REVIEW ARTICLE

Zinc Supplementation During the Growing Years

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ABSTRACT

Zinc is an essential mineral perceived by the people today as being of "exceptional biological and public health importance", mainly regarding prenatal and postnatal development. Zinc deficiency affects about 2 billion people in the developing world and is associated with many diseases. In growing children, it causes growth retardation, delayed sexual maturation, infection susceptibility and mainly diarrhea. Consumption of excessive zinc can cause ataxia, lethargy and copper deficiency.

Keywords: Zinc, zinc metabolism, gastroenteritis, zinc deficiency

ZINC AS AN ESSENTIAL ELEMENT

Zinc is an essential trace element for humans. Zinc is found in nearly 100 specific enzymes. It is "typically the second most abundant transition metal in organisms" after iron and it is the only metal which appears in all enzyme classes. In proteins, zinc ions are often coordinated to the amino acid side chains of aspartic acid, glutamic acid, cysteine and histidine.

There is 2-4 g of zinc distributed throughout the human body. Most zinc is in the brain, muscle, bones, kidney, and liver, with the highest concentrations in the prostate and parts of the eye. Semen is particularly rich in zinc, which is a key factor in prostate gland function and reproductive organ growth.

IMPORTANCE OF ZINC FOR GROWING CHILDREN

Zinc is an essential component of the diet and is required for the synthesis of enzymes involved in nucleic acid and protein metabolism, including DNA polymerase, RNA polymerase, alcohol dehydrogenase, carbonic anhydrase and alkaline phosphatase. It is well known that zinc deficiency may result in diseases such as skin dermatitis and lead to taste disorders. However, the association of zinc deficiency with the pathogenesis of liver disease is less well understood.

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Importance of zinc in growing children is as follows:

- Vital for growth and cell division
- Vital for fertility
- Vital for the immune system
- Vital for taste, smell and appetite
- Vital for skin, hair and nails
- Vital for vision.

WHO NEEDS ZINC?

The essentiality of zinc in humans was established in 1963. During the past 59 years, tremendous advances in both clinical and basic sciences of zinc metabolism in humans have been observed.

Children and even adults need zinc in sufficient quantities. Children need zinc to grow, adults need zinc for maintenance of optimum health. Growing infants, children and adolescents, pregnant women and lactating mothers, athletes, vegetarians and the elderly often require more zinc. Barnes and Moynahan (1973) reported a 2-year-old girl with severe acrodermatitis enteropathica who was being treated with diiodohydroxyquinoline and a lactase-deficient synthetic diet but was not showing any satisfactory response to this therapy. The serum zinc concentration was significantly decreased. They, therefore administered oral zinc sulfate to correct this deficiency. Surprisingly, the skin lesions and gastrointestinal symptoms cleared after zinc supplementation. A severe deficiency of zinc has also been observed in patients with Wilson's disease who received penicillamine

therapy as decoppering agent. This treatment may induce excessive zinc loss and cause severe deficiency of zinc. Implications of zinc deficiency in children to be discussed.

ZINC AND GROWTH

Growth is the first limiting effect of zinc deficiency in experimental animals. Zinc deficiency decreases circulating insulin-like growth factor 1 (IGF-1) concentration independent of total energy intake.

In humans, zinc deficiency decreases circulating IGF-1 concentration. IGF-1 receptor possesses tyrosine kinase activity. On activation of the receptor by IGF, a cascade of phosphorylation occurs within the cell leading to regulation of cell cycle and cell division. Tyrosine phosphorylation of the receptor is essential for its activation, and hypothesize that because zinc has been shown to inhibit various protein tyrosine phosphatases, phosphorylation of the tyrosine kinase receptor by zinc is perhaps the most important critical step of zinc action on human growth. Thus, it appears that zinc has multiple roles in growth. It is required for IGF-1 generation and phosphorylation of IGF-1 receptor, which are involved in cell division and growth.

ZINC AND GASTROENTERITIS

Gastroenteritis, presenting mostly as diarrhea, is associated with severe zinc deficiency and is frequently seen in developing countries. A pooled analysis of all published and unpublished randomized controlled trials of zinc supplementation in children up to 5 years old with acute or persistent diarrhea found that zinc-supplemented children had a 15% lower probability of continuing diarrhea on a given day.

A Canadian group working in Karachi, Pakistan, reported that mean standard deviation (SD) longitudinal prevalence of diarrhea among 75 young children aged 6-12 months at high-risk of diarrhea-related mortality who received micronutrients with zinc for 2 months was 15% (10%) child-days compared with 26% (20%) child-days in the placebo group. Among almost 300 children from India with diarrhea resulting in dehydration and hospitalization, stool output was reduced in more than 30% (95% CI 1-52%) of children receiving zinc treatment compared with children receiving placebo. Duration of illness and proportion of episodes lasting more than 7 days were also substantially reduced.

The mechanism of action of zinc in the management of diarrhea is not completely understood. It is likely to be involved in improving the absorption of fluids from the intestine, helping with clearance of organisms, and supporting regeneration and mucosal integrity, and is likely to have an immunity-related mechanism. Other roles of zinc can also be discussed, for instance in immunity.

SIDE EFFECTS OF ZINC SUPPLEMENTATION

Till date there have been no reports of severe adverse reactions from any form of zinc supplementation used in the treatment of diarrhea. A zinc dose of 40 mg has been approved as being safe to use by the US Food and Drug Administration (FDA), and a zinc dosage of more than this can pose certain risks.

Too much zinc will probably interfere with the metabolism and absorption of other essential minerals in the body, especially iron, magnesium and copper reduce the body's immune function, and reduce the high-density lipoprotein level. Oral zinc sulfate supplements can also cause side effects such as stomach upset, heartburn and nausea.

CONCLUSION

Zinc is essential element for growth and cell division, fertility, for the immune system, for taste, smell and appetite, for skin, hair and nails, for vision, especially in growing children. Diarrhea is associated with severe zinc deficiency and is frequently seen in developing countries such as India, Bangladesh, Pakistan, etc. The government should start specific programs to educate people about the importance of zinc in growing years of children.

SUGGESTED READING

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