



Vitamin D and Parathyroid Hormone Levels and Their Relation to Serum Ferritin Levels in Children with Thalassemia Major: One-Center Study in Western Indonesia

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Children with thalassemia major need regular blood transfusions to survive. These multiple transfusions put them at risk for iron overload, which result in organ damage such as parathyroid gland. The aim of this study is to determine levels of calcium, phosphorus, vitamin D and parathyroid hormone in children with thalassemia major and compare them with controls, and analyze their correlation with serum ferritin level.

Methodology: This was a cross-sectional study in 37 patients with thalassemia major in Department of Pediatrics, Dr. M. Jamil Hospital Padang and 37 age- and sex-matched healthy controls. Serum calcium ion, inorganic phosphorus, vitamin D (25-hydroxycholecalciferol), parathyroid hormone (PTH) and ferritin levels were measured.

Results: There were 18 boys and 19 girls in each group. Their age ranged between 2 and 16 years,

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with 20 (54%) children aged more than 10 years. Median of ferritin level in patients and controls were 2981 (IQR 3662) ng/mL and 36.6 (IQR 27.5) ng/mL respectively. Mean level of calcium ion and phosphorus levels in patients were 1.17 (SD 0.07) mmol/L and 5.42 (SD 0.76) mg/dL respectively. Median values of vitamin D and PTH in patients were 54.3 (IQR 21.1) ng/mL and 127.5 (IQR 183.1) pg/mL respectively. Compared to healthy controls, calcium ion level in patients was significantly lower ($P = .001$). On the contrary, phosphorous, vitamin D and PTH levels were not significantly different. Vitamin D and PTH levels had no significant correlation with serum ferritin levels ($P = 0.147$ and $P = 0.2$ respectively, while calcium ion level showed significant negative correlation with serum ferritin levels ($r=-0.44$, $P=0.007$).

Conclusion: Vitamin D and PTH levels have no significant correlation with serum ferritin level. The calcium ion level has a moderate negative correlation with serum ferritin level.

Keywords: Parathyroid hormone; vitamin D; ferritin; thalassemia; children.

1. BACKGROUND

Thalassemia is an autosomal recessive inherited blood disorder caused by defect of globin chain synthesis. Thalassemia major is a severe form of disease that requires lifelong blood transfusion, resulting in excess iron level in body. Excess iron can cause oxidative stress through production of highly reactive hydroxyl ($\cdot\text{OH}$) radicals, which cause oxidative damage and dysfunction of various organs, including parathyroid gland [1]. Parathyroid hormone (PTH) is a hormone secreted by the parathyroid gland that plays a role in calcium hemostasis, together with vitamin D and calcitonin. Parathyroid hormone keeps blood calcium levels within normal range by increasing serum calcium, by facilitating absorption of calcium ions in gastrointestinal tract, or by calcium reabsorption and phosphate excretion in the kidney, and increasing calcium absorption from bone, and also plays a role in the formation of active vitamin D (1, 25 dihydroxyvitamin D) in the kidney [2].

Some studies have reported that some of thalassemia patients had significantly low levels of PTH, vitamin D and calcium, and high level of phosphorous compared with healthy controls [3-5]. Hagag AA et al. in their study in Egypt reported that there were significant negative correlation between PTH level with serum ferritin level [5]. In contrast to this, some have reported that there were no clear relationship between PTH and ferritin serum level [6-8]. In the pediatric ward of Dr. M. Jamil hospital Padang, there are 37 children with thalassemia major who get routine transfusion every month. These children are at risk of high iron load because of not optimal iron chelation treatment, whether due to lack of drug availability or bad compliance to medication. With this background we want to determine the levels of calcium, phosphorus, vitamin D and parathyroid hormone in children

with thalassemia major in our center, compare them with controls, and analyze their correlation with serum ferritin level.

2. METHODS

This study was a correlational study with a cross-sectional design, taken place in Dr. M. Jamil hospital Padang from July to October 2016. The samples included 37 children with thalassemia major and equal amount of age- and sex-matched healthy children as controls. Present study had been approved by the research ethics committee of Faculty of Medicine, Andalas University Padang. All subjects were fasted for 8 hours before blood collection. Blood was taken aseptically through peripheral veins by trained personnel. A total of 6 ml of blood was taken and the serum was collected for laboratory investigation of calcium ion, inorganic phosphorus, ferritin, vitamin D (25-hydroxyvitamin D), and intact parathyroid hormone (PTH). Calcium ion investigation was performed by ion selective electrode (ISE) method by using kit from SnapPak Roche. Phosphorus inorganic investigation was performed by phosphomolybdate calorimetric method by using kit from Siemens Healthcare Diagnostic. Investigation of ferritin (using Diagnostic Biochem Canada), vitamin D (using Diagnostic Biochem Canada), and PTH (using Bioassay Technology Laboratory) were performed by enzyme-linked immunosorbent assay (ELISA) method.

2.1 Statistical Analysis

All parametric results were expressed as mean \pm SD for each group when data normally distributed and as median \pm IQR when data not normally distributed. Statistical analyses were performed using the student t test to compare concentration among the patients and controls

when data were normally distributed, and Mann-Whitney test were used when data were not normally distributed. For correlation analysis, Pearson coefficient of correlation was used if data were normally distributed, and Spearman's correlation test if not normally distributed. A probability value of less than 0.05 was assumed as significant.

3. RESULTS

Of 37 children with thalassemia in this study, the number of boys is almost the same as girls and children aged 10-16 years are the most age group (54%). Nutritional status of children with thalassemia major by body weight per body height (BW/BH) is particularly good nutrition (81%), but much more appear as short stature (56.8%) (Table 1).

The mean of calcium level in thalassemic patients is lower than that of healthy controls,

and these results differ significantly ($P = 0.001$). Similarly, the median serum ferritin level of children with thalassemia major was significantly higher than that of healthy controls ($P = 0.000$). In contrast, levels of phosphorus, vitamin D and PTH of children with thalassemia major did not differ significantly with healthy controls (Table 2).

By using Spearman's correlation test, there was negatively significant correlation between calcium with serum ferritin levels ($r_s = -0.44$, $P = 0.007$). There were no significant correlations between inorganic phosphorus, vitamin D, PTH level with serum ferritin level (Table 3).

4. DISCUSSION

This cross sectional study included 37 children with thalassemia major at M. Djamil hospital Padang and equal number of healthy children as a control group. The number of female and male

Table 1. Characteristic of subject study

Parameters	Patients (%) n = 37	Controls (%) n = 37
Sex		
- Boy	18 (48,6)	18 (48,6)
- Girl	19 (51,4)	19 (51,4)
Age		
- 2- 4 years old	4 (11)	4 (11)
- 5 – 9 years old	13 (35)	13 (35)
- 10-16 years old	20 (54)	20 (54)
Nutritional Status (BW/BH)		
- Undernourished	7 (19)	9 (24,3)
- Well-nourished	30 (81)	22 (59,5)
- Overweight	0	6 (16,2)
Stature		
- Short	21 (56,8)	7 (19)
- Normal	16 (43,2)	30 (81)

Table 2. Comparison of calcium ion, inorganic phosphorus, vitamin D, PTH and serum ferritin between patients and controls group

Parameter	Patients N = 37	Controls N = 37	P
Calcium ion (mmol/L)			
Mean (SD)	1.17 (0.07)	1,21 (0.04)	0.001*
Phosphorus (mg/dL)			
Mean (SD)	5.42 (0.76)	5,3 (0.63)	0.417*
Vitamin D (ng/mL)			
Median (IQR)	54.3 (21.1)	53,3 (47)	0.563 [#]
PTH (pg/mL)			
Median (IQR)	127.5 (183.1)	155,8(69.1)	0.165 [#]
Ferritin (ng/mL)			
Median (IQR)	2981 (3662)	36,6 (27.5)	0.000 [#]

*Student t – test; [#]Mann-Whitney test

Table 3. Correlation between serum ferritin levels with calcium, phosphorus, vitamin D and PTH levels in children with thalassemia major

		Calcium ion	Inorganic Phosphorous	Vitamin D	PTH
Ferritin	r_s	-0,44	0,31	-0,24	-0,16
	P	0.007	0.06	0.147	0.2

patients is almost the same. This is in agreement with Hagag et al. who found that of 60 children with thalassemia major in their study, there were 32 (53.5%) females and 28 (46.7%) males. This revealed that thalassemia is inherited in an autosomal recessive fashion, not through sex chromosome [5].

The levels of PTH in children with thalassemia in our study is not different significantly to healthy controls. This result is in accordance with a study in Egypt that reported the level of PTH in both patients and controls groups were not significantly different with a higher level in patients group [9]. This study is also in agreement with Zoga J [10], but is not in agreement with some studies that found PTH levels of children with thalassemia major were significantly lower than healthy controls [3,5,8].

Vitamin D is a prohormone that plays an important role in calcium hemostasis. Liver and kidneys play an important role in vitamin D metabolism. Liver iron overload may interrupt its metabolism. Vitamin D levels of patients in this study do not differ significantly with healthy controls. This result disagree with some studies [5,10,11].

Calcium is a mineral that has an important role in many physiological processes of the body, including the contraction of striated muscles, heart and smooth muscle; blood clots and nerve impulse transmission. In present study calcium levels of children with thalassemia major were significantly lower than that of healthy controls. This result is consistent with Hagag AA et al. Similar results were also obtained by Soboor M, et al. in Pakistan, Modi AS et al. and Goyal M in India [3-5,12].

Phosphorus, along with calcium, is a major structural component of bone in the form of a calcium phosphate salt called hydroxyapatite. In addition, phosphorus is an important component of cell membranes, energy production, phosphorylation reactions, and acid-base hemostasis. Phosphorus levels in the body, similar to calcium are regulated by vitamin D and PTH [2]. In present study, the average

phosphorus levels in children with thalassemia major were higher than healthy controls, but not statistically significant. This result was similar to Mahachoklertwattana P [13] and Fahim FM [11] who reported that phosphorus level of thalassemic patients were nearly the same as controls. This result is in contrast to Modi AS in India, Soboor M in Pakistan and Hagag AA in Egypt, who found that phosphorus levels in children with thalassemia major were significantly higher than those in healthy controls [4,5,12].

In this study, PTH level has no correlation with serum ferritin level. This result is in agreement with Sleem et al. [6] and Basha N KP [8] et al., while not in agreement with Hagag AA [5]. Furthermore, in this study there is no significant correlation between vitamin D level and ferritin serum. These results are in agreement with those reported by Zoga J [10] and Fahim FM [11], but disagree with Fadilah TF [14]. Calcium is the only parameter that has significant correlation with serum ferritin.

There is an interesting result in our study, showing that only calcium is lower compared to control, while PTH and vitamin D that control hemostasis of calcium are almost similar to control. How this happen is not clearly understood whether this lower level of calcium is only because of citrate toxicity due to repeated blood transfusion or due to the assumption that the calcitonin hormone has an important role in this condition, has not yet understood. Further study should be carried out to answer this question.

Based on this study, the supplementation of calcium in children with thalassemia major in Dr. M. Jamil Padang hospital should be recommended, while vitamin D supplementation might not be given. Further study should be performed to evaluate whether calcium supplementation alone can increase calcium levels of children with major thalassemia.

5. CONCLUSION

We conclude that calcium levels of children with thalassemia major are significantly lower than

healthy controls, while phosphorus, vitamin D and PTH levels do not differ significantly. There is moderate negative correlation between serum ferritin and calcium levels, while there are no significant correlations between serum ferritin and phosphorus, vitamin D and PTH levels.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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