Zinc Deficiency in the Elderly

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Introduction

Zinc is one of the essential micronutrients, and plays an important role in human nutrition and health. In 1961, Prasad first recognized zinc deficiency as the cause of dwarfism and hypogonadism among iron-deficient adolescent Iranian village boys.[1,2]

Zinc deficiency occurs in individuals and populations with diets low in sources of readily bioavailable zinc, such as red meat, and high in unrefined cereals that are rich in phytate. The elderly population is potentially vulnerable to zinc deficiency because of decreased intake of food energy, protein, vitamins and minerals, and increased intake of carbohydrates.[3,4]

In this review, we discuss the importance of zinc to humans, as well as the causes, clinical features and management of zinc deficiency in the elderly population.

Importance of Zinc

Zinc is an essential mineral, present in most systems of the human body, and plays a role in stabilization of cell membranes, tissue regeneration and protein synthesis. It also serves as a structural component of at least 70 metalloenzymes. Examples of zinc metalloenzymes are carbonic anhydrase, alkaline phosphatase, alcohol dehydrogenase and zinc-copper superoxide dismutase.

In addition, zinc is needed for growth, normal development, DNA synthesis, RNA conformation, immunity, neurosensory function and other important cellular processes.[5,6,7]

Table 1
Causes of Zinc Deficiency

Inadequate dietary intake
Decreased absorption
a. Age
b. Phytates
c. Fibre
Increased excretion
a. Medication
b. Diabetes

Prevalence and causes of Zinc Deficiency in Elderly

Older people appear to be at higher risk for zinc deficiency because of poor intake of dietary sources rich in zinc. This can result from poor appetite, brought on by various medications and changes to taste and smell sensitivities; difficulties in chewing because of poor-fitting dentures or oral health problems; interaction with medications and changes in physiology and metabolism associated with aging.[8,9] (Table 1).

The third National Health and Nutrition Examination Survey (NHANES III), conducted from 1988-1994 on a cross-sectional population sample representative of the U.S. population, showed that the proportion of adult males with "adequate" zinc intake declined from 77% in those aged 19-50 y, to 44% in those over the age of 71. For females, the proportion of the population with adequate zinc intake was lower, with only 45% of those aged 19–50 y having adequate zinc intake with little change with age. Adequate zinc intake was defined as a total zinc intake at or above 77% of the 1989 recommended daily allowance (RDA), which is 15mg / d for males and 12mg / d for nonpregnant and nonlactating females.[9] Similar results were also reported by others.[4,10,11]

Zinc deficiency may arise from low dietary intake, low bioavailability and / or interaction with other nutrients and losses of the mineral through disease processes. The zinc content of foods varies widely, as does its bioavailability. The richest sources of zinc are oysters, liver, beef, dark poultry meat, veal and crab (Table 2).

It is estimated that 50% of zinc in US diets is provided by meat, and that beef is the principle source. Dairy products provide another 20%, and cereals and legumes provide the remainder.[12,13]

The most important dietary inhibitor of zinc bioavailability is phytate. Studies showed that phytate forms an insoluble complex with zinc, preventing its absorption and leading to its excretion in the stool. Phytate is present in many plant-derived food products. Whole grain cereals and legumes are the major sources of phytate for humans.[10,13,14]

Clinical Features of Zinc Deficiency

Zinc deficiency is associated with significant physiologic and functional impairment. The clinical signs of marginal zinc deficiency are depressed immunity, impaired taste and smell, onset of night blindness, impairment of memory, and decreased spermatogenesis in males. Severe zinc deficiency is characterized by severely depressed immune function, frequent infections, bullous pustular dermatitis, diarrhea, alopecia and mental disturbance.[15] (Table 3).

A few of these effects will now be discussed.

Effects of Zinc on Immune Function

Tissue culture studies, and trials in both animals and humans, have demonstrated that zinc is essential for the integrity and function of the immune system.[10]

Zinc deficiency can lead to decreased lymphocyte concentrations, depressed T- and B-lymphocyte function and can affect other mediators of nonspecific immunity such as polymorphonuclear leukocyte function, natural killer cell function and complement activity.[15]

Several studies indicate that zinc deficiency is associated with a depressed

immune response.[3,15,16] It is possible that the well-documented, age-associated deterioration of T-cell immune function, which increases the susceptibility of the elderly to infectious disease may result, in part, from zinc deficiency. Supplementing elderly patients with zinc led to increased concentrations of circulating T-lymphocytes, and improved delayed hypersensitivity reactions to purified proteins. In addition, there was a significant improvement in IL-1 production, serum thymulin active peptide (believed to play an important role in the maturation of lymphocytes), and skin reactivity to common antigens after six months of zinc supplementation in zinc-deficient elderly subjects.[3]

Effect of Zinc on Wound Healing

Zinc is essential for tissue regeneration. In patients with poor zinc nutriture prior to hospitalization, less zinc may be available for redistribution to the tissue during the healing process, delaying wound healing. In addition, the catabolism associated with injury enhances the urinary excretion of zinc: the greater the injury and catabolism, the greater the zinc excretion.[17]

Studies are limited, but there are indications that zinc supplementation improves wound healing in the elderly. In one study,[27] patients with venous leg ulcers were divided into two groups: thirteen patients (average age of 64 years) received zinc supplementation daily, and fourteen patients (average age of 63 years) were given placebo. At baseline, 14 of the 27 patients had low serum zinc levels. The rate and frequency of healing were significantly greater in those supplemented with zinc when compared to those receiving placebo.[18]

Effect of Zinc on Taste Acuity

Decreased taste acuity related to zinc deficiency has been reported in subjects with liver disease, malabsorption syndrome, thermal burns or chronic uremia, as well as in patients receiving penicillamine or histadine.[7,19] Prasad *et al.*, found that supplementing zinc-deficient elderly patients with 30 mg of zinc daily for six months significantly improved taste acuity.[3]

Diagnoses of Zinc Deficiency

There is no universally accepted single measure suitable to assess zinc status. The method most frequently used is the measurement of plasma zinc level (range from 70–130 µg/ dL). However, a normal plasma zinc level

Table 2
Zinc Content of Common Household Portions of Selected Foods

Food	Portion	Zinc, mg
Fish	3 oz	0.58
Oysters	3 oz	77.51
Crab	3 oz	6.48
Poultry		
Dark meat	3 oz	2.20
Light meat	3 oz	0.87
Beef	3 oz	4.60
Pork	3 oz	4.40
Liver	3 oz	4.90
Whole egg	1 large	0.70
Dried beans and lentils	1/2 cup	0.95
Milk	1 cup	0.93
Cheese	1 oz	0.88
Bread		
White	1 slice	0.15
Wheat	1 slice	0.47
Rice		
White	1/2 cup	0.35
Brown	1/2 cup	0.60
Cornmeal (cooked)	1/2 cup	0.15
Oatmeal (cooked)	1/2 cup	0.58
Bran flakes (40%)	1 oz	1.16
Corn flakes	1 oz	0.03

* Source: United States Department of Agriculture; Agricultural Handbook, 1976-1988.

Table 3
Clinical Effects of Zinc Deficiency

1. Impaired taste and smell
2. Impaired immune function
3. Poor appetite
4. Delayed wound healing
5. Skin lesions
6. Altered mental status
7. Night blindness
8. Frequent infections
9. Oligospermia in men
10. Diarrhea

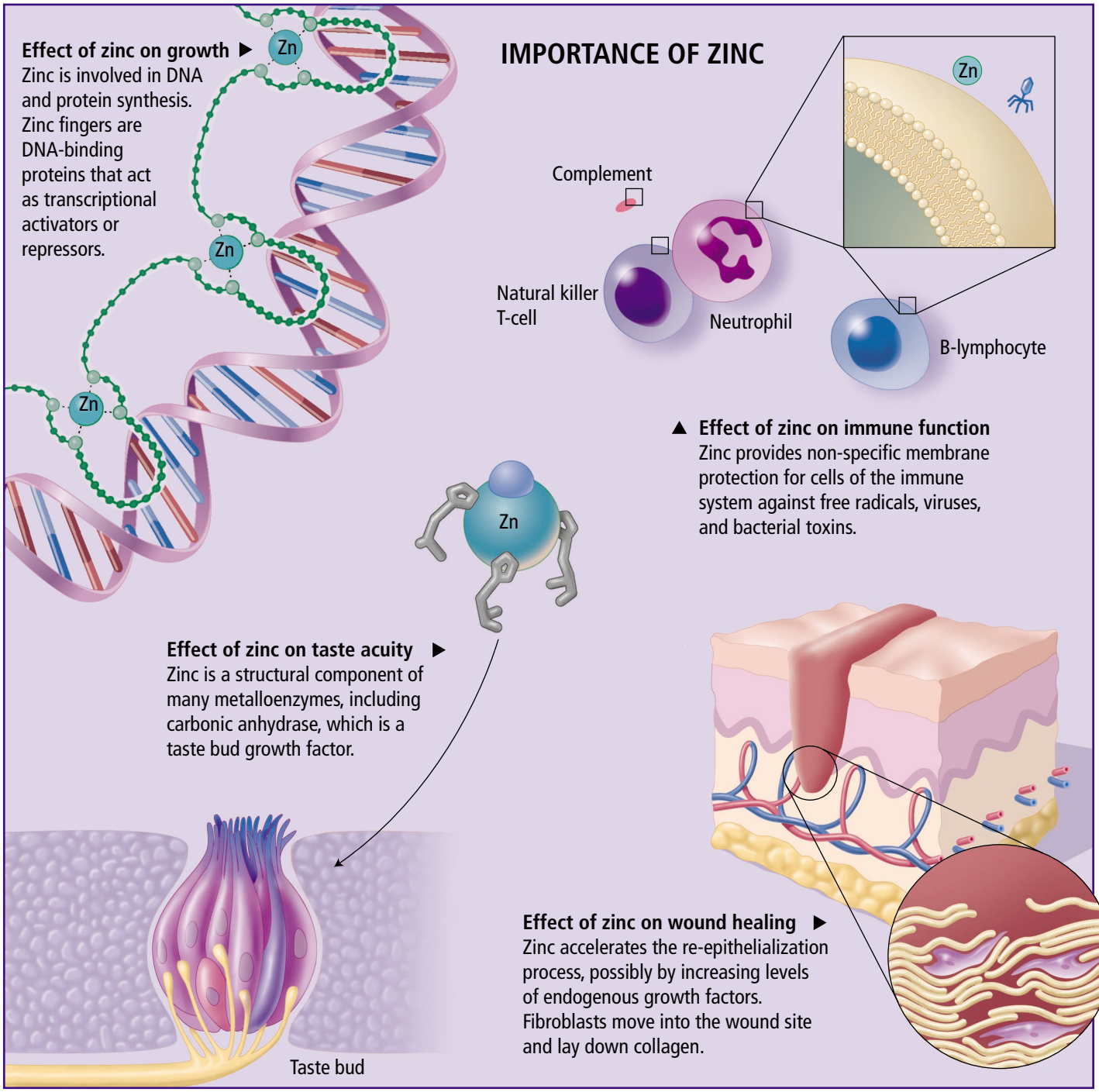
does not rule out zinc deficiency. Also, external contamination or hemolysis of the sample artificially increases the measured levels of zinc. Acute stress, following myocardial infarction or acute infections, artificially lower zinc levels secondary to redistribution of zinc from plasma to other tissues. Because zinc is bound to albumin in the circulation, conditions causing hypoalbuminemia also account for a low zinc level.[19]

Other methods to assess zinc status are measurement of zinc in hair and red cells. However, because of slow tissue turnover, these zinc levels do not reflect recent changes with respect to body zinc stores. Neutrophil zinc determination appears to reflect the body zinc status more accurately and is a very useful parameter.[19]

A patient's zinc status may also be estimated by inquiring about their dietary patterns. A rule of thumb is to consider patients at risk for zinc deficiency if they eat less than 5–7 oz of lean meat, poultry and fish daily, as recommended by U.S Department of Agriculture and health organizations.[7]

Treatment of Zinc Deficiency

In order to reach the RDA requirement of zinc, elderly people should be encouraged to eat a variety of foods that



are rich in zinc, such as red meat, poultry and fish. However, in situations where frank zinc deficiency is known or suspected, zinc supplementation (in the form of zinc sulfate) is required. Daily supplements in the range of 15–40 mg will be safe and adequate for most patients.[6,7]

In Summary

Zinc is an essential micronutrient for the function of the human body. It serves as a structural component for metalloenzymes and helps in the stabilization of cell membrane, tissue regeneration and protein synthesis. It is found in a wide variety of foods, and its deficiency leads to growth retardation, immune suppression, delayed wound healing, impaired smell and taste, and skin lesions. Elderly people are more susceptible to zinc deficiency because of poor food energy intake.

There are no universal tests to diagnose zinc deficiency. However, the plasma zinc level is the test of choice. If zinc deficiency is suspected in an elderly patient, then a balanced diet rich in zinc is encouraged, and additional zinc supplementation (as zinc sulfate) may be required. ◆

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