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Ascorbic Acid Status in Children with Malnutrition

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Although reports concerned with the level of Vitamin A, D, E, riboflavin and thiamine in malnourished children have been published,[1, 2] studies about the vitamin C status are relatively scarce.[3-5]

Since no studies concerning the leucocyte ascorbic acid concentration and relationship between levels of ascorbic acid in the leucocytes and plasma in children with malnutrition have been reported, this study was performed.

Materials and Methods

The study group consisted of 42 children with malnutrition and 15 children with bronchopneumonia. The control group consisted of 11 boys and 9 girls in good health.

The diagnosis and classification of malnutrition was made according to a modified version of Gomez's.[6] With the exception of 2 children with fourth degree malnutrition, the rest of the children had second and third degree malnutrition. The cause of malnutrition was simply inadequate diet; none of them exhibited malabsorption or kwashiorkor.

Since 22 out of 42 malnourished children had upper respiratory tract infection or bronchopneumonia, the study population was divided into three groups:

a. Children with malnutrition only.

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b. Children with both malnutrition and infection.

c. Children with bronchopneumonia only (control group for group B).

Data related to the age of children is given in Table I. Hemoglobin, hematocrit, white blood cell count and urine analyses were performed on every subject by routine procedures. Total plasma protein levels were determined by the Henry Biuret method.

Ascorbic acid concentrations in both leucocytes and plasma were measured using the method described by Denson and Bowers[7] with slight modification to permit easier separation of the white cells. After six hours of fasting, four to six ml. blood samples were drawn from all the subjects into a plastic syringe containing 0.2 ml. of heparin. The leucocyte ascorbic acid level is expressed in terms of μg. per 10^8 white blood cells.

Results

The mean values of leucocyte ascorbic acid concentrations and plasma ascorbic acid levels are shown in Table I. The leucocyte ascorbic acid concentration showed wide variation in every group of subjects, but was especially pronounced in the control group.

Leucocyte ascorbic acid concentrations and plasma ascorbic acid levels of children with malnutrition and children with malnutrition plus infection were both significantly lower than those of the controls. ($P < 0.05$). The results of these two groups of malnourished children differed very little from each other.

The leucocyte ascorbic acid concentrations of children with infection were significantly higher than the controls and other study groups. ($P < 0.05$). On the other hand plasma ascorbic acid levels of these children were significantly lower than those of controls. ($P < 0.05$).

Table I contains an analysis of variance of regression lines for leucocyte and plasma ascorbic acid values from study and control groups. No correlation was found between leucocyte and plasma ascorbic acid levels in the control group. On the other hand, the correlation between the leucocyte ascorbic acid concentrations and plasma ascorbic acid levels was significant in the group consisting of children with malnutrition ($P < 0.05$). Figure 1 shows the calculated regression lines relating leucocyte ascorbic acid concentrations with plasma ascorbic acid values in the four groups of children under study.

TABLE I

ASCORBIC ACID LEVELS IN LEUCOCYTES (μg/10^8 CELLS) AND PLASMA (mg/100 ml)

Group	Number of Cases	Age (Months) Mean	Age (Months) Range	Ascorbic Acid Levels: Leucocyte Mean, S.D	Ascorbic Acid Levels: Plasma Mean, S.D	Correlation	Regression Coefficient	Correlation Significance (P)	
Controls	20	24.1	6–42	23.2 ± 6.03	0.40 ± 0.16	−0.0396	−1.42	−0.16	> 0.05
Malnutrition	20	15.1	4–42	14.4 ± 1.11	0.22 ± 0.23	0.7771	16.6	5.23	< 0.05
Malnutrition + Infection	22	14.7	3–36	15.6 ± 10.1	0.23 ± 0.23	0.4116	17.7	2.01	> 0.05
Cases with Infection	15	22.7	4–36	29.1 8.8	0.26 0.13	0.2821	18.9	1.06	> 0.05

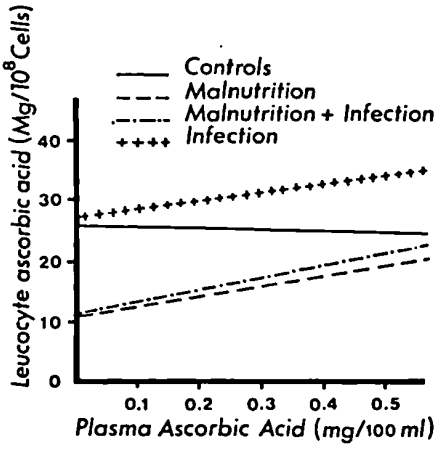

Figure 1
Calculated Regression Lines Relating Leucocyte with Plasma Ascorbic Acid Values in Four Groups of Children

Discussion

There are only a few studies concerning the vitamin C status of children with malnutrition. These studies were mainly based on the plasma ascorbic acid levels and urinary ascorbic acid excretions.[3, 4, 5]

Some investigators have stated that the white blood cell ascorbic acid is the most sensitive index of ascorbic acid deficiency.[8] However, others consider leucocyte ascorbic acid as a labile component of blood and, therefore, determination of leucocyte and plasma ascorbic acid levels from the same sample have been suggested.[9] As a consequence, in our studies the white blood cell ascorbic acid concentration and plasma ascorbic acid levels were determined separately.

Both the leucocyte ascorbic acid concentration and plasma ascorbic acid levels of malnourished children were significantly lower than those found for the control group. Throughout this study a few malnourished children with plasma ascorbic acid levels as low as 0.02 mg./100 ml. were observed. (Normal 0.40 mg./100 ml $\pm$ 0.16). These children did not show any clinical signs of scurvy, suggesting that plasma ascorbic acid level alone is not sufficient to make the diagnosis of scurvy. It seems, for this purpose, that the leucocyte concentration should also be low, and, clinical and X-ray findings should confirm the disease.

Since no correlation was obtained between leucocyte ascorbic acid concentrations and plasma ascorbic acid levels in the control group, it may be that normal children have a relatively high storage of ascorbic

acid, and slight changes in the plasma levels do not alter the leucocyte ascorbic acid concentration. The existence of a significant correlation between the decreased leucocyte and plasma ascorbic acid levels in children with malnutrition suggests that any rise in plasma ascorbic acid level would tend to increase the leucocyte ascorbic acid. This finding, together with decreased leucocyte and plasma ascorbic acid levels may be considered as indicating an ascorbic acid deficit in malnourished childern.

It is of interest, that the children with infection (group C) had significantly higher leucocyte ascorbic acid concentration, while their plasma levels were significantly lower than those of the controls. Similarly, the group of children with both malnutrition and infection had slightly higher leucocyte ascorbic acid concentration than those of the children with malnutrition alone (Table I). Figure 1. It has been previously reported that during an infection, plasma ascorbic acid levels are decreased.[10, 11] We were not aware, however, of any report concerning the leucocyte ascorbic acid concentration in subjects with infection.

Summary

Leucocyte ascorbic acid concentration and plasma ascorbic acid levels were measured, and the correlation was determined in 42 children with malnutrition, 15 children with bronchopneumonia, and in 20 healthy children.

Children with malnutrition had significantly lower leucocyte and plasma ascorbic acid levels than those of the controls. ($P < 0.05$).

No correlation was found between the leucocyte ascorbic acid concentration and plasma ascorbic acid levels in the control group. The correlation between these two variables was significant in children with malnutrition. This positive correlation finding, together with decreased ascorbic levels in leucocytes and plasma, may be considered as a criteria indicating an ascorbic acid deficit in malnourished children.

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