Linear Growth in Homozygous β-Thalassemia and β-Thalassemia/Hemoglobin E Patients Under Different Treatment Regimens

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Abstract

The effects on linear growth and development among thalassemic patients under different treatment regimens were compared. Twelve homozygous β-thalassemia (homozygous β-thal) and 36 β-thalassemia/Hb E (β-thal/Hb E) were studied longitudinally between 1977 and 1998. Eighteen cases (10 homozygous β-thal and 8 β-thal/Hb E) received hypertransfusion with iron chelation by desferrioxamine. Another 30 cases (2 homozygous β-thal and 28 β-thal/Hb E) were given a low transfusion (depending on their clinical requirement). Their heights were measured serially and are presented as a standard deviation score (SDS). There was no significant difference in initial basic hematological data and ferritin levels between either group. However, the hypertransfused group, seemed to be clinically more severely affected than the other group as evidenced by early age at initial transfusion, the early onset of anemia and diagnosis and also their large acquired iron load after a period of transfusion.

The average height SDS of the hypertransfused patients was within the 50th percentile ± 1 SD during the first decade of life in both sexes and both genotypes. Whereas, in patients who were transfused infrequently, the SDS was always below the -1 SD and decreased gradually. In severe β-thal/Hb E cases, their growth SDS showed no difference from those with homozygous β-thal.

Normal linear growth in those with homozygous β-thal and severe β-thal/Hb E was only seen in the group that underwent hypertransfusion and this regimen contributed to normal growth during the first ten years of life. However, adequate iron chelation and hormonal treatment in these patients were also required in order to achieve normal adult height.

Key word : Linear Growth, Homozygous β-thalassemia, β-thalassemia/Hb E, Blood Transfusion, Iron Chelation

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J Med Assoc Thai 2001; 84: 929-941

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Growth retardation and delay or absence of pubertal development are common findings in untreated thalassemic patients, especially those with homozygous β-thal. Chronic hypoxia[1,2] and hormonal dysfunction such as growth hormone and sex steroids have been implicated as the cause in these patients, but other factors that could adversely influence growth have also been suggested[3-5].

Early, regular (maintenance) blood transfusion aims to keep the hemoglobin (Hb) level of thalassemic patients in the normal range with a mean Hb of 12 g/dL[6]. This transfusion regimen can prevent hypoxemia, reduces compensatory bone marrow hyperplasia, prevents many consequences due to anemia and promotes normal physical activity and growth. However, recent evidence from many studies still demonstrates interference in growth and pubertal development[7-9], especially in adolescents who have undergone multiple transfusions for β-thalassemia. Iron overload due to multiple blood transfusions and the toxic effects of desferrioxamine therapy on spinal cartilage[10] have been suggested as possible causes of linear growth failure.

In Thailand, due to the high prevalence of thalassemia (thal) and other hemoglobinopathies, interaction of these abnormal genes has led to more than 60 reported genotypes of the thalassemia syndrome[11-13].

The most common beta-thalassemia syndrome in Thailand and other countries in this region is β-thal/Hb E disease with an estimated 97,500 patients in Thailand. Nevertheless, the natural history and clinical course of this syndrome is still unclear due to its genetic heterogeneity and many factors that modify its phenotype[14].

There are few reports in the literature concerning growth and its disturbance in this type of thalassemia as well as the effects of transfusion on linear growth in such patients[15-21].

In this study, the effects on growth under different transfusion and iron chelation regimens were retrospectively and longitudinally investigated in two types of transfusion dependent thalassemia i.e. homozygous β-thal and β-thal/Hb E disease.

PATIENTS AND PROFILE

This study included 12 patients with homozygous β-thal (8 males and 4 females) and 36 patients with severe β-thal/Hb E (18 males and 18 females) who registered between 1978 and 1994 and were regularly followed at the Thalassemia Clinic, Department of Pediatrics, Faculty of Medicine Siriraj Hospital, Bangkok, Thailand until 30 March 1999. All were alive at the time of study.

The diagnosis of thalassemia was performed on the basis of clinical and laboratory findings as previously described[12]. In cases of β-thal/Hb E disease, due to the variation of the clinical course, the criteria to designate severe cases included presentation before 2 years of age, a hemoglobin consistently less than 7 g/dL and clinical symptoms of anemia, such as inadequate growth, were used for enrolling cases to the regular transfusion regimen[6].

Transfusion Regimens

Regular high transfusion (group I) was provided to 10 patients with homozygous β-thal (7 males and 3 females) and 8 patients with β-thal/Hb E (3 males and 5 females). All patients were regularly transfused with leukocyte poor packed red cells (LPB) at a pre-transfusion Hb level of 10 g/dL every 2-4 weeks[22]. They also received premedication with furosemide, acetaminophen and chlorpheniramine at the standard dosage[23]. The ages of the patients in this group (I) ranged from 4 to 14 years (median 10) and one case (β-thal/Hb E male) was splenectomized at the age of 4 years.

Occasional transfusion (group II) was provided to 2 patients with homozygous β-thal (1 male, 1 female) who could not follow the regular transfusion program and 28 patients with β-thal/Hb E (15 males, 13 females). The patients in this group were transfused occasionally when they developed symptoms of anemia, such as fatigue, as paliative therapy. In general, the pre-transfusion Hb in this group was between 6-7 g/dL and they were followed-up every 8-12 weeks. The type of blood product and method of transfusion was the same as in the high transfusion group. The age of the patients in this group (II) ranged from 8.25 to 19.9 years (median 11.6). All cases were splenectomized at a mean age of 9.4 years (range 4.16 to 17 years) due to hypersplenism. Baseline Hct before splenectomy was 17.9 ± 0.5 per cent (14-25%) and the Hct rose to 23.6 ± 0.5 per cent (17.2-28%) 6 months after the operation.

Chelation Therapy

Iron chelating therapy (desferrioxamine: DFO, Ciba - Geigy; Basel, Switzerland) was given subcutaneously by slow infusion, 20-30 mg/kg body

weight, 5-6 times/week only in group I. Chelation was started when a patient's serum ferritin reached 1,000 ng/ml which was approximately one year after regular high transfusion was begun. Compliance and mean dosage of DFO administered were determined from the patient-calendar chart by a single investigator and varied from patient to patient. The mean (± SD) dosage of DFO was 16.83 ± 5.3 mg/kg/day (range 6-26.5 mg/kg/day). The mean duration of DFO was 73.2 ± 7 months (range 36-132 months).

The total iron load from blood transfusion in both regimens was calculated from the total volume of blood transfused (1.16 mg of elemental iron per 1.0 ml of pure RBC) and presented as gram per kg body weight. Assessment of iron overload was done by monitoring serum ferritin concentrations by radioimmunoassay (RIA)[24] twice a year along with a fasting blood sugar and liver function test.

All of the regularly high transfused patients had normal limit of liver function test including aspartate transaminase, alkaline phosphatase and bilirubin. No cases of diabetes were observed in our study.

Anthropometry

The patient's weight was measured at every visit to the nearest 0.1 kg with a Schonle digital scale. Height measurements were made to the nearest 0.1 cm using a single locally constructed anthropometer. Body mass index was calculated and expressed as a mean in each case[25].

Height measurments were compared with the standards of the World Health Organization[26] and expressed as standard deviation scores (Z score).

The Z score was calculated as the value for the individual patient minus the 50th percentile value of normal subjects of the same chronological age divided by the standard deviation corresponding to that age[27,28]. Z scores greater than -1 height-for-age were considered normal.

This data was compared for differences in growth between the different diagnostic groups, gender and transfusion regimens.

Pubertal development (Tanner's classification[29]) was used to stage puberty in thalassemic cases who were older than 10 years. With the exception of two female patients in the regular transfusion group, all of the other patients (4 males and 3 females in the regular transfusion, 13 males and 12 females in the occasional transfusion regimen) experienced delayed or arrested puberty. Some cases had problems such as secondary amenorrhea or irregular menstruation.

Statistical Analysis

The basic characteristics between the two groups were expressed as mean ± SE. The ranges are reported in Tables 1, 2 and 3 because the data were not normally distributed.

Univariate analysis by X^2 test, two-tailed Student's *t*-test and Fisher's exact test were performed to compare the data and to establish the significance level ($p < 0.05$).

The non-parametric Wilcoxon test for age matched pairs was applied for comparison of the Z-score between the different groups and this was also used to compare the continuous variables with proven skewed distribution by the Kolmogoro-Smirnov test.

Table 1. Comparison of clinical and hematological parameters in patients with homozygous β-thalassemia under different treatment regimens.

	Group I*			Group II**			P value
	No.	Mean ± SE	range	No.	Mean ± SE	range	
1. Initial Hct (%)	9	17.77 ± 1.32	12 - 20	2	18.67 ± 2.1	16.4, 20.8	0.775
2. Age at diagnosis (months)	10	13.10 ± 2.1	5 - 24	2	21 ± 7	14, 28	0.182
3. Age at study (yrs)	10	8.36 ± 0.91	4 - 12	2	14.7 ± 1.9	12.8, 16.7	0.018
4. Age at initial transfusion (yrs)	10	1.40 ± 0.22	0.8 - 2.7	2	2.6 ± 1.2	1.4, 3.8	0.104
5. Initial serum ferritin (ng/ml)	7	1,060 ± 42	1,220 - 3,200	1	2,058.0	2,058.0	0.435
6. Last serum ferritin (ng/ml)	10	3,756.7 ± 221	2,880 - 4,870	1	628.6	628.6	0.002
7. Total iron load (g/kg)	10	2.92 ± 0.45	0.86 - 4.43	2	0.60 ± 0.27	0.33, 0.87	0.051
8. Length of follow-up (yrs)	10	7.6 ± 0.79	4 - 11	2	12.9 ± 1.4	11.5, 14.3	0.019

* Group I : regular transfusion and iron chelation
** Group II : occasional transfusion

Linear regression and Pearson correlation coefficient were used to evaluate correlation between variables.

RESULTS

Table 1 shows the comparison of the clinical and hematological parameters in cases with homozygous β-thal under different transfusion regimens. There were no statistically significant differences in the baseline data e.g. initial Hct, age of diagnosis and serum ferritin between the 2 groups. In β-thal/Hb E cases in different groups, the baseline data were not different except the age at diagnosis which showed an earlier presentation in the regular transfusion group (Table 2).

In addition, the parameters influenced by the treatment regimen e.g. age at diagnosis, age at study, last serum ferritin level and total iron load were significantly higher in the regular transfusion group in both thalassemia syndromes.

Moreover, within the regular transfusion group (Group I), most of the comparisons between those with homozygous β-thal and those with β-thal/Hb E did not show any difference except the age at initial transfusion which was earlier in the homozygous β-thal group.

Without considering the difference in genotype, the patients in group I had clinically significantly more severe disease due to early presentation and early transfusion compared with group II. However, other baseline data (initial Hct, initial serum ferritin) were not different (Table 3).

The longitudinal mean Z score of height from the age of 1 to 17 years in both transfusion regimens in different types of diseases and sexes are presented in Fig. 1 (male) and 2 (female).

Table 2. Comparison of clinical and hematological parameters in patients with β-thalassemia/Hb E under different treatment regimens.

	Group I*			Group II**			P value
	No.	Mean ± SE	range	No.	Mean ± SE	range	
1. Initial Hct (%)	8	20.00 ± 1	15 - 23	27	18.01 ± 0.57	14.03 - 25.6	0.101
2. Age of diagnosis (months)	7	15.57 ± 1.65	12 - 25	28	38.42 ± 4.1	5 - 96	< 0.001
3. Age at study (yrs)	8	9.98 ± 1.02	5 - 14	28	14.8 ± 0.56	8.2 - 19.9	< 0.001
4. Age at initial transfusion (yrs)	8	5.05 ± 1.24	1 - 7.6	27	5.66 ± 0.54	1.1 - 11.9	0.616
5. Initial serum ferritin (ng/ml)	8	582.3 ± 348	130 - 3,000	24	592.1 ± 116	17.26 - 1,580	0.503
6. Last serum ferritin (ng/ml)	8	3,389.1 ± 589	1,187 - 5,932	23	1,967.2 ± 585	180 - 4,625	0.19
7. Total iron load (g/kg)	8	4.05 ± 0.67	1.79 - 6.80	27	0.59 ± 0.08	0.08 - 1.65	< 0.001
8. Length of follow-up (yrs)	8	8 ± 0.92	4 - 12	28	11.66 ± 0.59	5.8 - 16.3	0.005

* Group I : regular transfusion and iron chelation
** Group II : occasional transfusion

Table 3. Comparison of clinical and hematological parameters in thalassemic patients under different treatment regimens.

	Group I*			Group II**			P value
	No.	Mean ± SE	range	No.	Mean ± SE	range	
1. Initial Hct (%)	17	19.16 ± 0.88	12 - 23	29	18.05 ± 0.54	14.03 - 25.6	0.23
2. Age of diagnosis (months)	17	14.2 ± 1.50	5 - 25	30	38.42 ± 4.1	5 - 96	0.0002
3. Age at study (yrs)	18	9.08 ± 0.69	4 - 14	30	14.8 ± 0.56	8.2 - 19.9	< 0.0001
4. Age at initial transfusion (yrs)	18	2.42 ± 0.46	0.80 - 7.6	29	5.6 ± 0.5	1.1 - 11.9	< 0.0001
5. Initial serum ferritin (ng/ml)	15	805.2 ± 268	130 - 3,200	25	592.1 ± 116	17.2 - 2,058	0.41
6. Last serum ferritin (ng/ml)	18	3,593.3 ± 282	1,187 - 5,932	24	1,967.2 ± 585	180.0 - 462.5	0.02
7. Total iron load (g/kg)	18	3.41 ± 0.40	0.86 - 6.80	29	0.61 ± 0.81	0.08 - 1.65	< 0.0001
8. Length of follow-up (yrs)	18	7.7 ± 0.58	4 - 12	30	11.6 ± 0.55	5.8 - 16.9	< 0.0001

* Group I : regular transfusion and iron chelation
** Group II : occasional transfusion

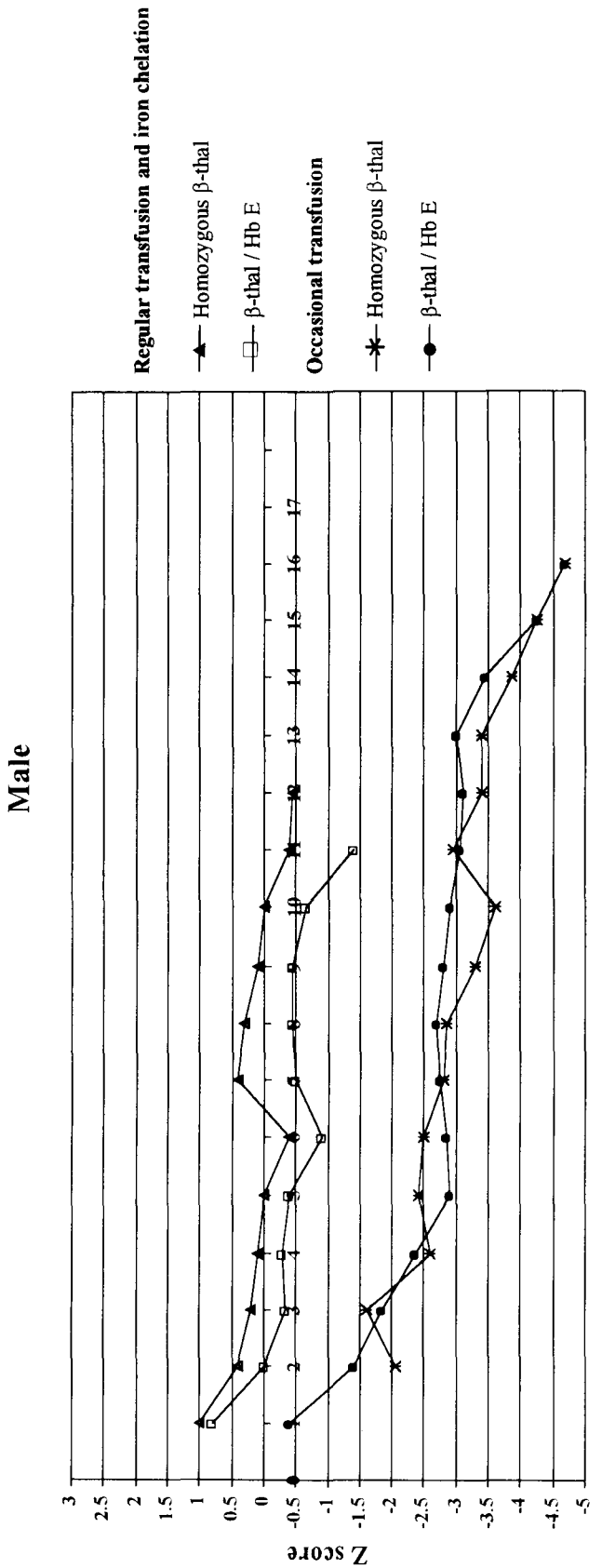

Fig. 1. Z score (SDS for height) in males with homozygous β-thal and β-thal/Hb E under different treatment regimens.

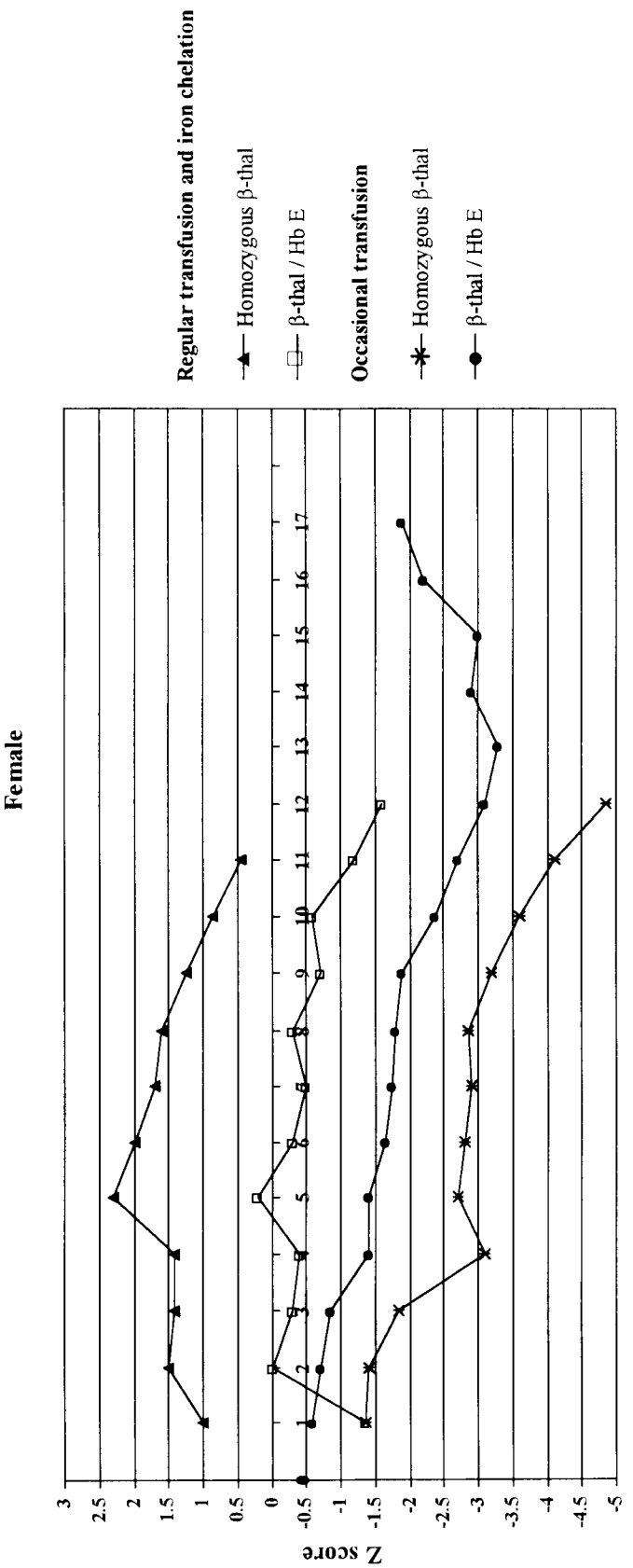

Fig. 2. Z score (SDS for height) in females with homozygous β-thal and β-thal/Hb E under different treatment regimens.

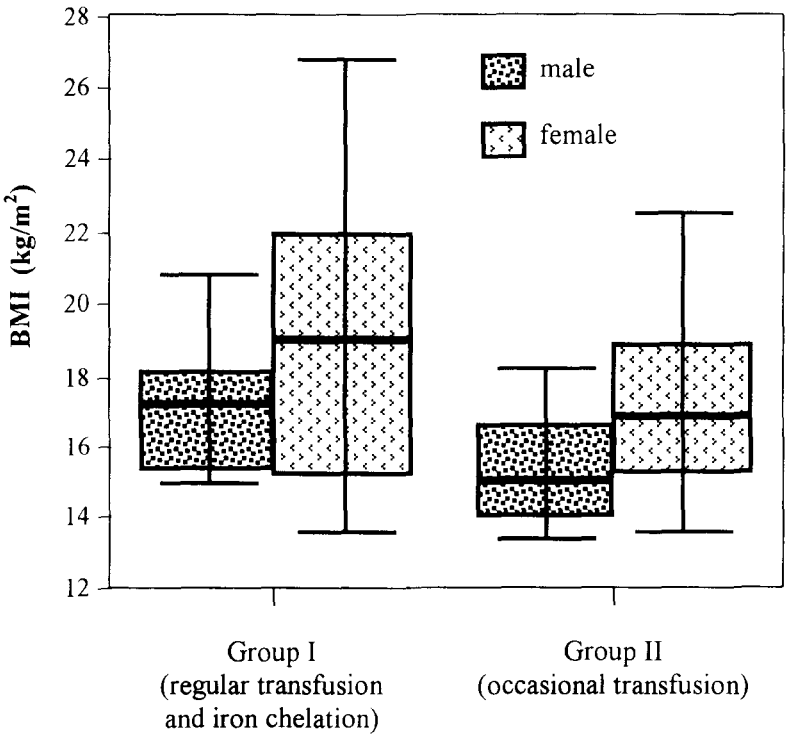

Fig. 3. Box plots and density traces of the body mass index (BMI) in both treatment regimens treatment groups. The limits of the boxes represent the 25th, 50th and 75th percentile of distribution; the lower and upper bars represent the 10th and 90th percentile.

Both figures, revealed the same trend during the first 10 years. Both boys and girls who received the high transfusion regimen grew normally. Their Z score for height continuously kept more than -1 standard deviation from the 50th percentile.

During the same period, boys and girls under the occasional transfusion regimen became increasingly retarded in their linear growth.

Using the original Z score at one year of age, the difference in Z score between the regular transfusion group and the occasional transfusion group in both sexes increased and was statistically significantly different for every age above one year for the same phenotype. However, in the regular transfusion groups, there were no significant differences in height growth between the homozygous β-thal and β-thal/Hb E cases.

Nevertheless, after ten years of age, the benefits of regular transfusion to growth in both phenotypes decreased in both sexes. The Z score for height in those patients declined from the normal range.

Fig. 3 shows box plots and density traces of body mass index (BMI) between the sexes in the regular transfusion and occasional transfusion groups. The mean BMI in group I and II were 18.09 ± 0.8 and 16.21 ± 0.43 kg/m^2, respectively. There was statistically significantly difference between both groups ($P = 0.03$, unpaired t test).

The Z scores (height SDS) at ten years of age were correlated with the BMI (Fig. 4).

DISCUSSION

Many contributing factors have been proposed to explain the short stature or growth failure of thalassemic patients, a commonly observed condition among children with homozygous β-thal especially in the adolescent period.

Before the period when regular high transfusion with chelation therapy was recommended, chronic anemia and tissue hypoxia[2] were sug-

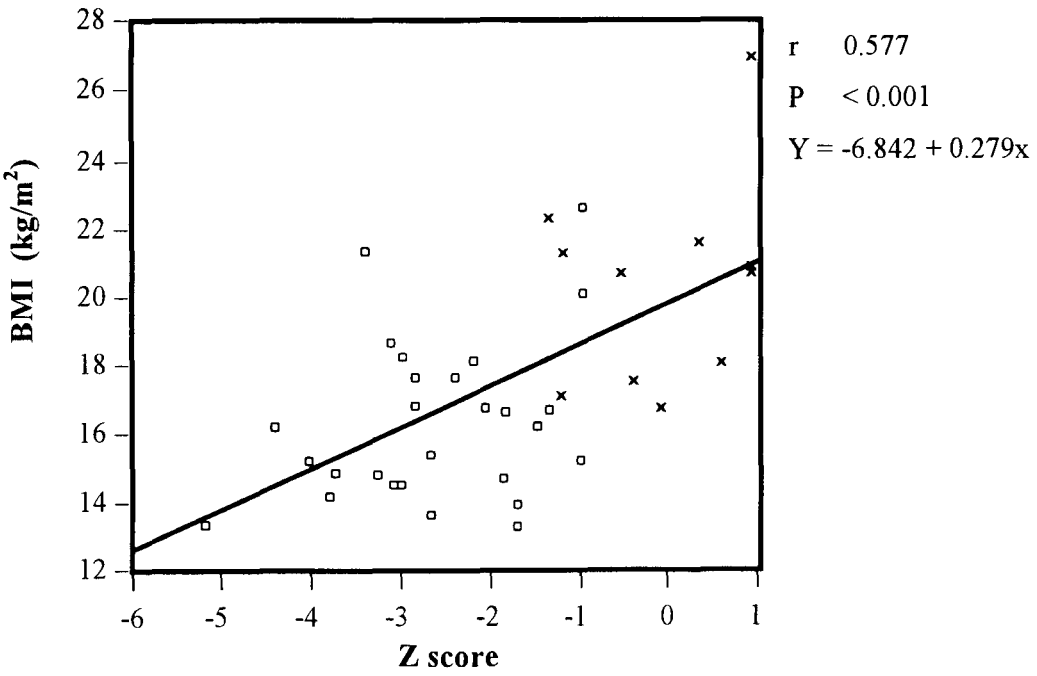

Fig. 4. Linear regression and correlation between body mass index and Z score (height SDS) at 10 years old in patients with regular transfusion and iron chelation x and occasional transfusion ɔ.

gested as factors in early childhood with the combination factors such as hypersplenism[30], multiple nutritional deficits including Zn[31,32], vitamin E[14,33], folic and B_{12} deficiency[34]. The iron burden due to secondary hemosiderosis was implicated as a further major cause of growth failure[4].

Hypogonadotropic hypogonadism is another important cause of growth failure in thalassemic children[4,35,36] as well as hypothalamic and pituitary dysfunction, growth hormone and its generation e.g. IGF_1, IGF BP3 dysregulation[3,37,38].

At present, intensive treatment with high transfusion and iron chelation (desferrioxamine) is a conceptual means of attaining growth in thalassemic patients to the final height within normal range [39]. However, many recent reports have indicated a reduction in growth rate of thalassemic patients even with adequate transfusion maintaining a desirable Hb level along with adequate chelation (serum ferritin being consistently within acceptable level) [40]. Kwan Ey et al from Hong Kong[41], found that in children with thalassemia, 75 per cent of the girls and 62 per cent of the boys over the age of 12 years had heights below the third percentile, despite regular transfusion and iron chelation. Saka N et al from Turkey[42] reported that abnormal growth and delayed puberty are frequently seen in transfusion dependent thalassemics.

The most suspicious factors causing this problem are delayed pubertal development, due to endocrinological dysfunction, especially within the growth hormone axis and desferrioxamine toxicity [10]. Abnormal spinal growth with radiological evidence of platyspondylosis produced a reduction in sitting height and consequently led to marked body disproportion after the age of 10 years[43,44]. This was possibly caused by iron overload and/or the complication of iron chelation therapy.

The recent recommendation to use desferrioxamine early in life was to reduce its dose. This was considered as a balance between the risk of iron overload, hepatic damage in young transfused children and the cartilaginous dysplasia from desferrioxamine itself.

Iron chelation therapy was introduced in Thailand more than 15 years ago. In our clinic, more than 120 cases of transfusion dependent thalassemia (homozygous β-thal and severe cases of β-thal/Hb E) were under regular transfusion with iron chelation regimen. However, due to the relative expense

of this regimen, only a minority of cases can attain and continue this treatment in the long term and most of the patients receive blood transfusion as supportive therapy only.

Our study indicates that in the first decade of life, thalassemic children who received regular transfusion at pre-transfusional Hb levels of 10 g/dL from an early age, even with inadequate iron chelation due to a relatively low dosage of desferrioxamine and with increasing serum ferritin level within the treatment period can achieve normal growth. These findings are seen in both homozygous β-thal and β-thal/Hb E disease.

Additionally, the height SDS in those with β-thal/Hb E, who had an early presentation and were as clinically severe as homozygous β-thal under regular transfusion was no better than in those with homozygous β-thal. This finding confirms that there is a very high range of heterogeniety of the phenotype of β-thal/Hb E.

Growth failure in β-thal/Hb E has rarely been reported. Tienboon P[17] reported that such patients were generally stunted by grade 2 by Waterlow's criteria and their growth retardation was more severe in older age groups especially more than 7 years old. This finding was also found by Tuchinda C[15] who demonstrated impaired growth hormone response after provocation in those with β-thal/Hb E disease.

Anthropometric parameters were less affected in those patients with β-thal/Hb E disease who had not undergone splenectomy compared with those who were splenectomized. This was probably due to the greater clinical severity of the splenectomized group[19]. Similarly, in our study, all cases in the occasional transfusion group were splenectomized. Their growth slowed after the age of 1 year. This group of patients, except that they presented at a later age, had the same clinical presentation as compared to those with β-thal/Hb E disease who underwent regular transfusion.

This finding can help the physician make a decision concerning the treatment regimen in such patients because the precise explanation of the clinical course of this phenotype is still an enigma.

We conclude that in the cases of β-thal/Hb E disease who presented with a Hb level of less than 7 g/dL before the age of 2 years should receive intensive monitoring of their growth and be provided with regular, high transfusion with iron chelation to guarantee their growth and development, at least in the first decade of life.

An important factor that determined growth in our patients is nutritional status. We used the body mass index as an indicator of this and found that there was a statistically significant difference in BMI between group I and group II. Group I had a higher mean BMI and more cases who had a BMI of over 18 kg/m^2. Besides, the BMI also correlated with the Z score. Recent data[45,46] from Thailand showed that malnutrition in thalassemic patients was one of the primary etiological factors of growth retardation. It was reported that an intensive short course of nutritional support could accelerate the height velocity which exceeded normal after the fourth month of treatment in 12 thalassemic children under 3 years of age[45].

In the present study, patients in group I who received iron chelation had to pay the medical cost themselves while the patients in group II could not afford iron chelation. This was due to the difference in socioeconomic status between the 2 groups. We can assume that socioeconomic status played some role in the difference of BMI in both groups. Beside the treatment regimens, undernutrition may contribute to the loss of height growth by a decrease in the synthesis of IGF-1 and resulting in the difference of their Z score.

After the age of 10 years, a decrease in the Z score was seen in group I. This finding was probably due to abnormal pubertal development because most of the cases in both groups (except two girls) had delayed or arrested puberty. Hypogonadotropic hypogonadism caused the lack of pubertal growth spurt.[41,46,47] This condition, as well as the iron burden, probably plays a major role that interferes with endocrinological function and hepatic production of IGF-1[48].

However, further endocrinological study, especially of pituitary function after stimulation with GnRH and GHRH, is also needed in our patients. There is controversy concerning the role of growth hormone in such patients.[9,41,49-52] Some of these cases showed impairment of the GHRH axis. Cavallo L et al[50] reported short-term therapy with recombinant growth hormone in 28 regularly transfused thalassemics with growth failure at the age of 14 ± 2 years. The results of treatment revealed an increase in both growth velocity and height calculated for chronological age, although there was

no significant change in their final height between the beginning and at the end of therapy.

In cases with growth failure accompanied by delayed puberty without growth hormone deficiency, a low dose of long-acting sex steroid treatment can produce similar results to those obtained with growth hormone treatment[49].

Body disproportion is also another complication seen in thalassemic patients. It has been concluded that spinal growth impairment results from desferrioxamine toxicity[53]. In a recent report [39], it was found that 14 per cent of thalassemic patients had disproportion between the upper and lower body segments, and exhibited short stature. However, in another 40 per cent of thalassemic patients, a short trunk but normal stature was present. This was due to impairment of spinal growth which occurs early in infancy and progresses thereafter. They concluded that a short trunk is due to the disease itself, however, other factors such as desferrioxamine induced bone dysplasia, hypogonadism and siderosis probably augmented this complication in these patients.

The high prevalence of growth failure after the age of 10 years despite a regular transfusion regimen in thalassemic patients makes regular follow-up essential to ensure regular and adequate chelation balanced with the chelator's toxicity[54-56]. Besides, after bone marrow transplantation, iron status should be continuously monitored with early intervention[54,57-59]. The early detection of a decline in Z score for height and searching for associated causes such as hypogonadism, an abnormal growth hormone axis and spinal dysplasia are recommended in order to improve the care and quality of life for these patients.

SUMMARY

In conclusion, regular, high transfusion along with iron chelation therapy in severe β-thal/Hb E and homozygous β-thal patients were shown clearly in this study to be sufficient to promote normal growth and development in these cases within the first decade of life.

It was also shown that in some β-thal/Hb E patients who had a very severe clinical presentation, as judged by early onset of anemia, early requirement of transfusion and a low baseline hemoglobin (Hb) and hematocrit (Hct), also suffered failure in growth and development which did not differ from homozygous β-thal.

Occasional transfusion was shown in this study to be inadequate to promote normal growth in these patients. Adequate iron chelation and hormone replacement is usually required after the first ten years in order to promote normal adult height in regularly transfused patients.

ACKNOWLEDGEMENT

The authors wish to thank Ms. Narisara Viprakasit for the data collection and statistical analysis, Ms. Darika Seeloem and Ms. Jutarat Jutatap, for the preparation of the manuscript, Associate. Prof. Supawadee Likitmasakul for providing the PC program for Z score calculation and Dr. Jane Hardy for subediting the English.

(Received for publication on May 3, 2001)

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ความสัมพันธ์ระหว่างรูปแบบการรักษา ต่อ การเปลี่ยนแปลงของความสูงและการเจริญเติบโต ในผู้ป่วยธาลัสซีเมียชนิดโฮโมซัยกัสเบต้าธาลัสซีเมีย และเบต้าธาลัส-ซีเมียฮีโมโกลบิน อี

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คณะผู้วิจัยได้ศึกษาเปรียบเทียบการเจริญเติบโต และความสูงในผู้ป่วยธาลัสซีเมียที่ได้รับการรักษา 2 รูปแบบที่แตกต่างกัน ตั้งแต่ปีพ.ศ. 2520 – 2542 ผู้ป่วยกลุ่มแรกจำนวน 18 รายได้รับการรักษาโดยการให้เลือดอย่างเต็มที่สม่ำเสมอทุก ๆ 3–4 สัปดาห์ เพื่อรักษาระดับความเข้มข้นของเลือด (Hematocrit) ให้ใกล้เคียงกับระดับปกติ และได้รับยาขับเหล็ก (Desferrioxamine) ผู้ป่วยอีกกลุ่มจำนวน 30 รายได้รับเลือดเป็นครั้งคราว เฉพาะเมื่อมีอาการแสดงจากภาวะซีด ทั้ง 2 กลุ่ม ประกอบด้วยผู้ป่วยธาลัสซีเมียชนิดโฮโมซัยกัสเบต้าธาลัสซีเมีย (10 ราย ในกลุ่มแรก และ 2 ราย ในกลุ่มที่ 2) และ เบต้าธาลัส-ซีเมีย ฮีโมโกลบิน อี (8 ราย และ 28 ราย ตามลำดับ)

คณะผู้วิจัยไม่พบความแตกต่างในเชิงโลหิตวิทยาเมื่อเริ่มต้นการรักษาในผู้ป่วยทั้งสองกลุ่ม แม้ว่าผู้ป่วยกลุ่มแรกจะมีอาการที่ค่อนข้างรุนแรงมากกว่ากลุ่มที่ 2 ได้แก่ มีอาการซีดและได้รับการให้เลือดเมื่ออายุน้อยกว่า อย่างไรก็ตามในผู้ป่วยกลุ่มแรกซึ่งได้รับเลือดอย่างเต็มที่ สามารถเจริญเติบโต และมีความสูงอยู่ในเกณฑ์ปกติเมื่อเทียบกับมาตรฐาน โดยการเปรียบเทียบคะแนนเบี่ยงเบนจากมาตรฐาน (Standard Deviation Score; SDS) ภายในช่วงอายุ 1–10 ปี ในขณะที่ผู้ป่วยกลุ่มที่ 2 มีความสูงต่ำกว่ามาตรฐานโดยตลอด

การรักษาด้วยการให้เลือดอย่างเต็มที่ในผู้ป่วยธาลัสซีเมียที่มีอาการรุนแรงสามารถส่งเสริมการเจริญเติบโตและความสูงให้ได้ใกล้เคียงกับเด็กปกติในช่วง 10 ปีแรกของชีวิต นอกจากนั้นผู้ป่วยเหล่านี้จำเป็นต้องได้รับยาขับเหล็กอย่างสม่ำเสมอรวมทั้งการเสริมฮอร์โมนอย่างเหมาะสมด้วย จึงจะมีความสูงเป็นปกติเมื่อเป็นผู้ใหญ่

คำสำคัญ : ความสูงและการเจริญเติบโต, ธาลัสซีเมีย, การให้เลือด, การให้ยาขับเหล็ก

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จดหมายเหตุทางแพทย์ ฯ 2544; 84: 929–941

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