EFFECTS OF PROTEIN ENERGY MALNUTRITION ON CIRCULATING THYROID HORMONES

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ABSTRACT

The effect of protein energy malnutrition (PEM) in the children on serum levels of total thyroxine (TT4), total triodothyronine (TT3) and thyrotropin (TSH) were evaluated. There were 107 children aged 2 to 60 months in the malnurtition group and 54 healthy age and sex matched controls. Serum TT4 and TT3 were all reduced in the malnutrition group. This decrease in TT3 was more significant ($p<0.01$) in severe malnutrition than in mild PEM. Serum TSH levels in the malnutrition and control groups were similar. These results suggest that the children remained euthyroid and represent an adaptive response to protein energy malnutrition.

Keywords: *Protein energy malnutrition, Thyroxine, Triiodothyronine, Thyrotropin.*

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Protein energy malnutrition (PEM), seen as a result of inadequate and insufficient nutrition is still an important health problem for our region and developing countries. Alterations in nutritional state, whether short term or chronic, affect physiology of the thyroid hormone, especially peripheral hormone metabolism(l-5).

The thyroid gland is the sole source of T4 but most of the T3 in blood is derived from the peripheral conversion of T4 by 5' deiodinase. Both T3 and T4 in blood are associated with plasma proteins. The binding proteins normally include thyroxine-binding globulin (TBG), thyroxine-binding pre-albumin (TBPA) and albumin(3,5-7). In children with PEM, concentrations of all three thyroid hormone binding proteins are extremely low, and the serum T4 and T3 levels decline abruptly, often into clearly hypo-thyroid range. However, serum TSH concentration is unchanged. This study was undertaken to study the effect of malnutrition on thyroid function, as assessed by T3, T4 and TSH levels.

Material and Methods

One hundred and seven with PEM (66 boys and 41 girls), and 54 healthy children (34 boys and 20 girls), aged 2 to 60 months who were followed in our clinic were studied. None of the malnourished patients had endocrine or metabolic disorders and congenital anomalies.

The degree of malnutrition was determined by modified criteria of Gomez(8,9). PEM Grade I was characterized by 75-90%, Grade II by 60-75%, Grade III less than 60% and Grade IV less than 50% of the normal weight.

Controls who were age and sex matched were also included.

Blood samples were obtained from peripheral veins and the levels of T4, T3 and TSH measured by radioimmunoassay (RIA) method(10). For measuring, TKT41 DPC kit for TT4, TKT-31-DPC kit for TT3 and KTS-IRMA-Count kit for TSH were used (Source of kits: Diagnostic Products Corporation, Los Angeles).

Statistical significance was measured by Mann-Whitney U test(11).

Results

Table I shows the grade of malnutrition and age profile of patients. The patients and the controls were age and sex matched.

The median level of T4 in first degree PEM was 8.90 ± 0.27 μg/dl and in control group was 9.33 ± 0.25 μg/dl ($p > 0.05$) *(Table II)*. In second degree PEM, median TT4 was 8.28 ± 0.38 μg/dl, in control group 8.63 ± 0.29 μg/dl ($p > 0.05$). In third degree PEM, median TT4 was 7.97 ± 0.74 ng/dl, in control group, it was 10.80 ± 0.27 ng/dl. These difference were statistically significant ($p < 0.05$). In fourth degree PEM, TT4 was 6.93 ± 0.60 μg/dl; in control group it was 10.52 ± 0.43 μg/dl ($p < 0.05$).

The levels of T3 were significantly low in all grades of PEM as compared to controls *(Table II)*.

The levels of TSH in patients with PEM and controls were similar.

Discussion

The circulating concentrations of thyroid hormones in our children with acute PEM were similar to previously published values(12-15). Our results show that PEM in children is characterized by significant decrease in serum TT3 concentrations. Serum T3 levels were reported to be lower than normal

TABLE I–*Anthropometry in PEM and Controls*.*

Groups	n	Age (mo)	Weight (kg)	Height (cm)	Weight loss (%)
First degree PEM	53	21.0 ± 2.1	9.55 ± 0.37	78.4 ± 1.7	19.5
Controls	53	17.1 ± 2.0	9.79 ± 0.42	76.1 ± 1.7	
Second degree PEM	37	17.4 ± 2.4	7.53 ± 0.39	72.7 ± 1.9	31.8
Controls	37	15.3 ± 2.1	9.69 ± 0.49	76.3 ± 2.1	
Third degree PEM	10	13.8 ± 5.3	5.80 ± 1.84	66.8 ± 2.8	42.7
Controls	10	17.8 ± 4.3	10.59 ± 1.13	78.1 ± 3.2	
Fourth degree PEM	7	8.0 ± 2.4	3.52 ± 0.42	57 ± 3.2	56.3
Controls	7	11.7 ± 3.9	9.03 ± 1.07	71.2 ± 5.1	
PEM in all groups	107	18.2 ± 1.4	8.10_0.29	73.9 ± 1.2	28.3
Controls in all groups	54	15.3 ± 1.7	9.77 ± 0.41	75.9 ± 1.7	

*Mean values ± SD.

TABLE II—*Serum TT4, TT3 and TSH Levels (Mean ± SD) in Children with PEM and Controls*

	n	T4 (μg/dl)	T3 (ng/dl)	TSH (μU/ml)
First degree PEM	53			
Hormone levels		8.90 ± 0.27	145.00 ± 4.38	2.49 ± 0.11
Range		5.90-12.40	75.00-190.00	0.72-3.98
Hormone levels in controls		9.33 ± 0.25	158.82 ± 3.11*	2.29 ± 0.08
Second degree PEM	37			
Hormone levels		8.28 ± 0.38	1.40 ± 4.90	2.30 ± 0.11
Range		2.25-11.60	86.00-182.00	0.58-3.85
Hormone levels in controls		8.63 ± 0.29	154.46 ± 3.70	2.22 ± 0.10
Third degree PEM	10			
Hormone levels		7.97 ± 0.74	126.20 ± 10.98	2.23 ± 0.30
Range		4.20-10.40	54.00-158.00	0.48-3.76
Hormone levels in controls		10.80 ± 0.27*	168.90 ± 5.73*	2.55 ± 0.17
Fourth degree PEM	7			
Hormone levels		6.93 ± 0.60	114.43 ± 16.65	2.80 ± 0.24
Range		4.80-9.20	58.00-176.00	1.92-3.68
Hormone levels in controls		10.52 ± 0.43*	168.30 ± 6.20*	2.30 ± 0.21
PEM group as a whole	107			
Hormone levels		8.47 ± 0.21	139.96 ± 3.19	2.42 ± 0.07
Range		2.25-12.40	54.00-190.00	0.48-3.98
Hormone levels in controls		9.29 ± 0.25*	156.87 ± 3.50*	2.28 ± 0.08

* $p < 0.05$.

in many illness(5,16). Studies on T3 levels in children with PEM are rare. Ingenbleek *et al.* (13) were the first to show a similar decrease in malnutrition, the serum T3 levels were two-third of the control levels. Ingenbleek has reported a decrease in T3 and free -T3 levels to one-third and one-fourth of normal(17). Low levels of binding proteins, altered rate of total and free fractions and decreased peripheral conversion of T4 and T3 are considered to be responsible for such low levels(12-17).

Previous studies have shown that serum T4 levels decrease in malnourished children(12-15). In our study, the mean T4 values were significantly low in patients with Grades III and IV PEM as compared to controls.

Low levels of thyroid hormone binding proteins in malnutrition are thought to be due to decreased protein intake and reduced hepatic biosynthesis of

these proteins in liver(15). The rise in serum total T3 and T4 levels that occurs on refeeding can be largely accounted for by the increasing concentrations of TBG, TBPA and albumin. By contrast children who do not receive adequate nutritional supplements do not show significant changes in levels of these proteins(l-3,12,13). Although T4 and T3 levels are low, physiological activities of free thyroid hormones depend on their plasma concentrations. In acute PEM, free T4 levels may be either normal or high. After acute decrease in thyroid hormone binding proteins, free T4 levels increase but as malnutrition prolongs, free T4 levels decrease. For this reason it is reported that free T4 levels are important in explaining thyroid functions in children with PEM(5,17,18).

There was no significant difference between serum TSH concentrations in our children with PEM and the controls. This result accords with previously reported data(12-15).

Since T3 is the major active thyroid hormone, it is surprising that patients with decreased serum T3 do not appear hypothyroid. Low serum T3 is probably an adaptive change to PEM, which at least enables the sick patient to conserve protein. Because the changes in thyroid hormone metabolism that occur in PEM probably represent adaptive changes to the illness, treatment with 1-thyroxine to restore serum thyroid concentrations to the normal range is not indicated.

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