitamins and minerals. Hence this study was conducted in MLB medical college, Jhansi to evaluate the level of serum zinc and copper in severe acute malnutrition and its comparison with healthy controls.

Method- 82 cases of severe acute malnutrition has been taken according to WHO criteria and compared with 25 healthy controls. Serum zinc and copper levels measured by calorimetric method. Mean, standard deviation calculated in each sample. Differences in parameters were tested for statistical significance at $p<0.05$ using the student's t-test.

Result- Mean serum zinc and copper were significantly reduced ($p<0.05$) in severe malnourished than in healthy controls. There was statistically significant ($p<0.05$) low levels of serum zinc and copper in SAM with diarrhea also.

Conclusion – This study suggest that there is significant low levels of serum zinc and copper in severe malnutrition, which leads to various complications. So, in management of severe malnutrition we should supplement these micronutrients to reduce the complications and mortality.

Keywords: Micronutrients ; Undernutrition; Under 5 years children

Introduction

Protein energy malnutrition is the cellular imbalance between supply of nutrients and energy and the body's demand to ensure growth, maintenance and specific functions. Malnutrition is recognized globally as the most important risk factor for illness and death. Severe acute malnutrition among children less than 5 years of age remains a major impediment to human capital development in India. Malnutrition is a significant factor in approximately one-third of the nearly 8 million under-five deaths worldwide [1]. Severe acute malnutrition (SAM) affects nearly 20 million preschool-age children all over the world mainly from south-east Asia and Africa [2]. In India, prevalence of SAM is 6.4% in children <5 years as per National Family Health Survey 3 (NFHS-3) and is home to 8 million children with SAM (31.2% of the world's severely wasted children) [3].

Children with SAM have nine time higher risk of death and morbidity like growth retardation not only due to protein deficiency but also due to micronutrient deficiency like vitamins , trace minerals , essential amino acids, poly unsaturated fatty acids .[4,5]. Although there is deficiency of all vitamins and micronutrients, the levels of zinc and copper are rarely determined in malnourished children [6].

Zinc is important as a cofactor for various enzymes required for growth and immune regulation whereas Copper is required for proper functions many metalloproteinase and enzymes for example superoxide dismutase (SOD), an important antioxidant enzyme and collagen production. [7,8]

This study aims to evaluate the serum levels of zinc and copper in patients with malnutrition in an attempt to throw light on the possible role of these trace elements in the prevention and management of severe acute malnutrition.

Material And Method

The study was conducted in the Department of Pediatrics in collaboration with Department of Biochemistry, MLB medical college, Jhansi from October 2016 to September 2017. Ethical clearance to conduct the present study was obtained from the ethical committee of Institute. Informed consent was taken from the attendants of the patients. Total one hundred seven children of age between 6 months to 5 years attending OPD or admitted in nutritional rehabilitation center were selected in study. 82 children, fulfilling any one of following criteria were taken into study group –

1- Weight for height/ length <- 3SD of median WHO growth reference
2- Mid Upper arm circumference < 11.5cm
3- Presence of bipedal edema

Out of these 14 children were full filing all three criteria, 38 children were full filling two criteria and 30 children were full filling only one criteria. Remaining 25 children apparently looking normal & healthy and presenting no clinical and anthropometric sign or symptoms suggestive of any form of malnutrition were used as control group to compare with. Children under 6 month of age or more than 5 year of age and children suffering from any chronic renal, hepatic, pulmonary disorders, any congenital malformations, diabetes mellitus, myxedema, primary hypertension were excluded from study. Detail history with special emphasis on dietary history and bowel habits has been taken. Detail clinical examination was done for for signs vitamin and mineral deficiency. Anthropometric measurements of height, weight, mid upper arm circumference and chest circumference were taken. Blood sample were collected from cases and from normal subjects under aseptic condition. Five ml of venous blood was taken from each subject. Routine blood investigation Hb, TLC, DLC was done in all cases.

Stool routine microscopy, urine routine microscopy, urine culture sensitivity, chest Xray , mantoux test was done wherever needed. Serum Zinc and Copper estimation was done in each case. After allowing 30-60 minutes for spontaneous blood clotting, the serum was separated from the blood cells by centrifugation at 3000 - 4000 rpm for 10 minutes at room temperature. The serum was decanted and centrifuged twice for 5 minutes at 3000 rpm to remove any blood cell remnants, decanted again, and then stored at -20oC in deionized vials until assay. The concentration of copper and zinc in plasma were measured by calorimetric method using standard calorimetric test kit with the help of auto analyzer. Working reagent was prepared by mixing recommended amount of specific colour reagent with buffer reagent . It was then pipetted into dry clean test tubes labeled as Blank (B) , Standard(S), Test (T). Distilled water, standard, serum sample added to B,S,T respectively . Test tubes were incubated at recommended temperature for recommended duration. Following which absorbance of standard and test sample against blank serum level calculated by Zinc or Copper (μg/dl) = Abs T / Abs S x 200

Statistical analysis: Data were analyzed for mean and standard deviation. Differences in parameters were tested for statistical significance at $p<0.05$ using the student's t-test.

Result

In our study, there were 82 cases of severe acute malnutrition while 25 were controls. Mean age of cases was 1.4 years. Male to female ratio was 2.03. 51.20% cases were without any complication while 48.80% cases were with complication such as diarrhea and acute respiratory infection etc. Only 17.07% cases were exclusively breast feed as compared with 40% controls. There was history of delayed complimentary feeding (>6months) in 26.82% cases as compared to 24% in controls. [Table 1]

Mean weight of cases and control was 6.48±1.26kg and 10.10±2.34 kg respectively. Mean height/length of cases and control was 72.04±2.86 cm and 74.64±3.75 cm respectively. Mean upper arm circumference of cases was 9.98±1.58 cm while of

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12.91±1.87cm was of controls. Mean head circumference of cases was 30.23±2.14 cm while 33.86±2.82 cm was of controls. All anthropometric measures were statistically significant (p value <0.05) as compared to controls. [Table 2]

Mean serum zinc level in SAM cases was 46.45± 4.36 µg/dl as compared to 111.36± 7.39 µg/dl in controls which was statistically significant (p value < 0.05) . Mean serum copper level in SAM cases was 49.44± 3.29 µg/dl as compared to 114.69± 8.37 µg/dl in controls which was statistically significant (p value < 0.05) . (Table 3)

Mean serum zinc and copper levels in SAM with diarrhea were significantly lower than control group (p value <0.05). (Table4)

TABLE 1 – Demographic and Clinical profile of study subjects

S.No.	Parameters	Number of Cases (Percentage)	Number of Controls (Percentage)
1.	Age		
	6 -12 months	43 (52.4%)	6 (24%)
	12-24 months	25 (30.48%)	13 (52%)
	> 24 months	14 (17.07%)	6 (24%)
2.	Sex		
	Male	55 (76.07%)	15 (60%)
	Female	27 (32.92%)	10 (40%)
3.	Exclusive Breast Feeding	14 (17.07%)	10 (40%)
4.	Delayed complimentary foods	22 (26.82%)	6 (24%)
5.	SAM without complications	42 (51.21%)	-
6.	SAM with complications		-
	Diarrhea		
	Illness other than diarrhea	20 (24.39%)	
		20 (24.39%)	
	Total	82	25

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TABLE 2 – Anthropometric measures of cases and controls

Parameters	Cases	Controls	t value	P value
Weight (kg)	6.48±1.26	10.10±2.34	10.06	<0.0001
Height/Length (cm)	72.04±2.86		3.68	0.0004
MUAC (cm)	9.98±1.58	12.91±1.87	7.76	<0.0001
Head circumference (cm)	30.23±2.14	33.86±2.82	6.86	<0.0001

TABLE 3 – Serum zinc and copper levels in SAM children vs control group

	Cases (n = 82)	Controls (n = 25)	t value	P value
Serum zinc level (mean ± SD)	46.45± 4.36	111.36± 7.39	54.684	< 0.0001
Serum copper level (mean ± SD)	49.44± 3.29	114.69± 8.37	57.863	<0.0001

TABLE 4 – Serum zinc and copper levels in SAM children with Diarrhea vs control group

	Cases (n = 20)	Controls (n = 25)	t value	P value
Serum zinc level (mean ± SD)	44.9± 2.98	111.36± 7.39	37.76	< 0.001
Serum copper level (mean ± SD)	48.62± 4.98	114.69± 8.37	31.12	<0.001

Discussion

In the present study, majority of our subjects were within the age 6- 12 months, which may be due to lack of exclusive breast feeding, delayed and inadequate complimentary feeding, illiteracy and low socio economic status of family.

In the present study, there were significantly lower mean serum zinc concentrations in malnourished children than the healthy controls. This is in accord with previous studies (8,9). This may be due to inadequate dietary intake of animal foods, whole grains, legumes and cheese, which are good source of zinc. There is higher frequency and duration of diarrheal episodes in these SAM children as reported by Bahl et al (10) which further reduces the serum zinc levels due to zinc loss and malabsorbtion. In our study there is statistically significant (p value < 0.05) low level of serum zinc level in SAM with Diarrhea children as compared to control group which is similar to previous studies (9.11). Zinc is essential component of enzymes involved in RNA and DNA synthesis.

In present study there was significantly lower copper concentration in SAM children without diarrhea and SAM children with Diarrhea than healthy controls which is similar to previous studies (8,9). This may be due to faulty feeding and grossly inadequate dietary intake and excessive loss of copper due to gut malabsorbtion. Copper has an essential role in several enzymatic reactions in RBCs, and copper deficiency interferes with iron transport and utilization and, therefore, with heme synthesis. In addition to interference with heme synthesis, there is approximately 85% reduction of superoxide dismutase activities in the RBC membrane in copper deficiency, which decreases RBC survival time. On the other hand, copper may be needed for the formation of bone marrow necessary for the formation of red cells. Hence too low a copper status will result in iron deficient anaemia.

Zinc and copper are important components of many enzymes and metalloproteinase, which are involved, in many metabolic processes in the body (12).

The mechanism by which lower levels of copper and zinc occurred concurrently is not known, since the two elements exhibit antagonistic relationships (13). Excess zinc levels induce the synthesis of the intracellular ligand metallothionine (MTO) in enterocytes, which then binds zinc. The excess zinc bound to MTO then is excreted in the faeces through enterocyte shedding. However, copper, with its higher affinity for MTO, displaces zinc and also is excreted, reducing the amount of copper delivered to the enterocyte (14). It has been established that copper and zinc contents of diet in a given population depends on the soil contents of these elements (15). Malnutrition and infectious diseases like diarrhea may likely interact, thus resulting in compromised nutritional status (16).

Conclusion

As evident from our study that there is severe deficiency of serum zinc and copper in severe acute malnutrition children as compared to healthy controls. This deficiency further aggravated in diarrhea associated with severe acute malnutrition. Due to severe deficiency of serum zinc and copper these children are at risk of various infections and growth retardation. To break this vicious cycle of infection and malnutrition we should supplement zinc and copper in severe acute malnutrition. Exclusive breast feeding for 6 month , adequate complimentary feeding from 6 month, complete immunization, food fortification with micronutrient should be practiced to reduce the prevalence of severe acute malnutrition and it's complications in India.

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