Serum Levels of Trace Elements (Zinc and Coppper) in Malnourished Children in Bangladesh

Pages with reference to book, From 251 To 255

S.A.M. Khairul Bashar, Lamia Sharmeen (Department of Biochemistry, Dhaka University, Dhaka, Bangladesh.)

Abstract

Zinc (Zn), Copper (Cu) were measured in children suffering from Marasmic-Kwashiorkor with various infections. On admission to hospital Zn level was low in all patients (39.6 = 15.9 ug - 88.7 = 16.8 ug %). On nutritional rehabilitation without any Zn supplementation, Zn level showed improvement but in one group, who had initially very low level, subjects were still Zn deficient. Cu level was found low in 50% cases studied, and most of them had vit-B2 deficiency also. Cu level did not show significant rise on nutritional therapy without Cu supplementation (JPMA 33:251, 1983).

Introduction

The role of trace elements in human health and nutrition has attracted interest in recent times. Among different trace elements some are being widely investigated and their role in various aspects of growth and metabolism has been established.

Zinc (Zn) is needed for tissue synthesis, it plays its role, both as a component of the new tissue and in the form of the Zinc metalloenzymes essential for nucleic acid and protein synthesis. Various studies on animals indicate that Zn is stored in negligible amount in the body so that there is a day to day requirement for dietary Zinc (William et al., 1972; Hurley and Swenerton, 1971). Children recovering from “Protein-energy” “malnutrition” gain weight more than normal, during recovery period (Golden and Golden, 1981). In that condition, more Zn is required for growth of new tissue. When this is the case, dietary Zinc may both limit the absolute rate of weight gain and determine the composition of new tissue laid down. Data from Jamaica (Brooke and Wheeler, 1976) and Peru (Maclean and Graham, 1980) show that children recovering from malnutrition tend to synthesize excessive amounts of adipose tissue, which has a low zinc content, at the expense of lean tissue which is rich in zinc. In another report (Vitter and Glazer, 1954), Zinc deficiency was reported in pre-School children in Egypt. There are also other reports which suggest that zinc has a very important role in vit-A transport and metabolism (Smith and Mc Daniel, 1973).

Although the role of Copper (Cu) in protein-energy malnutrition has been less discussed, its importance in various metabolic functions cannot be ignored. Cu is required for the optimal activity of many enzymes, the best known of which are cytochrome oxidase, lysyl oxidase, ferroxidase and tyrosinase. An inadequate supply of Cu will eventually lead to anemia, neutropenia, skeletal and connective tissue changes and developmental delay in growing children.

The studies reported here were undertaken to investigate the Zn and Cu levels in malnourished children in Bangladesh. This will further illustrate whether additional Zinc or copper supplementation is necessary for normal and satisfactory recovery of the children.

Patients and Methods

Fourteen malnourished Bangladeshi children, aged between 15 months to 48 months, were studied. In these children Zn level was measured on admission and release from hospital. In another 11 malnourished children, aged between 16 months to 48 months, copper levels were measured on admission and release from hospital. Nutritional status of these children was determined by the Mclaren's points method (Donald et al., 1976). These children were admitted to a local hospital of "SAVE THE CHILDREN'S FUND, NUTRITION UNIT" for treatment.

On admission to the hospital, a standarized clinical examination was carried out. They were checked for conjunctival on cc teal signs of vit-A deficiency and associated infections like anaemia, upper respiratory tract infection (URTI), lower respifatory tract infection (LRTI) and tuberculosis. The degree of edema was assessed both clinically and by decrease in body weight with loss of edema. Vit-B2 deficiency in these children was determined from clinical symptoms of angular stomatitis.

After obtaining initial sera for the studies outlined below, the children were placed on a high protein diet (948 cal/6 kg body weight/day). Antibiotics and vitamin-A supplement were given according to the requirement and when clinically indicated. When their conditions improved in the next 10-15 days, second sample of sera were drawn from them. Children classified "as improved" were those children whose albumin levels showed tendency of increasing but had not yet returned to normal. The sera were collected in tubes, washed with deionized water, and kept frozen until analysis.

A Estimation of serum levels of Zn:

Zn level in serum was determined by absorption spectroscopy (Dawson and Walker, 1969; Prasad et al., 1965).

B. Determination of copper level in serum:

Cu level in serum was measured by absorption spectroscopy (Parker et al., 1967; Underwood, 1977).

Results and Discussion

Most of the patients under our study had total protein 4.1 - 6.1 g/100 ml, weight/height 70-80% of the normal (of local standard) with oedema on admission. Using Mclaren's classification of the severe form, patients under our study were found to have a nutritional status of Marasmic-Kwashiorkor

Table – 1

Zinc (Zn) Level in Malnourished Children on Admission and Release from Hospital.

Nutritional status	Age (in months)	Sex	Associated infections	Zinc level on admission (ug%)	Zinc level on release (ug%)
Marasmic-Kwashiorkor (M.K.)	48	Male	1. Anemia 2. Xerosis 3. Amebiasis 4. Tuberculosis	84.8	137.0
M.K.	48	Female	1. Upper respiratory tract infection (URTI) 2. Ascariasis 3. Trichuriasis	78.2	131.0
M.K.	48	Female	1. Trichuriasis 2. Ascariasis 3. Rectal prolapse	84.0	114.2
M.K.	20	Female	1. URTI 2. Xerosis 3. Anemia	19.0	74.0
M.K.	24	Female	1. Bronchopneumonia 2. Keratomalacia 3. Amebiasis	32.6	75.0
M.K.	16	Male	1. Vit–A deficiency 2. URTI 3. Amebiasis	85.7	98.4
M.K.	20	Male	1. URTI 2. LRTI 3. Shigalosis 4. Vit–A deficiency	32.6	75.0
M.K.	48	Female	1. Keratomalacia 2. LRTI 3. Vit–B_2 deficiency 4. Anemia	35.9	54.7
M.K.	24	Male	1. Amebiasis 2. URTI	71.8	91.4
M.K.	16	Male	1. URTI 2. Xerosis 3. Amebiasis	65.3	82.4
M.K.	20	Male	1. Shigalosis 2. Vit–A, B_2 deficiency	52.2	92.0
M.K.	18	Female	1. URTI 2. Vit–B_2 deficiency 3. Amebiasis	36.5	65.0
M.K.	15	Male	1. LRTI 2. Vit–B_2 deficiency 3. Skin Sores.	120.0	124.0
M.K.	16	Female	1. URTI 2. Amebiasis	92.7	110.0
M.K.	24	Female	1. Xerosis 2. Anemia 3. Rectal Prolapse	26.0	35.0

* The results were statistically significant at P .001

Table I shows that children suffering from severe and moderately severe vit-A deficiency (determined from the clinical symptoms of keratomalacia and Xerosis) had much low levels zinc compared to others. Children having no vit-A deficiency symptoms, but suffering from protein-energy malnutrition also had low levels of Zn. One report on Jamaican children (Dawson and Walker, 1969) shows that children suffering from Marasmic-Kwashiorkor have Zn level of 69.2 ug% in serum. Our results show that some of our children have extremely low levels of Zn (19 ug% - 36.5 ug%) which is one third to half of that found for Jamaican children. Mother report on Egyptian children suffering from protein energy malnutrition (Vitter and Glazer, 1954) showed that those children had Zn level of 42 ug% - 63 ug% on average against the standard literature value of 102 ± 13 ug%. Some of our children with only mild vit-A deficiency had Zn level of 84.8 ug% - 92.7 ug%.

On nutritional rehabilitation with protein rich diet (948 cal/6 kg/day) without any additional Zn supplementation in next ten to fifteen days, Zn level was improved. This Zn was coming from diet and some of unused Zn might have come to blood bound with proteins like retinol binding protein (REP) and prealbumin (PA).

Those patients who did not have very low levels of Zn initially (85 ug%-92.7 ug%) show better improvement. Almost in all cases, Zn had returned to normal or near to normal standard values. But those patients who had extremely low levels of Zn initially (19-32 ug%) were still Zn deficient. And most of these patients had severe or moderately severe vit-A deficiency.

As some reports suggest (Wilkins et al., 1972) that Zn supplementation improves vit-A transport and metabolism, supplementation with Zinc in the diet may be considered in these children.

Table – II Copper (Cu) Level in Malnourished Children on Admission and Release from Hospital.

Nutritional status	Age (in months)	Sex	Associated infections	Copper level on admission (ug%)	Copper level on release (ug%)
Marasmic-Kwashiorkor (M.K.)	48	Female	1. Vit–B_2 & Vit–A deficiency 2. LRTI 3. Anemia	52	55
M.K.	16	Male	1. Vit–B_2 & Vit–A deficiency 2. URTI 3. Amebiasis	58	62
M.K.	24	Female	1. URTI 2. Amebiasis 3. Vit–B_2 deficiency	54	58
M.K.	24	Female	1. Xerosis 2. URTI 3. Amebiasis	87	80
M.K.	24	Male	1. Xerosis 2. URTI 3. Amebiasis	54	65
M.K.	36	Female	1. Ascariasis 2. Staphylloma	95	105
M.K.	24	Female	1. Amebiasis 2. URTI 3. LRTI	100	102
M.K.	16	Male	1. Amebiasis 2. URTI	117	127
M.K.	18	Male	1. Ascariasis 2. Measles 3. URTI	112	120
M.K.	16	Male	1. LRTI 2. Skin sores	130	135
M.K.	40	Male	1. URTI 2. LRTI 3. Xerosis 4. Anemia	90.2	95.5

* The results were statistically significant at P .001

In case of Cu (Table II) the picture was different from that found in case of Zn. About 50% patients studied had normal Cu levels, (110 ± 16 ug%), and these patients had various infections like URTI, LRTI, Ascariasis, Amebiasis, Xerosis, Anemia. Rest 50% had low levels of Cu (52 ug% 87 ug%). On nutritional rehabilitation with same diet and without any Cu supplementations, Cu level improved in all patients but the change was not very significant as found in case of Zn. Only 5 to 10 ug% Cu level increased on average in each patient. The patients who were Cu deficient initially had same type of infections like others but most of these patients had vit-B2 deficiency. Mter nutritional rehabffitation, the condition remained same with only slight improvement.

There are some suggestions that Cu and Zn play antagonist role; whether this is working here will be very interesting.

References

1. Brooke, O.G. and Wheeler,E.F. (1976) High energy feeding in protein-energy malnutrition. Arch. Dis. Child., 5 1:968.

2. Dawson, J.B. and Walker, B.E. (1969) Direct determination of zinc in whole blood, plasma and urine

by atomic absorption spectroscopy. Clin. Chem. Acta, 26:465.
3. Golden, B.E. and Golden, M.H.N. (1981) Plasma zinc, rate of weight gain, and the energy cost of tissue deposition in children recovering from severe malnutrition on a cow's milk or soya protein based diet. Am. J. Clin. Nutr., 34:892.
4. Hambridge, K.M. (1977) Trace elements in paediatric nutrition. Advances Pediat., 24:191.
5. Hurley, L.S. and Swenerton, H. (1971) Lack of mobilisation of bone and liver zinc under tetratogenic conditions of zinc deficiency. J. Nuti., 101:597.
6. MacLean, W.C. Jr. and Graham, G.G. (1980) The effect of energy intake on nitrogen content of weight gained by recovering malnourished infants. Am.J.Clin.Nutr., 33:903.
7. Parker, M.M., Mumoller, F.L. and Mahler, D.J. (1967) Determination of Copper and Zinc in biological material. Clin. Chem., 13:40.
8. Prasad, A.S., Oberleas, D. and Halsted, J.A. (1965) Determination of zinc in biological fluids by atomic spectro photometry in normal and cirrhotic subjects. J.Lab. Clin. Med., 66 :508.
9. Sandstead, H.H., Shukry, A.S.,Prasad A.S. et al. (1965) Kwashiorkor in egypt. Clinical and Biochemical studies, with special reference to plasma zinc and serum lectic dehydrogenase. Am.J. Clin. Nutr., 17:15.
10. Smith, J.C. Jr. and McDaniel, E.G. (1973) Zinc; a trace element essential in vitamin-A metabolism. Science, 181:954.
11. Smith, C.J. and Brown, E.D. (1980) Short term supplementation with oral Zn increased with circulating Vit-A and RBP levels in children with protein-energy malnutrition. Nutr. Rev., 38:278.
12. Underwood, EJ. Trace elements in human and animal nutrition. 4th ed. New York; Academic Press, 1977.
13. Vitter, D. and Glaze (1954) A survey of Pellagra and nutritional anemia in Egypt. WHO, Bull. WHO.
14. Wilkins, P.J., Grey, P.C. and Dreosti, I.E. (1972) Plasma zinc as an indicator of zinc status in mts. Br.J.Nutr., 27:113.