Oxidative Stress and Zinc Status in Children with β-Thalassemia Major and its Relation to Growth Retardation

Prof.Magdy Karam Eldean Ali Professor of Preventive Medicine and Epidemiology Institute of Postgraduate Childhood Studies Ain Shams University
Prof.Hayam Kamal Nazif Professor of Pediatrics Medical Studies Department Institute of Postgraduate Childhood Studies Ain Shams University
Prof.Manal Mohamed Abdel Aziz Professor of Clinical Pathology Ain Shams University
Nermein Gamal Eldean Abdel Hameed

Abstract

Objective: The objective of the present study was to assess oxidative stress and zinc status and its relation to growth retardation in children with β- thalassemia major.

Methodology: This study was carried out on 50 β- thalassemia major children recruited from the Hematology clinic, Children's Hospital, Ain Shams University, their ages ranged from 5 to 12 years with a mean of 8.5±2.3, from both sexes and 50 healthy children as a control group, from December 2010 to December 2012. Patients were subjected to full history taking and thorough clinical examination, height for age, weight for age and BMI for age were taken as parameters for auxological assessment using the Egyptian growth charts and Tanner staging for assessment of pubertal development. In addition detection of hemoglobin concentration, serum ferritin, serum ALT and serum zinc were carried out. Furthermore the evaluation of serum Malondialdehyde as a diagnostic marker of oxidative stress was done. Data about Hb electrophoresis was obtained from patients records.

Results: There was a non significant statistical difference between β- thalassemia major children and control group as regards age, sex. There was a significant decrease in height for age, weight for age and BMI for age, Tanner staging, hemoglobin concentration and serum zinc in β- thalassemia major patients compared to control group, and a significant increase in serum ferritin, serum ALT and serum Malondialdehyde in β- thalassemia major patients compared to control group.

There was a significant decrease in height for age, weight for age and BMI for age, Tanner staging and serum zinc in β- thalassemia major patients with short stature compared to β- thalassemia major patients with normal stature, and a significant increase in duration of illness, serum ferritin and serum Malondialdehyde in β- thalassemia major patients with short stature compared to β- thalassemia major patients with normal stature.

Conclusion: There was a significant positive correlation between serum MDA level and serum ferritin in β- thalassemia major patients and a significant negative correlation between serum zinc level and serum ferritin in β- thalassemia major patients.

إجهاد التأكسد وحالة الزنك فى الأطفال مرضى أنيميا البحر المتوسط وعلاقتهما بتأخر النمو

خلفية: يعتبر الزنك من أهم المعادن التى توجد فى بعض الأطعمة ويساهم فى العديد من عمليات الأيض الخلوى ويدعم النمو والتطور الطبيعى للطفل، ومرض الثلاسيميا هو فقر الدم الوراثى الناتج عن خلل فى تصنيع الهيموجلوبين، وبيتاثلاسيميا هى النوع الناتج عن نقص تصنيع سلسلة (البيتاجلوبين) تؤثر فى العديد من أعضاء الجسم وتكون مصحوبة بنسبة عالية من المرضية الشديدة والوفاة، ويعتبر مرض أنيميا البحر المتوسط من أشهر أسباب أنيميا التكسير الدموى فى مصر ويترتب عليها اضطراب النمو لدى هؤلاء المرضى، ويعتبر نقص الزنك واحداً من أهم العوامل المؤدية إلى اضطراب النمو والبلوغ لدى هؤلاء المرضى، ويلعب الإجهاد التأكسدى دوراً كبيراً كعامل مؤدى إلى تأخر النمو لدى هؤلاء الأطفال.

الهدف: هدفت الدراسة إلى تقييم مدى اجهاد التأكسد وحالة الزنك وعلاقتهما بتأخر النمو فى الأطفال مرضى أنيميا البحر المتوسط.

المنهجية: أجريت هذه الدراسة على عدد (٥٠) من مرضى أنيميا البحر المتوسط (نوع بيتا) المترددين على عيادة أمراض الدم بمستشفى الأطفال الجامعى بجامعة عين شمس، وأيضاً على نفس العدد من الأطفال الطبيعيين الأصحاء. وتم أخذ التاريخ المرضى للمرضى والفحص الإكلينيكى الشامل وعمل القياسات البدنية وكذلك قياس نسبة الهيموجلوبين بالدم، وكذلك نسبة الفيرتين ووظائف الكبد ونسبة الزنك بالإضافة إلى قياس نسبة (مالونديالديهيد) الناتج الرئيسى عن تأكسد الأحماض الدهنية غير المشبعة.

النتائج: وأثبتت النتائج وجود تأخر فى النمو وعلامات البلوغ لدى هؤلاء المرضى بمقارنتهم بالأطفال الطبيعيين. وكذلك أثبتت وجود نقص فى نسبة الزنك بالدم لديهم وإرتفاع نسبة (مالونديالديهيد). وايضاً أثبتت وجود علاقة طردية بين نسبة الزنك بالدم ومستوى الطول. وكذلك وجود علاقة عكسية بين نسبة (مالونديالديهيد) ومستوى الطول، كما وجدت علاقة طردية بين نسبة الفيرتين بالدم ونسبة (مالونديالديهيد).

الاستنتاجات: استنتجت الدراسة أهمية الزنك كعامل مضاد للتأكسد لدى الأطفال مرضى أنيميا البحر المتوسط، وكذلك كعامل مساعد للنمو والتطور لدى هؤلاء الأطفال.

الكلمات المفتاحية: أنيميا البحر المتوسط (بيتا ثلاسيميا) – الإجهاد التأكسدى– تأخر النمو– مالونديالديهيد– الزنك.

Introduction:

Thalassemia is a hereditary anemia resulting from defects in hemoglobin production. β- thalassemia, which is caused by a decrease in the production of β- globin chains, affects multiple organs and is associated with considerable morbidity and mortality. Accordingly, lifelong care is required, and financial expenditures for proper treatment are substantial (Rund and Rachmilewitz, 2005).

Growth disturbances are a major clinical feature of untreated patients with thalassemia (Saxena, 2003). Zinc deficiency is considered to be one of the main factors contributing to growth and puberty disorders in thalassemic patients, it is due to the hyperzincuria under the influence of chelating agents (Arcasoy et al., 2001).

Repeated blood transfusion in beta thalassemia major patients may lead to peroxidative tissue injury by secondary iron overload. Oxidative stress and reduced antioxidant defense mechanism play an important role in pathogenesis of beta thalassemia major (Rahul et al., 2008).

In spite of the iron overload, oxidants originate from sources other than the iron loaded tissues. In β- thalassaemia the excess unpaired α- haemoglobin chains denature and autoxidise, contributing to increased oxidants, ineffective erythropoiesis, haemolysis and shortened erythrocyte survival (Scott et al., 1993). Biomarkers of oxidative damage are increased in thalassaemia (Repka and Hebbel, 1991).

Lipid peroxidation products as malondialdehyde (MDA), nitric oxide (NOx), superoxide dismutase (SOD), glutathione (GSH), and glutathione peroxidase (GPx) are elevated in thalassaemia (Cighetti etal., 2002). Malondialdehyde (MDA) is the principal and most studied product of polyunsaturated fatty acid peroxidation.

This aldehyde is a highly toxic molecule and should be considered as more than just a marker of lipid peroxidation. Its interaction with DNA and proteins has often been referred to as potentially mutagenic and atherogenic (Rioa et al., 2005).

Aim Of The Study:

The objective of the study was to assess oxidative stress and zinc status and its relation to growth retardation in children with β- thalassemia major.

Subjects And Methods:

The present study is a cross sectional study which was conducted at the Hematology clinic, Children's Hospital, Ain Shams University. It included fifty children suffering from β- thalassemia major selected according to the following inclusion criteria Patients (Group 1), from December 2010 to December 2012.

- Inclusion Criteria:
  1. Age range 5-12 years.
  2. Males and females are included.
  3. Clinical and laboratory diagnosis of β- Thalassemia Major.
  4. Patients on blood transfusion therapy.
- Exclusion Criteria:
  1. Patients with other chronic diseases.
  2. Other causes of zinc deficiency as (Crohns disease, Wilsons disease, cystic fibrosis, parasitic infections, inflammatory bowel disease, diabetes, collagen diseases, renal diseases).
  3. Patients who refuse to cooperate.
  4. Failure to obtain parents consent.
  5. Other causes of oxidative stress such as, heart disease, renal disorders, chronic lung diseases, malignancy and diabetes mellitus.

The present study also included fifty age and sex matched healthy children serving as control subjects (Group 2).

All participating thalassemia major children and control subjects were subjected to:

1. Thorough medical history: Laying stress on age of diagnosis, history of splenectomy, frequency of transfusion, chelation therapy and its type, duration, dose and compliance to chelation therapy (Patient with less adherence to the instrucuions given by the hematologist were considered noncompliant) (David and Lowrence, 2006).
2. Thorough Medical Examination Included:
   a. General Examination: Laying stress on signs of diseases mentioned in the (exclusion criteria).
   b. Systemic Examination: Laying stress on gastrointestinal, cardiovascular, Chest as well as neurological examination laying stress on hair fall, skin lesions, delayed healing of wounds, stunting, and organomegaly.
3. Auxological assessment: Assessment of growth using:
   a. Height for age: Measured against an appropriate stabiometer and recorded to the nearest 0.1 Cm.
   b. Weight for age: measured using self calibrating scale (SEKA scale) that records to the nearest 0.1 Kg.
   c. BMI for age: Calculated at weight (Kg/ Height) (m^2).
   d. Puberty was assessed by rating breast development in girls and genitalia development in boys.

   Using the Egyptian growth percentile charts and Tanner staging criteria for assessment of pubertal development (Pediatric Endocrinology, second edition, 1992).
4. Laboratory Investigations, Determination of Hemoglobin concentration, serum ferritin, serum ALT, serum zinc using Atomic absorption technique (Fernandez and Khan, 1971), Serum (Malondialdehyde) using colorimetric method (Johnston et al., 2007).

Statistical Analysis:

The collected data was revised, coded, tabulated and introduced to a PC using Statistical Package for Social Science (SPSS 15.0.1) for windows; SPSS Inc, Chicago, IL, 2001).

Numerical data are presented as means ± standard deviations. Differences were considered significant when p value <0.05. All factors were tested for their distribution model and, in case of normal distribution one- way ANOVA to compare means. We considered the Mann- Whitney test, when distributions were not normal. Spearman or Pearson has been expressed to show correlations. T test for independent samples.

Results:

Results of the study showed a significant decrease in serum zinc and a significant increase in serum Malondialdehyde compared to control subjects with a significant negative correlation between both parameters. 50% of patients were below 3rd height centile (short stature) while 0% of controls subjects were below 3rd height percentile. There was a significant positive correlation between serum zinc level and the height percentile and a significant negative correlation between serum Malondialdehyde and height percentile among β- thalassemia major patients.

Table (1): Comparison between β- thalassemia major patients and control group as regards main descriptive and anthropometric data

Clinical Data	β- thalassemia major patients (n= 50)		Control Group (N= 50)		T- Test	P- Value
	Range	Mean ± SD	Range	Mean ± SD		
Age (Y)	5-12	8.5±2.3	6- 12	9.0±4.8	1.6	>0.05***
Height (Cm)	107-146	128.4±11.2	111- 149	130±3.6	2.01	<0.05*
Height SDS	- 4.92-1.79	- 1.23±1.12	1.1- 2.1	1.5±0.3	1.9	<0.05
Weight (Kg)	20-39.5	28±5.5	17- 38	26±6.3	5.8	<0.01**
Weight SDS	- 2.93- 3.42	- 0.67±1.17	1.8- 2.3	2.1±0.1	3.1	<0.05
BMI (Kg/m2)	9.8-18.3	15.4±2.4	13- 25	16.7±2.2	1.77	<0.05*
Bmi Sds	- 2.48- 2.81	- 0.16±0.93	1.4- 2.1	1.7±0.2	2.1	<0.05

BMI: Body mass index SDS: standard deviation score
* Significant P<0.05 ** Highly significant P< 0.01 *** Non significant P>0.05

Table (1) shows that height, weight and BMI and their standard deviation scores were statistically significantly lower among β- thalassemia major patients compared to control group (p<0.05 and p<0.01) while there was no statistically significant difference regarding age among both groups.

Table (2): Comparison between β- thalassemia major patients and control group as regards height for age centiles

Height Centile		β- thalassemia major patients (n= 50)	Control group (n= 50)
Below 3rd	No	25	0
	%	50.0%	0.0%
3rd- 5th	No	3	0
	%	6.0%	0.0%
5 Th- 10 Th	No	5	0
	%	10.0%	0.0%
10 Th- 25 Th	No	3	10
	%	6.0%	20.0%
25 Th- 50 Th	No	1	33
	%	2.0%	66.0%
50 Th- 75 Th	No	13	7
	%	26.0%	14.0%
75 Th- 90th	No	0	0
	%	0.0%	0.0%
90 Th- 95 Th	No	0	0
	%	0.0%	0.0%
95 Th- 97th	No	0	0
	%	0.0%	0.0%
Above 97th	No	0	0
	%	0.0%	0.0%
χ2		68.687	
P- Value		0.000**	

χ2: Chi- Square test. ** Highly significant P<0.01

Table (2) shows that the height for age centiles of β- thalassemia major patients were statistically highly significantly lower (p< 0.01) compared to control group.

Table (3): Classification of β- thalassemia major patients and control group according to pubertal stage

Pubertal Stage	β- thalassemia major patients (n= 50)		Control group (n= 50)		χ2	P- Value
	No	%	No	%		
Tanner 1	35	70	21	42%	22.727	<0.05*
Tanner 2	13	26%	20	40.0%	54.674	<0.05*
Tanner 3	2	4%	9	18.0%	78.472	<0.01**

*Significant P<0.05 ** Highly significant P<0.01
χ2: Chi- Square test.

Table (3) shows that number of patients in stages 2 and 3 were more in control group than patient group and the difference was statistically significant.

Table (4): Comparison between β- thalassemia major patients and control group aging (10- 12) years as regards pubertal staging

Puberty		β- thalassemia major patients (n= 28)	Control Group (n= 18)
Delayed Puberty	No	13	0
	%	46.4%	0.0%
Normal Puberty	No	15	18
	%	53.6%	100.0%
Chi- Square	χ2	11.649	
	P- Value	0.001**	

χ2: Chi- Square test. ** Highly significant P<0.01

Table (4) shows that pubertal staging was highly statistically significantly lower among β-thalassemia major patients compared to control group (p< 0.01).

Table (5): Comparison between β- thalassemia major patients and control group as regards serum zinc and MDA levels

Laboratory Data	β- thalassemia major patients (n= 50)		Controls (n= 50)		T- Test	P- Value
	Range	Mean±SD	Range	Mean±SD		
Serum Zinc (µg/Dl)	21- 96	35.5±18	69-128	104.5±19	5.8	<0.01**
Serum MDA (nmol/ mL)	14- 49	34±8.7	6-22	11.3±3.4	2.3	<0.05*

* Significant P<0.05 ** Highly significant P<0.01
Normal reference range of serum zinc: 70-110 µg/dl (Gibson RS., 1990)
Normal Mean±SD of serum MDA: 6-20.4 nmol/mL (Bhutia et al., 2011)

Table (5) shows that serum zinc was statistically significantly lower among β- thalassemia major patients compared to control group while serum MDA was statistically significantly higher among β- thalassemia major patients compared to control group (p< 0.01 and p< 0.05).

Table (6): Comparison between β- thalassemia major patients with normal stature and β- thalassemia major patients with short stature as regards laboratory data

Laboratory Data	Short stature (n= 25)		Normal stature (n= 25)		T-Test	P- Value
	Range	Mean±SD	Range	Mean±SD		
Hb (g/dl)	5.7- 9.1	7.5±. 85	5-8	7.2±1.08	1.3	>0.05*
Hb F%	61.9- 92	75.7±9.7	63-92	76.6±9.0	2.5	>0.05*
Serum ALT (U/L)	16.00- 753	384.5±20.8	17-572	294.5±23.9	0.7	>0.05*
Serum Ferritin (µg/L)	1963- 8000	4947.2±16.7	897-6194	2975.2±18.7	5.7	<0.01**

* Non significant P>0.05 ** Highly significant P< 0.01
Short stature: height for age < 3rd percentile.
Normal stature: height for age >3rd percentile, <97th percentile.

Table (6) shows that serum ferritin was statistically significantly higher among β- thalassemia major patients with short stature compared to β- thalassemia major patients with normal stature (p< 0.01) while there were no statistically significant differences regarding fetal hemoglobin%, hemoglobin concentration and serum ALT among both groups.

Table (7): Comparison between β- thalassemia major patients with normal stature and β- thalassemia major patients with short stature as regards serum zinc and MDA

Laboratory Data	Normal stature β- thalassemia major patients (n= 25)		Short stature β- thalassemia major patients (n= 25)		T- Test	P- Value
	Range	Mean±SD	Range	Mean±SD		
Serum Zinc (µg/Dl)	25- 96	44.7±23.13	21-41	27.3±4.8	4.6	<0.001**
Serum MDA (nmol/mL)	14- 42	29.2±9.54	28-49	38.1±5.4	2.0	<0.05*

*Significant P<0.05 ** Highly significant P<0.01

Table (7) shows that serum zinc was statistically significantly lower among β- thalassemia major patients with short stature compared to those of normal stature and that serum MDA was statistically significantly higher among β- thalassemia major patients with short stature compared to those of normal stature.

Table (8): Comparison between β- thalassemia major patients with delayed puberty and β- thalassemia major patients with normal puberty as regards serum zinc and MDA

Laboratory Data	Delayed puberty β- thalassemia major patients (n= 37)		Normal puberty β- thalassemia major patients (n= 13)		T- Test	P- Value
	Range	Mean±SD	Range	Mean±SD		
Serum Zinc (µg/Dl)	22- 35	38.31± 1.4	21-99	54.12± 5.2	4.9	<0.01**
Serum MDA (nmol/mL)	30- 46	36.81± 8.7	12-49	27.62± 1.85	3.3	<0.05*

*Significant P<0.05 ** Highly significant P<0.01

Delayed puberty β- thalassemia major patients: prepubertal β- thalassemia major patients aging (10- 12) years.

Table (8) shows that serum zinc is statistically significantly lower among β- thalassemia major patients with delayed puberty compared with β- thalassemia major patients with normal puberty and that serum MDA is statistically significantly higher among β- thalassemia major patients with delayed puberty compared with β- thalassemia major patients with normal puberty.

Table (9): Correlation between serum Zinc and serum MD A among β- thalassemia major patients

Laboratory Data	r	P- Value
Serum MDA (nmol/mL)	- 0.88	<0.05*

r: pearson correlation *Significant P<0.05

Table (9) shows that there was a significant negative correlation between serum MDA and serum Zinc among β- thalassemia major patients (p< 0.05).

Table (10): Correlation between height centile and both of serum zinc and Serum MDA among β- thalassemia major patients

Height Centile	r	P- Value
serum Zinc (µg/dl)	0.943	<0.05*
Serum MDA (nmol/mL)	- 0.909	<0.05*

r: pearson correlation *Significant P<0.05

Table (10) shows that there was a significant positive correlation between serum zinc and height centile among β- thalassemia major patients (p< 0.05) and a significant negative correlation between serum MDA and height centile among β- thalassemia major patients (p< 0.05).

Discussion:

In the present study, there was a significant statistical difference of height between both groups, it was statistically lower in beta thalassemia major patients (mean height for age SDS 118.4± 11.2 cm) compared to control subjects (mean height for age SDS 130± 3.6 cm). 50% of patients were below 3rd height centile (short stature) while 0% of controls subjects were below 3rd height centile.

The previous results can be interpreted as; 50% of were growth retarded and there was no statistical significant difference between beta thalassemia major children with short stature and beta thalassemia major children with normal stature as regards age and sex.

The results of the present study agreed with the studies done by De Sanctis et al. (2004) who documented that growth retardation is a major problem in beta thalassemia major children as they reported that short stature was present in 31.1% of patients.

Several studies attributed failure of physical growth in beta thalassemia major patients to be a result of chronic anemia, oxidative stress, zinc deficiency, folate deficiency, hypersplenism, endocrine disorders (hypogonadism, hypothyroidism, Growth hormone deficiency), chronic liver disease, iron overload and desferrioxamine (DFO) toxicity (Albu et al. 2009), (Kyriakou and Kordis, 2009).

The results of the present work showed that mean serum ferritin level in beta thalassemia major children with short stature (4947.2± 1607.7 ng/ ml) was significantly higher than those with normal stature (2975.2± 1897.7 ng/ml).

Also, Shalitin et al. (2005) and Albu et al. (2009) documented that serum ferritin level is a predictor of impaired growth and puberty in thalassemia major patients. Growth failure appears mainly in subjects who have or have had very high serum ferritin levels. Iron overload, had for a long time been considered to be a major cause of endocrine abnormalities in thalassemia major.

In the present study, mean serum zinc level in beta thalassemia major children (35.5±18 µg/dl) showed a significant decrease (p<0.05) relative to control group (104.5±19 µg/dl). Zinc deficiency in beta thalassemia major is attributed to hyperzincuria which may be due to cirrhotic changes owing to hemosiderosis or to an increased rate of glomerular filtration of zinc seen in chronic hemolysis (Rahul et al. 2008).

These results agree with the study done by Nasr et al. (2002) that showed that there was a significantly lower level of serum zinc in thalassemic population than that in normal children where serum zinc level was (88.3±17.7 µg/dl) vs. (113.5±15.4 µg/dl) respectively.

Similarly, Bekheirnia et al. (2004) also reported that low serum zinc level was found in 84.8% (in 44.7% severely low) beta thalassemia major children compared to the healthy control subjects.

Sharply contrasting with these findings, Mansi et al. (2009) reported that mean serum zinc level in beta thalassemia major children was significantly higher than that in normal children (p<0.05). These finding were explained by the decreasing rate of glomerular filtration of zinc seen in chronic hemolysis and the disturbance in the metabolism of zinc in thalassaemic patients.

On the other hand, Morshed et al. (2012) reported that the mean serum zinc level of beta thalassemia group was almost identical with that of the control group (97.4±18.4 µg/dl) vs. (99.6±18.7 µg/dl).

In the present study, the mean serum zinc of of beta thalassemia major children with short stature (27.3±4.8U/L) was significantly lower than those of normal stature (44.7±23.1U/L) probably due to hyperzincuria due to the release of zinc from hemolysed red cells (Shazia et al. 2012).

This agrees with Fikry et al. (2003), who detected a positive correlation between serum zinc level and height for age.

The results of the present work showed a significant negative correlation between the serum zinc level and the serum ferritin level among beta thalassemia major children.

This was documented also by, Yazdiha et al. (2003) who performed a study on 77 beta thalassemia major children (7- 12) years old, they demonstrated a significant negative correlation between the serum zinc level and the serum ferritin level.

On the contrary, Mahyar et al. (2010) reported that beta thalassemia major patients had zinc deficiency but with no significant correlation with serum ferritin.

The results of the present study showed a significant positive correlation between the serum zinc level and the height percentile among beta thalassemia major children, this means that zinc deficiency may be a growth limiting factor of linear growth of thalassemia major patients. This can be interpreted by the fact that somatomedins mediate growth by contributing to the effect of growth hormone and they require zinc to be synthesized in liver (Faranoush et al. 2008).

These results go along with a study done by (Faranoush et al. 2008) who found that linear growth in thalassemia major patients who received zinc supplementation is equal to that of normal healthy children.

On the contrary a study done by Fikry et al. (2003) reported that there was no significant correlation between serum zinc level and height.

In the present study, serum MDA in beta thalassemia major children showed a significant increase ($p<0.05$) relative to control group. As absence of beta globin chains leads to accumulation of unpaired alpha globin chains. Excess presence of the alpha globin chains is a primary reason for the cellular oxidative damage and also iron overload. As a result of both high plasma iron and high intracellular non- hemoglobin iron in beta thalassemia, there is an enhanced generation of ROS. Moreover, repeated blood transfusion causes iron overload which increases free radical production and peroxidative damage of tissues. In such condition, depletion of endogenous antioxidants may be detected. Peroxidative damage of lipids is indicated by the increase in serum MDA levels (Rahul et al. 2008).

This is further supported by Hussein (2010) who detected a highly significant increase in MDA in beta thalassemia major children compared to control group.

In the present study, the mean serum MDA of beta thalassemia major children with short stature (38.1±5.4U/L) was significantly higher than those with normal stature (29.2±9.5U/L).

This was documented also by De Sanctis (2002) who reported that short stature is the commonest endocrine and auxological complication. The anterior pituitary gland is particularly sensitive to free radical oxidative stresses leading to Growth hormone deficiency, according to their study, thalassaemic patients may benefit from GH treatment.

A positive correlation between serum MDA and serum ferritin in the current study was documented by Naithani et al. (2006).

This goes along with a study done by Meerang et al. (2009) who found that iron overload in thalassemia patients can stimulate lipid peroxidation.

However, Gunarsih et al. (2012) reported that there was no correlation between serum MDA and serum ferritin among beta thalassemia major children.

In the present study, There was a significant negative correlation between serum MDA and serum Zinc among beta thalassemia major children. This can be explained by the increase in the generation of free radicals and lipid peroxidation in blood caused by zinc deficiency (Bao et al. 2010).

These results agree with the study done by Patne et al. (2012) who concluded that in patients with beta thalassemia major there is impairment of antioxidant enzymes and trace elements (especially serum zinc) associated with elevated plasma levels of lipid peroxidation (indicated by increase in serum MDA).

On the contrary, in a study done by Rahul et al. (2008), they found that there was no correlation between serum MDA and serum Zinc among 72 beta thalassemia major children as they found a significant increase in the lipid peroxidation (indicated by the increased serum MDA level) and the serum zinc level was significantly increased.

Conclusion:

The current study demonstrated that β- thalassemia major patients showed a significant decrease in height and weight percentiles compared to control subjects. β- thalassemia major patients showed a significant decrease in serum zinc and a significant increase in serum MDA compared to control subjects with a significant negative correlation between both parameters. There was a significant negative correlation between serum zinc and serum ferritin in β- thalassemia major patients and a significant positive correlation between serum MDA and serum ferritin in β- thalassemia major patients.

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