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Original Article

Growth velocity in elementary school children with iron deficiency anemia after iron therapy

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Abstract

Background Iron supplementation in children with iron deficiency anemia could decrease the incidence of stunting.

Objective To study the effect of iron therapy on growth velocity in children with iron deficiency anemia.

Methods A randomized clinical trial study was conducted at Labuhan Batu on November 2006 to May 2007. Iron deficiency anemia was diagnosed if there were anemia, with mean corpuscular hemoglobin concentration <31%, red cell distribution width index >220, and Mentzer index >13. Elementary school children (6-12 year old) with iron deficiency anemia were randomly assigned either to iron therapy group (children were given 6 mg iron/kg/day) or to placebo group for 3 months.

Results Among 300 children recruited, there were 125 children, who suffered from iron deficiency anemia. After one month of iron therapy, means of hemoglobin concentration were 12.4 g/dl in iron group and 11.7 g/dl in placebo group. There was a significant increase of height in iron group (129.9 (SD 7.58) cm vs. 132.2 (SD 7.23) cm) and in placebo (130.8 (SD 8.78) cm vs. 128.7 (SD 8.79) cm), However, no significant difference was found in the mean of growth velocity between placebo and iron groups (2.1 (SD 0.01) cm vs. 2.0 (SD 0.9) cm.

Conclusion There is a significant increase in height, but no significant difference between both groups in growth velocity. **[Paediatr Indones. 2009;49:249-52]**.

Keywords: *body height, growth velocity, iron deficiency anemia*

Assessment of growth in stature is an essential part of pediatric examination.[1] Growth is an important index of physical and mental health.[2] At the Division of Pediatric Endocrinology, H. Adam Malik Hospital, Medan, during the year of 2000 to 2004, there were 27 children (29%) with height below 3rd percentile.[3] Chronic illness is one of the factors that influence children's growth.[4] There are three stages of post-natal growth which have to be considered: infant, childhood, and puberty. Growth velocity in childhood stage is 5-7 cm per year until puberty. The alteration of body height will not stabilize on time but episodically, and because of that the growth velocity can only be seen on 4-6 months minimally.[5,6] Growth velocity can be evaluated by calculating the increment of body height between two different observation periods, and it is counted by cm/year[2] with formula: (Ht2 – Ht1)/Interval, where 'Ht1' is first height measurement (cm)'Ht2' is second height measurement (cm), and 'Interval 'is time of measurement (year).

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Anemia is decrement of red blood cell or hemoglobin concentration below the second standard deviation of mean hemoglobin according to age and sex.[7] Iron deficiency anemia is caused by decrement of iron required for hemoglobin synthesis.[8] In developing countries, iron deficiency anemia is commonly found due to economic problem, decreased intake of animal protein, and endemic problem of parasite infestation.[9,10] Angeles et al[11] concluded that iron supplementation in anemic children could decrease short stature incidence. Chwang et al,[12] from their study in Indonesia, stated that by giving 10 mg ferrous sulphate in elementary school children for 12 weeks resulted in growth increment after intervention. Sungthong et al[13], who conducted a study in Thailand, found that by giving iron supplementation for 16 weeks had an effect on increasing height in elementary school age children. However, Dijkhuizen et al[14] found that iron supplementation in infant for six months did not give a significant influence on growth. [14] The aim of our study was to determine the effect of iron on growth velocity in elementary school age children who suffered from iron deficiency anemia.

Methods

This was a randomized clinical trial performed for six months, since November 2006 to May 2007 in five elementary schools at Bilah Hulu, Labuhan Batu, North Sumatra. Blood samples at capillary tip were taken from elementary school children aged 6-12 years. According to WHO criteria (1975), anemia in children aged 6-14 years was determined if hemoglobin level (Hb) <12g/dl. Iron deficiency anemia criteria was determined if anemia was found, with mean corpuscular hemoglobin concentration (MCHC) <31%, red cell distribution width index >220 and Mentzer index >13, as inclusion criteria. Exclusion criteria were other blood disease, severe malnutrition, severe chronic infection, neurological deficit, any suspected syndrome, also severe anemia.

Children were randomly assigned in two groups of iron treatment and placebo. Iron was given in capsule containing ferrous sulphate, 6 mg of elemental iron per kilogram body weight per day (40 mg ferrous sulphate/capsule was given three times daily with total dosage of 120 mg/day). Placebos were capsules containing saccharum lactis and were given three times daily. The capsules containing iron and placebo had the same size and color. These capsules must be taken every day in front of teacher and parents for three months.

Body height anthropometry measurement was performed before and six months after treatment. Body height was measured with stadiometer (microtoise) MIC labeled (with sensitivity of 0.1 cm).

Minimum subjects for this study were 60 subjects for each group and data was processed with SPSS for WINDOW (SPSS Inc, Chicago). The data for laboratory and anthropometry in each groups before and after intervention were analyzed with independent t-test**,** paired t-test, and Mann-Whitney test. The test was significant if $P<0.05$.

Results

Among 300 elementary school children examined, there were 125 children suffering from iron deficiency anemia (IDA) who were taken as subjects. These subjects were divided into two groups. Those two groups consisted of 63 subjects who were given iron treatment and 62 subjects who were given placebo. At the end of study, only 121 subjects, 60 subjects in the iron group and 61 subjects in the placebo group, finished the study within six months **(Figure 1)**.

From blood sample and anthropometry measurement before intervention, there was no difference in characteristic of study subjects. **(Table 1)**.

There was a significant increased of hemoglobin level between the two groups after one month therapy **(Table 2)**.

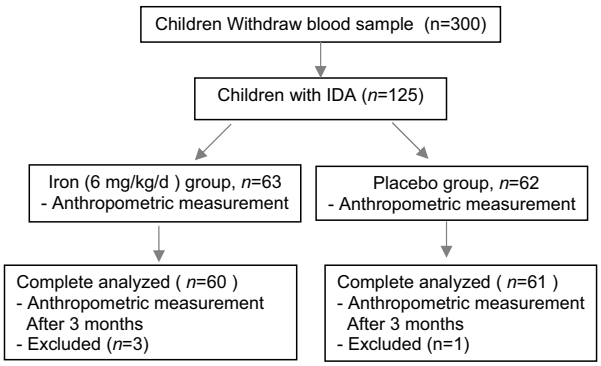

Figure 1. Consort algorithm

There was a significant increase in height between placebo and iron groups after therapy **(Table 3)**, but no significant mean of height and growth velocity was found between both groups **(Table 4)**.

Table 1. Characteristics of study subjects

Characteristic	Iron (n=63)	Placebo (n=62)
Age, mean (SD) months	117.9 (15.71)	119.4 (15.58)
Sex; n (%)		
- male	33 (52.4)	30 (48.4)
- female	30 (47.6)	32 (51.6)
Body height, mean (SD) cm	129.6 (7.65)	128.8 (8.73)
Father's height, mean (SWD) cm	164.8 (6.46)	161.6 (7.28)
Mother's height. mean (SD) cm	155.8 (6.80)	155.1 (5.67)
Hb, mean (SD) g/dl	10.1 (1.22)	10.2 (1.35)
MCHC, mean (SD) %	29.8 (0.75)	29.8 (0.71)
Mentzer Index, mean (SD)	17.3 (2.88)	16.8 (3.41)
RDW Index, mean (SD)	262.6 (50.17)	251.3 (35.06)

Table 2. Mean hemoglobin (g/dl) level before and one month after iron therapy

Groups	n	Before (g/dl)	After (g/dl)	P
Iron	60	10.1 (1.22)	12.4 (1.16)	0.0001*
Placebo	61	10.2 (1.35)	11.7 (0.77)	0.0001*

Value in mean (SD)
*P< 0.05

Table 3. Body height before and after therapy

Group	n	Body height (cm)		P
		Before therapy	After therapy	
Iron	60	129.9 (7.58)	132.2 (7.23)	0.0001*
Placebo	61	128.7 (8.79)	130.8 (8.78)	0.0001*

Value in mean (SD)
*P < 0.05

Table 4. Comparison of body height and growth velocity between the two groups

Parameter	Iron (n=60)	Placebo (n=61)	P
Body height before therapy (cm)	129.9 (7.58)	128.7 (8.79)	0.39
Body height after therapy (cm)	132.2 (7.23)	130.8 (8.78)	0.32
Growth velocity (cm)	2.1 (0.01)	2.0 (0.9)	0.16

Value in mean (SD)

Discussion

Children growth is influenced by genetic, nutritional, metabolic, and endocrine factors. The growth velocity in childhood stage is 5-7 cm per year until puberty.[4,5] The alteration of body height will not be stable on time but episodically, therefore, growth velocity will only be seen in 4-6 months, minimally.[5,6]

Iron plays an important role in children's growth and development, such as brain development, cognitive function, motoric function, behavior, and immunity.[15] High prevalence of IDA in developing countries is associated with economic problem (incidence of malnutrition, poor sanitation, high morbidity), low intake of animal protein, and endemic problem of parasite infestation.[9,16] Children with IDA have low body weight and are shorter than children who do not suffer from IDA.[12]

In treatment of IDA, it is important to give iron supplementation in order to increase hemoglobin to normal level and to fulfill iron deposit. This is our consideration to treat the underlying cause of IDA, such as improving the nutrition intake or treating the parasite infestation.[17]

This study showed that there was no significant difference in subjects' characteristics between iron and placebo groups. Before iron treatment, we gave nutritional education to parents, children, and teacher, such as kind of food containing iron, and factors influencing iron absorption. One of the topic given was also about the hygiene sanitation which was important to prevent and treat IDA.

After one month therapy, there was a significant change in hemoglobin level in each group. Unfortunately, this study did not include iron profile (serum iron, Total Iron Binding Capacity/TIBC, serum ferritin, transferrin saturation, and Free Erythrocyte Porphyrin/FEP) due to the expensive costs.

Growth velocity of less than 4.5 cm per year which is started at the age of 4 years old and lasts until the stage of puberty is considered abnormal.[2] In this stage, growth velocity until puberty is constantly 5-7 cm per year. Growth hormone is the most important hormone that influences growth in this stage.[2,18] This study showed that there was a significant increase in height between placebo and iron groups, but no significant mean of height and growth velocity found between both groups before and after treatment.

There were some limitations in this study. The incidence of morbidity in the subjects during six months study period was unknown and we did not perform nutritional evaluation, also intervention compliance was given under parents and teacher supervision. Due to cost and time limitation, iron intervention was given only within three months.

The study concluded that iron treatment will increase hemoglobin concentration and there is a significant increment of height in both placebo and iron groups, but no significant difference is found between both groups on growth velocity.

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References

1. Wales JKH, Rogol AD, Wit JM. Color atlas of pediatric endocrinology and growth. London: Mosby-Wolfe, 1996; p. 1-12.
2. Syne D. Growth. In. Greenspan FS, Gardner DG, editors. Basic & clinical endocrinology. 7th ed. New York: McGraw-Hill, 2004; p. 176-93.
3. Deliana M, Hakimi, Siregar CD. Gambaran kunjungan pasien rawat jalan endokrinologi anak dan remaja FK USU/ RS. H. Adam Malik Medan, tahun 2000-2004. Sari Pediatri. 2006;7:183-7.
4. Clayton PE, Gill MS. Normal growth and its endocrine control. In : Brook CGD, Hindmarsh PC, editors. Clinical pediatric endocrinology. 4th ed. London: Blackwell science, 2002; p. 95-103.
5. Batubara JRL. Perawakan pendek. In: Pardede N, Bakri A, Aditiawati, Prambudi, Herman E, editors. Proceedings of the first annual meeting of the Indonesian Pediatric Society. Palembang: Indonesian Pediatric Society, 2001; p. 83-93.
6. Styne DM. Pediatric endocrinology. Philadelphia: Lippincott Williams & Wilkins, 2004; p. 44-81.
7. Dallman PR. Nutritional anemia. In: Rudolph AM, Hoffman JIE, Rudolph CD,. editors. Rudolphs pediatrics. 20th ed. Connecticut: Appleton & Lange, 1996; p. 1176-80.
8. Raspati H, Reniati L, Susanah S. Anemia defisiensi besi. In: Permono B, Sutaryo, Ugrasena IDG, Windiastuti E, Abdulsalam M, editors. Buku ajar hematologi onkologi anak. Jakarta: Badan Penerbit IDAI, 2005; p. 30-43.
9. Lukens JN. Iron metabolism and iron deficiency. In: Miller DR, Baehner RI, Miller LP, editors. Blood disease of infancy and childhood. 7th ed. St. Louis: Mosby, 1995; p. 193-219.
10. Pusponegoro HD. Tumbuh kembang otak, pengaruh malnutrisi dan defisiensi besi. Jakarta: Medical School University of Indonesia; 2004.
11. Angeles IT, Schultink WJ, Matulessi P, Gross R, Sastroamidjojo S. Decreased rate of stunting among anemic Indonesian preschool children through iron supplementation. Am J Clin Nutr. 1993;58:339-42.
12. Chwang L. Soemantri AG, Pollitt E. Iron supplementation and physical growth of rural Indonesian children. Am J Clin Nutr. 1988;47:496-501.
13. Sungthong R, Mo-suwan L, Chongsuvivatwong V, Geater AF. Once weekly is superior to daily iron supplementation on height gain, but not on hematological improvement among school children in Thailand. J Nutr. 2002;132:418-22.
14. Dijkhuizen MA, Wieringa FT, West CE, Martuti S, Muhilal. Effects of iron and zinc supplementation in Indonesian infants on micronutrient status and growth. J Nutr. 2001;131: 2860-65
15. Oski FA. Iron deficiency in infancy and childhood. N Engl J Med. 1993; 329: 190-3.
16. Harmatz P, Butensky E, Lubin B. Nutritional Anemias. In: Walker WA, Watkins JB, Duggan C, editors. Nutrition in Pediatrics. Basic science and clinical applications. 3rd ed. London: BC Decker Inc, 2003; p.830-44
17. Abdulsalam M. Diagnosis, pengobatan dan pencegahan anemia defisiensi besi pada bayi dan anak. In: Triasih R, editors. Anemia defisiensi besi. MEDIKA: Medical school Gadjah Mada University, 2005; p.55-64
18. Tridjaja B. Perawakan dan pertumbuhan. In: Pulungan AB, editor. Makalah lengkap nutrition growth-development continuing professional development IDAI Jaya 2006. Jakarta: IDAI Jakarta, 2006; p.10-8.