Zinc and Copper Status in Anorexia Nervosa

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Anorexia nervosa (a.n.), a disorder afflicting mainly adolescent females and characterized by excessive food restriction resulting in severe weight loss, would be expected to represent a nutritional disorder par excellence; but this is not so, as most patients continue to conscientiously take their daily vitamins.

It is important to note, however, that most vitamins do not contain minerals. Thus, it is conceivable that certain minor symptoms of a.n., such as dryness of the skin, loss of hair (but rarely alopecia), anemia, and some biochemical abnormalities (e.g., an increased plasma carotene level), could be due to a relative deficiency in essential trace elements. The authors, therefore, investigated zinc and copper status in a.n. Zinc has been reported essential for the function of more than 50 enzymes and has been implicated in the synthesis of retinal-binding protein (RBP), a protein necessary for retinal transport. Copper deficiency has been found associated with anemia.

Furthermore, Henkin et al. (1) have shown that zinc plays several roles in the taste sense, and a change in zinc availability in a.n. might result in taste distur-

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lapses. Even though changes in appetite and cravings for specific food are not uncommon in a.a., the taste sense has not been objectively measured. The authors, therefore, undertook to evaluate taste sensitivity along with trace metals in a subgroup of patients.

The following parameters were obtained in 24 female patients with a.a. in the fasting state between 8 and 9 a.m., 1 to 2 days after admission to hospital: 1) plasma zinc, carotene, vitamin A, and RBP concentrations; zinc content in hair; and the results of testing taste acuity with increasing concentrations of NaCl, sucrose, urea, and HCl solutions; and 2) plasma copper, ceruloplasmin levels, and copper content of hair.

Methods

Blood was collected into opaque clouded falcon tubing which contained two drops of zinc-free Na-oxalate solution, centrifuged, and the plasma separated from red cells before storage at −20°C.

Plasma zinc and copper were determined by aspiration of a five-fold water diluted plasma into the atomic absorption flame and calibrated against aqueous standards (2). Values of plasma zinc were not obtained on hemolyzed samples. Vitamin A was determined by the macroprocedure of Neel and Pearson (3). Plasma RBP was determined by radioimmunoassay.*

Hair metals were measured by cutting one cm. of hair in the proximal scalp area of the occipital region. Samples were washed according to Klevay (4).

Ceruloplasmin was measured by a modified method of Ravin (5).

Taste discrimination was evaluated according to a standardized procedure described by Henkin et al. (6).

Results

Zinc, Carotene, Vitamin A, and RBP: Mean plasma zinc levels were significantly (p < .02) reduced (73.9 ± 18.3 μg/dl) in anorectics compared to a female control group (83.2 ± 8.9 μg/dl). As can be seen from the standard deviation, these levels showed a wider range from the lowest to the highest value. Zinc content of hair was 201.1 ± 46.3 μg/g in anorectics, compared to the mean value of 186.4 ± 38.1 μg/g, which is in the normal range. It is noteworthy that although most patients complained of continued hair loss during weight gain, only two patients had a substantial loss of hair during the course of the illness, and these same

two patients had lowered plasma zinc levels. The one patient who eventually lost all scalp hair during refeeding showed the lowest zinc hair content of 103 μg/g. Plasma zinc levels were neither found to be related to the amount of weight lost (r = .17) nor to the duration of illness (r = .10). Despite large individual variations, mean carotene levels were significantly elevated (218 ± 200 μg/dl) compared to normal female controls (132.2 ± 39.2 μg/dl).

Hypercarotenemia may be seen in hypothyroidism with a decreased catabolism of β-lipoprotein, the major carrier of carotene in plasma. As a result of the studies of Moschang et al. (7) and Boyar et al. (8) who have used a radioimmunoassay for triiodothyronine (T3) in contrast to less sensitive assays, it is now known that a.a. patients are actually deficient in functional T3. In contrast, vitamin A levels, though slightly reduced (16.9 ± 10.3 μg/dl), were not significantly lower as compared to normals (50.3 ± 9.9 μg/dl). The concentration of the vitamin A carrier protein, RBP, was similar in anorectics (53.3 ± 14.4 μg/dl) and in normals (53.0 ± 13.7 μg/dl). A significant correlation between carotene and vitamin A (r = .52; p < .02) and vitamin A and RBP (r = .61; p < .01) was observed, but plasma zinc levels were not found to be significantly related to vitamin A (r = 0.16) or carotene (r = 0.3) levels.

Copper: Plasma copper levels were significantly lower in patients with a.a. (85.5 ± 17.9 μg/dl; p < .001) compared to normal women (123.2 ± 3.9 μg/dl). In contrast, copper content of hair was actually increased in 12 patients (24.0 ± 17.8 μg/g) as compared to normals (12.7 ± 6.4 μg/g). The first carrier for the absorbed copper seems to be albumin; copper is then taken up by the liver and incorporated into ceruloplasmin, which is synthesized in the liver. Ceruloplasmin in plasma, which contains the major portion of copper in blood, was found to be reduced in a.a. (25.2 ± 8.7 mg/dl) although not significantly (30.9 ± 8.9 mg/dl).

Taste sensitivity was measured in 13 patients. The patients, whose ability to recognize different taste qualities of NaCl, sucrose, urea, and HCl was reduced, showed correspondingly lowered zinc values, but the converse did not hold; i.e., lowered zinc values were not necessarily found associated with taste disturbances. Thus, some patients whose zinc levels ranged between 56-58 μg/dl were accurate in detecting and recognizing the test substances. Many of these patients initially complain about the taste of the offered food; often this is interpreted as another maneuver to avoid food, but for some the food might really be

* M-Partigen Retinal Binding Protein Accuapak kit, Behring Diagnostics, American Hoechst Corporation, Somerville, New Jersey.
tasteless. None of the authors' patients reported dysgeusia or abnormal taste sensations.

Summary

The levels of the trace metals zinc and copper, carotene, vitamin A, RBP, and ceruloplasmin were studied in 24 female patients admitted to hospital with a diagnosis of anorexia. Plasma zinc and copper levels were significantly reduced, whereas zinc and copper content of hair was found to be in the normal range. In order to evaluate whether the lowered plasma zinc and copper levels reflect a deficiency of these trace metals in tissue, taste testing was performed in a subgroup of 13 patients. Five patients had a decreased taste acuity for salty, bitter, and sour qualities along with lowered zinc levels; in the remaining patients, decreased plasma zinc levels were not related to disturbances in taste acuity. Whereas, mean carotene levels were significantly elevated in anorectics as compared to normals; vitamin A and RBP plasma levels were within normal range and did not correlate with the plasma zinc concentrations. Ceruloplasmin in plasma was slightly, though not significantly, reduced.

References


