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Thyroid status in children with severe acute malnutrition

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ABSTRACT

Objectives: The objective of the study is to study thyroid hormone levels in children with severe acute malnutrition (SAM) and its correlation with serum total protein and albumin levels.

Materials and Methods: A prospective cross-sectional study was carried out at Nutritional Rehabilitation Centre, Hubli, from Dec 2018 to Nov 2019. Inclusion criteria: All children in the age group of 6–59 months with SAM. Exclusion criteria: (i) Children suffering from metabolic disorders, tuberculosis, urinary tract infection, malabsorption syndrome (celiac disease), protein losing enteropathy, and nephrotic syndrome; (ii) Children with major congenital anomalies; and (iii) Children with chronic liver and kidney diseases. All enrolled children's details of demography, clinical history, and examination were entered in a predesigned pro forma. Total triiodothyronine (TT3), total thyroxine (TT4), thyroid-stimulating hormone (TSH), and serum total protein and albumin were estimated. Data were analyzed using SPSS Version 16.

Results: Total of 50 children fulfilled criteria during study period. Mean age of presentation was 18 ± 2.1 months with male-to-female ratio 0.8:1. The mean TT3 (ng/dl), TT4 (mcdg/l), and TSH (mIU/L) were 109.8 ± 50.6, 8.36 ± 3.7, and 2.5 ± 1.8, respectively. Mean total protein and albumin were 5.5 ± 1.4 g/dl and 2.97 ± 0.9 g/dl. Overall, 18 (36%) children had low total protein and 17 (34%) have low serum albumin. Low serum TT3, and TT4 levels were found in 11 (22%) and 14 (28%), respectively, and elevated TSH in 4 (8%) children. Low T3 was significantly associated with low albumin ($P < 0.01$).

Conclusion: The impaired thyroid function and low serum T_3 levels seen in SAM children were probably an adaptive change to malnutrition.

Keywords: Severe acute malnutrition, Thyroid profile, Serum albumin, Total proteins

INTRODUCTION

Malnourished children suffer from numerous complications including vitamin deficiencies, deficiencies of minerals, and trace elements. Alterations in nutritional state, whether short term or chronic, affect internal milieu, one such change is in the physiology of the thyroid hormone, especially peripheral hormone metabolism.

Severe acute malnutrition (SAM) is a medicosocial disorder characterized by a range of pathological conditions arising from a deficiency of protein and energy and is commonly associated with infections.[1,2] The deleterious effects of protein energy malnutrition on the thyroid function were first demonstrated in animal experiments.[3]

The thyroid gland is the sole source of thyroxine (T4), but most of the triiodothyronine (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. In children with SAM, concentrations of all three thyroid hormone-binding proteins are extremely low; there is marked change in secretion and metabolism of thyroid hormones and in structure of thyroid gland. This result in reduction of activity of thyroid gland and hence decrease in TT3 and TT4. Several studies have been done to estimate the individual biochemical parameters in PEM. Kalk *et al*. in their study found that there was no significant difference between serum thyroid-stimulating hormone (TSH) concentrations in children with PEM and the controls.[4] However, Ingenbleek in their study found changes in thyroid function and attributed them to the reduced energy and protein intake characteristic of children with malnutrition.[5] The alteration of thyroid function is attributed to changes in iodine metabolism and decreased level of circulating proteins.

Due to paucity of literature on thyroid harmones and SAM and conflicting results specially on TT4[4,5] levels has prompted us to do this study,on concentration of serum thyroid hormone levels in SAM children and its correlation with serum total protein and albumin levels.

MATERIALS AND METHODS

The study was carried out at Nutritional Rehabilitation Centre, department of pediatrics, KIMS, Hubli. A prospective cross-sectional study done over a period of 1 year from Dec 2018 to 2019. Ethical clearance was obtained from Institutional Ethical Committee.

Inclusion criteria

- All children in the age group of 6–59 months with SAM.

Exclusion criteria

- Children suffering from metabolic disorders
- Children suffering from chronic infection such as tuberculosis, urinary tract infection
- Children suffering from malabsorption syndrome (celiac disease), protein losing enteropathy, and nephrotic syndrome
- Children with major congenital anomalies
- Children with chronic liver and kidney diseases
- Children on chronic medication.
- All those children who fulfilled the inclusion/exclusion criteria were enrolled into the study. The details of demography and clinical history, (dry skin, constipation, psychomotor retardation, and coldness of extremities) were entered in a predesigned pro forma. All children underwent detailed anthropometric measurements and systemic examination.
- SAM was defined as per the WHO Criteria.[6]

Anthropometry

Weight (>1 year) was taken on a digital weighing scale, and for infants, it was taken on infant digital weighing scale. Weight was recorded to the nearest 100 g, height (>2 year) was measured by stadiometer, and for infants, length was taken by infantometer. Patients more than 2 years were made to stand upright with heel, buttocks, shoulder blade and occiput touching the wall, and Frankfurt plane parallel to floor. Mid-arm circumference (MAC) was taken over the left triceps, with the arm hanging by the side, a non-stretchable tape passed around the circumference of the arm at the midpoint of left arm, midway between acromion process and olecranon process. Weight for height was calculated by dividing weight of the child by ideal weight of a normal child of same height ×100. Length/height of the child was measured to the nearest cm, MAC was measured to the nearest mm; and head circumference and chest circumference were measured to the nearest 0.5 cm

Sample blood collection

Taking aseptic precaution, 3 ml of venous blood was collected in a test tube. The blood collected in a plain test tube without anticoagulant was centrifuged, and the serum obtained was used to estimate total T3 (TT3), total T4 (TT4), TSH, total proteins, and albumin. TT3, TT4, and TSH were estimated by chemiluminescence method (using IMMULITE 1000 immunoassay system-Siemens). Serum total protein was estimated by biuret method, and serum albumin was estimated by bromocresol green dye method. The data obtained were entered in MS Excel spreadsheet; the results were expressed in mean ± standard deviation (SD) for continuous variables and as percent (%) for categorical data. Data were analyzed in terms of Chi-square test. All the statistical methods were performed through SPSS for windows version 16, and $P < 0.05$ was considered statistically significant. The normal cut of values of TT3, TT4, and TSH as per the standard reference was followed.[7]

RESULTS

Total of 50 children fulfilled inclusion/exclusion criteria during study period.

The demographic profile, mean thyroid function, and protein/albumin levels are shown in [Table 1]. Mean age of presentation was 18 ± 2.1 months with male-to-female ratio 0.8:1. Sixty-two percent (31 children) of our children were <12 months.

The prevalence of hypothyroidism with raised TSH was noted in 4 (8%) of children [Table 2]; however, these children did not have any overt clinical symptoms or signs suggestive of hypothyroidism.

[Table 3] shows the relationship between thyroid profile and total protein and albumin. The relation between total proteins, serum albumin, and T4 and TSH revealed no statistical significance; however, there was significance relation between low serum albumin levels and T3 with $P = 0.019$.

Table 1: Demographic profile of SAM children (n=50).

S. No.	Variables	Results
1.	Age in months (mean)	18±2.1
2.	Gender (M: F ratio)	0.8:1
3	Socioeconomic status Class IV and V	50
4.	Clinical features (%)	
	Skin changes	7 (14)
	Tremors	11 (22)
	Constipation	2 (4)
	Psychomotor changes	42 (84)
	Coldness of extremities	7 (14)
	Hypotonia	6 (12)
5.	Mean T3 (ng/dl)	109.8±50.6
	Mean T4 (mcg/dl)	8.36±3.7
	Mean TSH (mIU/L)	2.5±1.8
6.	Mean total albumin (g/dl)	2.97±0.9
	Mean protein (g/dl)	5.5±1.4

T3: Triiodothyronine, T4: Thyroxine, SAM: Severe acute malnutrition, TSH: Thyroid-stimulating hormone

Table 2: Prevalence of hypothyroidism in SAM children (n=50).

	Low (%)	Normal (%)	High (%)
T3	11 (22)	39 (78)	-
T4	14 (28)	36 (72)	
TSH	-	46 (92)	4 (8)

SAM: Severe acute malnutrition, T3: Triiodothyronine, T4: Thyroxine, TSH: Thyroid-stimulating hormone

DISCUSSION

SAM is a multisystem disease and involves almost all organs of the body. In SAM, there will be decrease in the synthesis of serum proteins which have an indirect or direct effect on hormones levels in our body. Thyroid hormone plays an important role in regulation of lipid and carbohydrate metabolism and is necessary for normal growth and maturation.

We observed that low serum TT3 and TT4 levels were 22% and 28%, respectively, and elevated TSH in 08% children in our study. Turkay *et al*. found significant decrease in serum TT3 and TT4 in children with malnutrition with no significant increase in serum TSH concentration.[8] In other study by Sircar *et al*. lower T3 levels were found among hospitalized severely malnourished children.[9] However, Osman *et al*. observed no significant differences in TT3 and TT4 in malnourished and well-nourished children.[10] The impaired thyroid functions in our children were probably due to various mineral, micronutrient (especially iodine and selenium), amino acid deficiency, and low levels of binding proteins.

We found that low T3 was significantly associated with low albumin ($P < 0.01$). This finding was similar to the study done by Dhanjal *et al*.[11] The lowering of T3 in our children explained by the fact that lower plasma proteins consequent to dietary protein deficiency and reduced hepatic biosynthesis of these proteins. Sometimes, even vitamin deficiency usually presents in SAM and also contributes to hormone deficiency due to liver dysfunction causing decrease hepatic deiodination of T3 and T4.[12]

Eight percent of our children showed elevated TSH without any overt symptoms and signs of hypothyroidism. This could be probably due to exaggerated response to stimulation

Table 3: Relation between total proteins, serum albumin and T3, T4, TSH.

	T3		Total (n=50)	Chi-square test
	Low (n=11)	Normal (n=39)		
Low total protein	5 (45.45)	13 (33.33)	18 (36)	P=0.459
Low serum albumin	7 (63.64)	10 (25.64)	17 (34)	P=0.019 (Sig.)
	T4		**Total (n=50)**	**Chi-square test**
	Low (n=14)	**Normal (n=36)**		
Low total protein	7 (50)	11 (30.56)	18 (36)	P=0.198
Low serum albumin	7 (50)	10 (27.78)	17 (34)	P=0.13
	TSH		**Total (n=50)**	**Fischer Exact test**
	Low (n=4)	**Normal (n=46)**		
Low total protein	2 (50)	16 (34.78)	18 (36)	P=0.543
Low serum albumin	1 (25)	16 (34.78)	17 (34)	P=0.692

T3: Triiodothyronine, T4: Thyroxine, TSH: Thyroid-stimulating hormone

by thyrotropin-releasing hormone or more of impaired catabolism of TSH due to SAM.[13] Although serum TT3 and TT4 levels were decreased with elevated TSH levels in a few of our children, still they did not appear clinically hypothyroid. This is probably an adaptive change to malnutrition, which at least enables the sick patient to conserve protein.

The limitations of our study were less sample size, and TBG, TBPA, and free T4 levels were not estimated in the present study which could have been more informative.

CONCLUSION

The impaired thyroid function and low serum T3 levels seen in SAM children were probably an adaptive change to malnutrition which enables the sick patients to conserve protein.

Declaration of patient consent

Institutional Review Board (IRB) permission was obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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