

Zinc Deficiency and Associated T-Cell Dysfunctioning among Human Immunodeficiency Virus Seropositives

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Abstract: Problem statement: All the nutrients in the diet play a crucial role in maintaining an optimal immune response. In both, deficient and excessive intake of nutrients can have negative consequence on the immune status and susceptibility to a variety of pathogens. Zinc is an essential micronutrient for human growth development and immune function. It plays a vital role in structure of protein and cell membrane. Zinc deficiency in biological membrane increases their susceptibility to oxidative damage and impairs T-cell function. Zinc deficiency causes serious metabolic disturbances and associated with adverse change in CMI and decrease in antibody response can be effectively observed in Immune deficient host (HIV). **Approach:** A total of 49 HIV patient serum sample were collected 16 HIV/AIDS male patients and 33 HIV/AIDS female patients. Serum iron concentration was analyzed by Atomic Absorption Spectrophotometer (AAS). **Results:** The Zinc deficiency leads to various types of Sexually Transmitted Disease in male and female HIV Seropositives. Zinc has been found to regulate gene expression by acting as transcription factor. It also plays a role in cell signaling and found to influence hormone release and nerve impulse transmission. Zinc found to be essential for DNA/RNA synthesis and also for apoptotic activity. **Conclusion:** Zinc supplementation has been observed to improve the HIV status from malnutrition as it stimulates T-cell differentiation and maturation, stabilize the cell membrane and increase the number of circulatory T lymphocytes there by inhibit the HIV progression.

Key words: HIV, Zinc, T-cell, AAS, opportunistic infection and trace element

INTRODUCTION

Human Immunodeficiency Virus (HIV) is a lentivirus (a member of the retrovirus family) that causes Acquired Immunodeficiency Syndrome (AIDS), a condition in humans in which the immune system begins to fail, leading to life-threatening opportunistic infections. All the nutrients in the diet play a crucial role in maintaining an optimal immune response. In both, deficient and excessive intake of nutrients can have negative consequence on the immune status and susceptibility to a variety of pathogens. These micronutrients include calcium, phosphorus, iron, zinc, magnesium, selenium, bromine and few others. Some of these minerals are called "Trace elements" as they are required by the body micro quantities. Many of these minerals are widely distributed in foods so that a well balanced diet will supply them in sufficient quantities. Zinc is an essential nutrient for human growth, development and immune function. Zinc play a important role in structure of proteins and cell

membrane. The structural functions of cell membrane are affected by Zinc. Loss of zinc in biological membranes increase their susceptibility to oxidative damage and impairs their function. Zinc has been found to regulate gene expressions by acting as transcription factor. Zinc also play a role in cell signaling and has been found to influence hormone release and nerve impulse transmission. It is needed in all DNA and RNA synthesis and is required at every step of cell cycle. Zinc deficiencies are associated with variety of adverse changes in cell mediated immunity. In particular, zinc is essential for thymic functions by means of a zinc-dependent thymic hormone called thymulin (ZnFTS), which is indispensable for the differentiation and maturation of T cells. In the course of infection, derangements of the immune functions at both central and peripheral levels are usual and constant events associated with more or less marked zinc deficiency (Shankar and Prasad, 1998). In HIV disease, the most poignant observation may be there. Zinc supplementation has been observed to improve the HIV

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status from malnutrition (Cavan *et al.*, 1993) as zinc stimulates T cell differentiation and maturation, stabilizes cell membrane and increases the number of circulatory T lymphocytes. It may thus diminish the immune defects in HIV infection thereby inhibit the progression of the disease and enhance resistance to opportunistic infections (Odeh, 1992).

MATERIALS AND METHODS

Serum collection from study population: A total of 49 HIV patient serum sample were collected which includes 16 HIV/AIDS female patients and 23 HIV/AIDS male patients. About 10 mL of whole blood on one occasion from each participant was collected in sterile screw capped Laxbro vials with informed consent of the patient The Blood sample subjected for the separation of serum and was used for trace element analysis.

Trace element analysis by Atomic Absorption Spectrophotometer: Atomic Absorption Spectrophotometer analysis of serum trace element zinc was carried out at characterization and Measurement lab of Center for Electrochemical Research Institute, CSIR, Karaikudi. All serum sample were independently prepared as per the procedure prescribed for zinc trace element analysis.

RESULTS

Figure 1 represents the age wise prevalence of HIV Seropositives. Highest HIV seropositivity is observed in 31-45 age group of males and 16-30 age group of females.

Figure 2 represents the observed percentage deviation compared to the standard normal serum zinc level is highest in 31-45 age group of males and 16-30 age group of females.

Figure 3 represents Serum Zinc concentration in sexually transmitted categories of HIV positive. The order of decrease percentage deviation is observed to be greater in syphilis followed by genital molluscum, pelvic inflammatory diseases. Genital warts, Herpes Simplex virus infection and genital candidiasis in male category. Among female HIV Seropositives the percentage deviation of serum zinc level is higher in genital candidiasis followed by more or less equal in genital warts.

Figure 4 represents serum zinc concentration in various clinical conditions of HIV sero positives. Mean serum concentration is more or less showing decrease of values when compared to normal values.

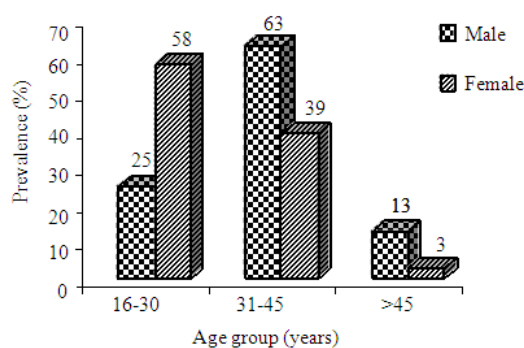


Fig. 1: Age wise prevalence of seropositive

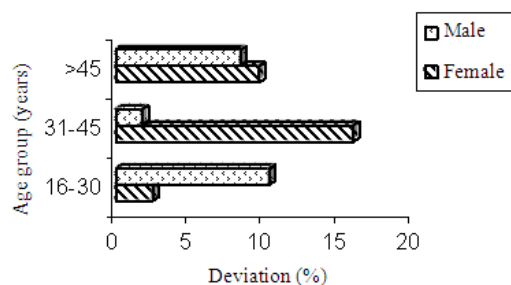


Fig. 2: Age wise determination of serum Zinc concentration of HIV seropositive

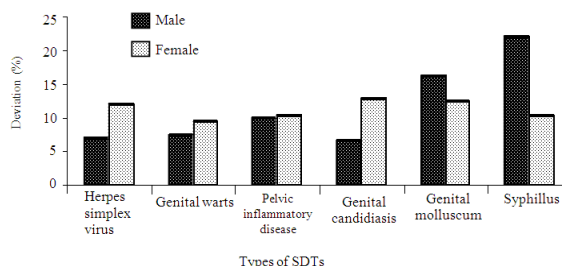


Fig. 3: Percentage Deviation of serum Zinc concentration in various STD categories of HIV seropositive

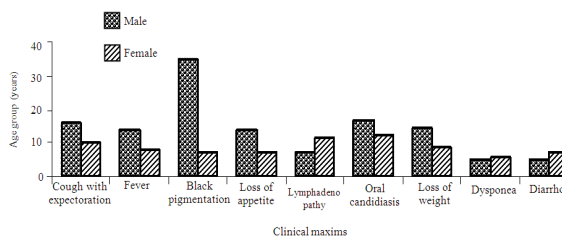


Fig. 4: Percentage deviation of serum Zinc concentration in various clinical condition of HIV seropositive

DISCUSSION

Almost all nutrients in the diet play a crucial role in maintaining an optimal immune response. In both, deficient and excessive intake of nutrients can have negative consequence on the immune status and susceptibility to a variety of pathogens.

The age wise prevalence of HIV positive among the study subjects reveals higher incidence in 16-30 age group of females and 31-45 age of males. This shows heterosexual transmission and sexually active stage both gender groups as reported else where in Indian context.

The normal serum zinc concentration (0.5-1.2 mg L⁻¹) is greatly deviated and the mean value of zinc concentration in the study subjects are greatly reduced. It shows there is a zinc deficiency and its association with the progression of AIDS.

Zinc deficiency among sexually transmitted diseases among HIV seropositives revealed that Herpes simplex virus, genital warts and pelvic inflammatory diseases might have responsible for severe immunodeficiency among HIV seropositives. The other sexually transmitted diseases study subjects are almost normal in serum zinc level.

Zinc is a relevant trace element in the body. Its requirement as a structural constituent of many proteins and, likely, its function in preventing free radical formation. zinc deficiency leads to a plethora of body homeostatic mechanism dysfunctions with consequent slowed growth, susceptibility to many diseases and decreased survival rates that can be corrected with zinc supplementation (Mocchegiani and Muzzioli, 2000). The major abnormalities during zinc deficiency in immune responses are in T-lymphocyte and neutrophil functions. The essential role of zinc in the efficiency of the immune system (Chandra, 1997; Prasad, 1996; Wellinghausen *et al.*, 2000), in particular for CD4⁺ cell growth and function, the strong depletion of CD4⁺ cells in the setting of HIV infection leading to the appearance or recidivism of opportunistic infections, followed by an unfavorable prognosis, may be in large part due to the low zinc bioavailability. Such an assumption may be supported by the discovery that zinc is also required for the biological activity of the thymic hormone ZnF₁ that is indispensable for the differentiation and maturation of CD4⁺ cells. The zinc-unbound form of thymulin (F₁) is inactive with an inhibitory effect on the zinc-bound active form (ZnF₁). The marked zinc deficiency in stage IV may be the cause of deranged immune functions with the consequent increased appearance of recidivistic opportunistic infections. The thymus gland is also

atrophic in the first phases of HIV infection (Gaulton *et al.*, 1997) due to increased apoptosis of thymocytes. Zinc prevents apoptosis (Fraker *et al.*, 2000). The low zinc bioavailability in HIV infection may have more of a harmful rather than a beneficial role for disease progression. Supplementation with zinc may be useful to block and, as such, to stabilize the disease with possibly no recidivism opportunistic infections. A beneficial effect of supplementation with zinc (135 mg zinc gluconate day⁻¹ for 15 day corresponding to 40 mg Zn²⁺ day⁻¹) on the recovery of immune efficiency (CD4⁺ cells and PHA-mitogen responsiveness) in stage IV of HIV infection. General good health as revealed by increments of body weights and increased survival are also associated. They are suggestive to give a pivotal role to zinc in HIV infection to thwart the appearance of opportunistic infections.

CONCLUSION

Supplementation of Zinc stabilize the functional role of T cell thereby, restore the immune functioning by restraining the replicative capacity of virus, which mediate the life expectancy of the HIV victim.

ACKNOWLEDGEMENT

Dr. Jeya Kumar retired professor sexually transmitted disease .Mohan Kumaramangalal Hospital, Salam.

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