ZINC SUPPLEMENTATION IN PROTEIN ENERGY MALNUTRITION

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ABSTRACT

A pair-matched controlled study was done with 30 children (15 males, 15 females) of mild to moderate PEM in test and equal number in control groups, aged 8-24 months old. At the beginning, in both test and control groups parents were advised to provide sufficient amount of home cooked foods so that the child received on an average 100-150 Kcal/kg/day of energy and 2-3 g/kg/day of protein. Vitamin supplements were provided to all children in both groups. In addition, the test group received a supplementation of 5.625 mg of elemental zinc daily orally while controls received a placebo.

Evaluation at the end of 3 months showed that children in test group had a weight gain of 3.742 ± 0.488 kg against 2.035 ± 0.383 kg of the control group. Similarly, weight velocity was 5.752 ± 0.818 g/kg/day in test group against 3.153 ± 0.617 g/kg/day of the control group. These differences in weight gain and weight velocity were highly significant ($p<0.001$). Serum zinc levels, initially and at the end of study were 87.5 ± 9.6 μg/dl and 121.0 ± 10.1 μg/dl, respectively in test group in comparison to 91.2 ± 9.8 μg/dl and 91.0 ± 10.1 μg/dl in controls. This difference was also highly significant ($p<0.001$). The daily total calorie intake remained comparable in both groups.

Our observations suggest that zinc supplementation during nutritional rehabilitation of mild to moderate PEM hastens the recovery.

Key words: *Zinc deficiency, Weight gain, Protein energy malnutrition.*

Failure to thrive due to mild to moderate degree of protein energy malnutrition (PEM) afflicts as many as 33% of preschool children(1). Amongst these patients, the largest group are the children in the age group of 8 to 24 months in whom, PEM can be attributed to faulty weaning techniques. In addition to protein and energy deficit, other nutrients particularly minerals may also contribute to growth failure. Serum level of zinc has been shown to be low in PEM(2). Zinc is important for growth in children and a syndrome of growth failure, hypogonadism and loss of taste has been described in zinc deficiency(3). Sharda *et al.*(2) recommended the supplementation of zinc in diet of cases with PEM.

Rich food sources of zinc are whole grain, dry beans, nuts and meat(4). Due to ignorance and financial, social, cultural and religious constraints these children are put on cereal rich vegetarian diets containing large amounts of fibres and phytates which hamper zinc absorption(5). During recovery from PEM, it is possible, that the catch-up growth of these children may be limited by a mild zinc deficiency state.

The objective of this study was to observe the effect of zinc supplementation on weight gain in cases with mild to moderate PEM.

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Material and Methods

The study was a blind, pair-matched, placebo controlled one, carried out by the Upgraded Department of Pediatrics, Patna Medical College. Sixty cases, between 8 and 24 months of age, were selected from the patients attending the Pediatrics Outpatient Department. The parents were explained about the nature of the study. Children with failure to thrive with weight between 61-80% of the reference weight for age (50th percentile of Harvard standard; IAP Grade I and II) were included. Any other concurrent cause of growth failure was excluded by history, examinations and where needed, laboratory investigations. The patients were pair-matched into two groups of 30 cases each (who received zinc supplementation and nutritional counselling) and controls (who received only nutritional counselling and placebo). For pair-matching the children were matched for sex, age within 4 months and weight for age.

The duration of the study was of 3 months. In their initial visit, both the groups received nutritional counselling with recommendation for adequate calorie and protein intake. All the parents were provided with printed diet charts with model diets in Hindi. Weight of the patient was taken and 5 ml blood was drawn, serum separated and analysed for zinc level by atomic absorption spectrophotometry(6). The children in test and control groups were advised to take 5 ml of zinc supplement syrup or placebo once daily after the meals. The zinc supplement syrup and placebo were prepared by incorporating 10 tablets each of Zeebex T and Surbex T (Abbott), respectively, in 200 ml syrup. Each Zeebex T and Surbex T tablet contains identical amount of vitamins. The former preparation also contains 68.5 mg of zinc sulphate monohydrate equivalent to 22.5 mg of elemental zinc. Adequate amounts of syrup were dispensed with a 5 ml measure by the investigators. Parents were asked to report if the child developed diarrhea, vomiting or pain abdomen.

In the final visit their weight was taken, the volume of syrup consumed was noted and dietary history was taken by 24 hour recall method. Twenty four-hour recall data was used because it has no consistent bias towards over reporting or under reporting(7). A 5 ml blood sample was drawn again for analysis of serum zinc level. The results were analysed using the tests of significance.

Results

Thirty children (15 males and 15 females) were included into Group A (supplemented), and equal number (15 males and 15 females) in Group B (control). Of the supplemented group, 13 females and 13 males completed the study and of the control group, 12 females and 14 males completed the study.

The total weight gain and rate of weight gain were faster in the zinc supplemented group in comparison to controls and difference was highly significant ($p<0.001$). Both the males and females of the supplemented group registered higher weight increment as compared to the males and females of the control group. Although initial serum zinc level was low in both groups, but after zinc supplementation its level returned to almost normal, whereas in controls the value further lowered. The zinc level in normal reference population as measured in the same laboratory was 130 ± 19.1 µg/dl. There was no significant difference ($p>0.05$) in daily calorie consumption between Group A (1048.8 ± 73.7 Kcal) and

TABLE I—*Mean (SD) Weight Gain and Serum Zinc Levels in Group A (Supplemented) and Group B (Placebo)*

Parameter	Group A (n = 26)		Group B (n = 26)	
Weight gain (kg)	3.742	(0.488)*	2.035	(0.383)
Rate of weight gain** (g/kg/day)	5.752	(0.818)*	3.153	(0.617)
Serum zinc level (μg/dl)				
Before zinc supplementation	87.5	(9.6)	91.2	(9.8)
After zinc supplementation	121.0	(10.1)*	91.0	(10.1)

* $p < 0.001$

** Rate of weight gain $= \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight} \times 90}$

Group B (1032.3±81.4 Kcal). However, when this was calculated on Kcal/kg/day basis the values were 95.5 ± 6.0 in the former and 111.4 ± 6.8 in the latter and this difference was significant ($p<0.005$). None of the parents reported any untoward effects after ingestion of zinc diet.

Discussion

As zinc deficiency has negative effect on weight gain in growing children, the common association of zinc deficiency in PEM may affect the optimum weight gain during recovery from PEM. Specially in children whose diet contains large amount of fibres and phytates thus reduces the bioavailability of zinc. Previous workers have showed that supplementation with zinc hastens the recovery of weight in malnourished children(8-12). The results of this study are highly significant. The group supplemented with 5.625 mg of elemental zinc per day showed an increased mean weight gain of 3.742 ± 0.488 kg as compared to the weight gain of 2.035 ± 0.383 kg in the control group. When the mean weight velocity was calculated, it was 5.752 ± 0.818 g/kg/day in the supplemented group as against a low 3.153 ± 0.617 g/kg/day in the control group. Serum zinc level in the supplemented group also improved considerably ($p<0.001$) from pre-supplemented level. The serum zinc level in the control group continued to be low.

There are reports that zinc improves appetite(13). We, therefore, endeavoured to know whether the increased rates of weight gain were merely due to increased food intake as a result of improved appetite. However, it was found that there was no significant difference in daily calorie intake between the two groups. Zinc supplementation did not influence the daily calorie intake. When final weights of the children were taken into account and calorie intakes were expressed in terms of Kcal/kg/day it was lower in supplemented group as compared to control group. This is probably due to improved lean tissue synthesis with zinc supplementation. Lean tissue is rich in zinc but poor in stored energy, while adipose tissue is poor in zinc

but rich in stored energy. Thus, energy costs of tissue deposition decreased with zinc supplementation. These results are in uniformity to that of an important Jamaican study(12). Zinc plays an important role in protein synthesis, bone growth and cell turnover. Recently, Payne-Robinson *et al.*(14) suggested that zinc is significantly associated with insulin like growth factor. Zinc may augment the production of the growth factor through linkage with peptide hormone cell surface receptors, thereby emphasizing its role in growth.

REFERENCES

1. Grant JP. The State of World's Children. UNICEF. Oxford University, New York Press, 1989, p 96.
2. Sharda B, Bhandari B. Serum zinc in protein calorie malnutrition. Indian Pediatr 1977, 14: 195-196.
3. Prasad AS, Halsted JA, Nadimi M. Syndrome of iron deficiency anemia, hepatosplenomegaly, hypogonadism, dwarfism and geophagia. Am J Med 1961, 31: 532.
4. Dwyer JT, Roy J. Diet therapy. *In:* Harrison's Principle of Internal Medicine, 12th edn. Wilson JD, Braunwald E, Isselbacher KJ, *et al.* New York, McGrawHill, 1991, pp 425.
5. Dwyer JT, Dietz WH, Andrews EM, Suskind RM. Nutritional status of vegetarian children. Am J Clin Nutr 1982, 35: 204-206.
6. Stevens MD, Mackenzie WF, Anand VD. A simplified method for determination of zinc in whole blood, plasma, and erythrocytes by atomic absorption spectrophotometry. Biochem Med 1977, 18: 158-163.
7. Madden JP, Goodman SJ, Cuthrie HA. Validity of the 24-hour recall. J Am Diet Assoc 1976, 68: 143-147.
8. Walravens PA, Hambidge KM, Koepfer DM. Zinc supplementation in infants with a nutritional pattern of failure to thrive. A double blind controlled study. Pediatrics 1989, 83: 532-538.
9. Ronaghy HA, Reinhold JG, Mahloudji M, Ghavami P, Spivey-Fox MR, Halsted JA. Zinc supplementation of malnourished school boys in Iran: Increased growth and other effects. Am J Clin Nutr 1974, 27: 112-121.
10. Friel JK, Gibson PS, Kawash GF, Watts J. Dietary zinc intake and growth during infancy. J Pediatr Gastrointerol Nutr 1985, 5: 746-751.
11. Walravens PA, Hambidge KM. Growth of infants fed a zinc supplemented formula. Am J Clin Nutr 1976, 29: 1114-1121.
12. Golden MHN, Golden BE. Effects of zinc supplementation on the dietary intake. Rate of weight gain and energy cost of tissue deposition in children recovering from severe malnutrition. Am J Clin Nutr 1981, 34: 900-908.
13. Krebs NF, Hambidge KM, Walravens PA. Increased food intake of young children receiving zinc supplement. Am J Dis Child 1984, 138: 270-273.
14. Payne-Robinson HM, Golden MHN, Golden BE, Simeon DT. The zinc sandwich and growth. Lancet 1991, 337: 925-926.