地中海貧血病兒蛋白質 —— 能量不足的原因

Causes of inadequate protein-energy status in thalassemic children

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Height-for-age, weight-for-age, triceps skinfold thickness (TST), mid upper arm circumference (MUAC), and mid upper arm muscle circumference (UAMC) were determined in 47 thalassemic children, ages ranging from 4– 5 years. Their mean (±SEM) height-for-age, weight-for age, TST, MUAC, and UAMC were 90.51±0.98, 79.91±2.33, 88.01±1.26, 83.02±1.37 and 80.09±1.59% of standard values. Based on height-for-age of less than 95% of standard values and weight-for-age, TST, MUAC, and UAMC of less than 90% of standard values, the prevalences of protein-energy malnutrition (PEM) in these thalassemic children were 72.3, 74.5, 53.7, 75.6 and 82.9%, respectively. The causes of their inadequate protein-energy status were due to: (a) chronic hypoxia evidenced by the significantly positive correlations between haemoglobin levels and height-for-age (r=0.65, $P<0.001$), weight-for-age (r=0.58, $P<0.001$), MUAC (r=0.67, $P<0.001$) and UAMC (r=0.63, $P<0.001$); (b) zinc deficiency evidenced by significantly positive correlations between plasma zinc levels and height-for-age (r=0.26, $P<0.05$), MUAC (r=0.41, $P<0.005$), and UAMC (r=0.41, $P<0.005$) and significantly negative correlation between urinary zinc levels and UAMC (r=0.34, $P<0.02$); and (c) low energy intake, ie 65% of the mean recommended energy intake.

Introduction

Our previous study has shown that inadequate protein-energy status exists in thalassemic children[1]. It is the purpose of this study to investigate the effects of anaemia, zinc status and protein-energy intake on their protein-energy status.

Patients and methods

The study was conducted in 11 children with Hb H disease, 26 children with β-thalassemic/Hb E disease, 10 children with β-thalassemia major and 10 healthy children. Their age ranged from 4–15 years. Their dietary intake was assessed by a 24-hour dietary record[2,3]. Their body composition was measured by height-for-age, weight-for-age, mid upper arm circumference (MUAC), triceps skinfold thickness by Harpenden skinfold caliper, and mid upper arm muscle circumference (UAMC)[4]. Percent standard (%std) of height-for-age, weight-for-age, TST, MUAC and UAMC were derived from the reference values[4,5]. Protein-energy malnutrition (PEM) was considered when their height-for-age was less than 95% std or other anthropometric parameter was less 90% std.

Venous blood was obtained from healthy and thalassemic children after an overnight fast for the determination of Hb and mean corpuscular volume (MCV) by an electronic counter, Linson 430 Hematology System (Linson Instrument, Stockholm, Sweden) and zinc levels in plasma and red blood cells (RBC) by a flame atomic absorption spectrophotometer[6,7]. (Varian Techtron Pty Ltd, Springvale, Australia). A 24-h urine sample preserved with concentrated HCl was also collected from each subject for the determination of zinc.

Statistical analysis was based on Student's t-test (2-tailed) and linear regression analysis[8].

Results

Table 1 shows inadequate protein-energy status existing in thalassemic children. Table 2 shows that all thalassemic children had significantly lower Hb, MCV and erythrocyte zinc levels than those in healthy children, whereas opposite results were observed for urinary zinc levels. Plasma zinc levels in children with β-thalassemia/Hb E disease and β-thalassemia major were also significantly lower than that in healthy children. Table 3 shows their dietary intake. Table 4 shows relationships between various biochemical and anthropometric parameters.

Table 1. Anthropometric parameters and prevalences of PEM in 47 thalassemic children.

Parameter	Mean±SEM	Prevalence of PEM
Height-for-age	90.51±0.98	72.3
Weight-for-age	79.91±2.33	74.5
TST	88.01±1.26	53.7
MUAC	83.02±1.37	75.6
UAMC	80.09±1.59	82.0

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Table 2. Haematological and zinc status in healthy and thalassemic children.

Children	Mean±SEM				
	Hb g/dl	MCV fl	Plasma Zn µg/dl	RBC Zn µg/gHb	Urine Zn µg/d
Healthy	14.8±0.3	81.5±1.5	118±5	91±3	322±19
Hb H disease	9.0±0.4[a]	66.7±2.2[a]	116±5	73±4[a]	453±30[b]
β-thalassemia/Hb E disease	6.5±0.3[a]	69.8±1.6[a]	98±3[a]	75±2[a]	618±32[a]
β-thalassemia major	7.7±1.1[a]	79.2±3.2[a]	95±5[b]	54±2[a]	768±36[a]

Significantly difference from healthy children: [a]$P<0.001$, [b]$P<0.005$.

Table 3. Age and dietary energy intake in thalassemic children.

Parameter	Mean±SEM		
	Hb H disease	β-thalassemia/ Hb E	β-thalassemia major
Age (years)	9.17±0.67	8.17±0.50	7.25±1.17
Energy (kcal)	1045±47	1063±65	1031±89
Protein (g)	39.4 ±3.5	35.0±2.6	35.6±3.2
Animal:plant protein	70:30	72:28	74:26
Fat (g)	41.5±5.2	48.1±3.9	42.6±5.2
Carbohydrate (g)	112.1±10.9	111.2±9.6	89.4±11. 1

Table 4. Relationships between biochemical and anthropometric parameters in healthy and thalassemic children.

X	Y	Y=a+bx	r	df	t	*P*
Hb	Height-for-age	80.83+1.30x	0.65	55	6.32	<0.001
Hb	Weight-for-age	60.88+2.61x	0.58	55	5.23	<0.001
Hb	MUAC	70.53+1.78x	0.67	49	6.64	<0.001
Hb	UAMC	66.89+1.94x	0.63	49	5.75	<0.001
Plasma Zn	Height-for-age	81.29+0.11x	0.26	55	2.02	<0.05
Plasma Zn	MUAC	61.61+0.23x	0.41	49	3.14	<0.005
Plasma Zn	UAMC	54.21+0.27x	0.41	49	3.18	<0.005
Urinary Zn	UAMC	93.93–0.02x	–0.34	46	–2.42	<0.02

Discussion

Our thalassemic children had inadequate protein-energy status evidenced by their mean height-for-age and weight-for-age being lower than 95 and 90% std values[5] and their somatic protein status was more affected than energy store supported by more prevalence of PEM based on UAMC than that based on TST (Table 1). Their low Hb and MCV are consistent with the established hematologic findings in thalassemia[9]. Kattamis et al.[10] have shown that growth of thalassemic children during the first decade largely depends upon the maintenance of fairly normal Hb levels. This implies that hypoxia is the main factor retarding growth. This is also observed in our study evidenced by the significantly positive correlations between Hb levels and height-for-age, weight-for-age, MUAC and UAMC (Table 4).

Low plasma and erythrocyte zinc levels in our thalassemic children also indicate their inadequate zinc status (Table 2). Our results agree with the previous reports[11,12]. The plausible cause of their zinc deficiency is hyperzincuria (Table 2) due to the release of zinc from hemolyzed red blood cells supported by the significantly negative correlation between urinary and erythrocyte zinc levels (y=104.14–0.05x, r=–0.70, df=51, t=–6.9, $P<0.001$). Impaired growth is one of the clinical manifestations in human zinc deficiency[13]. Thus zinc deficiency may be another factor affecting their growth evidenced by the significantly positive correlations between plasma zinc levels and height-for-age, MUAC and UAMC as well as significantly negative correlation between urinary zinc levels and UAMC (Table 4).

The current recommended daily dietary allowances (RDA) for energy and protein intakes in normal Thai children are 1600 kcal and 26.0 g, respectively. Thus the average energy intakes of our thalassemic children were 65% of the mean RDA whereas their protein intake was adequate (Table 3). Their inadequate energy intake may affect efficient utilization of dietary protein for growth and maintenance[14].

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