

Investigation of the Association of Serum Concentrations of Vitamin D with Tibial Fracture in Toddlers Aged 18 to 36 Months

Abstract

Background: The purpose of this study was to investigate possible correlation between vitamin D in 13-36 month old children with tibial bone fracture.

Methods: This cross-sectional study was conducted on children aged 18 to 36 months who referred to a medical center in South-East of Iran with tibial fracture. All the demographic information was collected and vitamin-D levels were measured and statistically analyzed.

Results: A total of 30 children were included in the study, and the mean vitamin D level in these subjects was 31.6 ± 6.1 . This study showed no significant relationship between low vitamin D levels with increase in the risk of tibia fracture in children who had recently started walking.

Conclusion: The present study revealed a significant association between vitamin D level and its deficiency with an elevated risk of tibia bone fracture in toddlers between 18-36 months.

Keywords: Vitamin D, Tibial Fractures, Child, Cross-Sectional Studies, Tibia

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Shahab Ilka, MD¹; Afshin Ahmadzadeh Heshmati, MD¹; AmirReza Mirzaei Susefidi, MD¹; Sahel Salari, MD²

¹Assistant Professor,

^{1,2}Bahonar Hospital, School of Medicine, Kerman University of Medical Science, Kerman, Iran.

Introduction

Tibia bone fractures are the most common fractures in the lower limb (accounting for 15 percent of all cases) and the third most common fractures in orthopaedic patients ⁽¹⁾. In toddlers aged 12 to 36 months, the most common cause of bone fractures is low-energy trauma such as feeling imbalanced (i.e., losing your balance while walking) or medium-height falls ^(2, 3). Generally, toddlers are less likely to have comminuted fractures and displaced bone due to the low-energy trauma and low-velocity injuries they encounter and the higher elasticity of most bones in them than in adults. In addition, a higher remodelling potential of bone in toddlers prevents painless bone deformities ⁽²⁾. However, bone fractures in toddlers and children may result in some complications such as soft tissue injuries, infection, compartment syndrome, malunion and non-union fractures, and physical injuries of the tibia, which can trigger irreparable secondary complications, for which there is no practical treatment reported so far ^(1, 2, 4). Vitamin D (calciferol) takes part in a variety of biological activities in the body and specifically affects bone metabolism and homeostasis. It controls not only the process of bone mineralization and calcium and phosphorus absorption in the body but also regulates a variety of biological activities of bone cells such as osteoclasts. As such, the prolonged deficiency of vitamin D and changes in its metabolism can cause diseases such as rickets ⁽⁵⁻⁷⁾. Taking note of the rather rare prevalence of fractures and associated post-fracture complications in toddlers and the key role that vitamin D plays in bone metabolism and mineralization and the likely problems that can occur following prolonged vitamin D deficiency, the present study investigates the correlation between the level of vitamin D and the likelihood of tibia bone fracture in toddlers aged 18 to 36 months. The study further sheds light on the necessity for taking timely preventive measures and

Corresponding author:

A Mirzaei Susefidi, MD

Email Address:

amirreza.mirzaei@live.com

treating toddlers with vitamin D deficiency to avoid its adverse complications in the future.

Methods

The present cross-sectional study recruited all toddlers aged 18 to 36 months with tibial fractures referred to an educational and treatment center in 2019. The inclusion criterion was being in the age range of 18 to 36 months and having a tibia bone fracture. Otherwise, toddlers with fractures in other areas or comminuted fractures of bone, and those having diseases such as osteogenesis imperfecta (OI), osteoporosis, congenital and hereditary disorders, metabolic diseases, coagulation disorders, renal diseases, hepatic diseases, digestive system problems, delayed growth, and systemic diseases such as cystic fibrosis (CF) were excluded from the study.

All toddlers aged 18 to 36 months referring to the hospital emergency department while complaining of a low energy trauma was examined for any probable fracture. Then, those toddlers diagnosed with a tibial fracture (as confirmed with examinations, imaging, and finally by an orthopaedist) were included in the study after signing the informed consent form. Ultimately, the required data (e.g., demographic information) were collected through the prepared checklists. The type of trauma was non-penetrating (blunt) and it was found to be arisen due to falls in most cases. Once the toddler's general condition became stable and proper treatment measures were taken immediately after the fracture in a peaceful space away from any tension, the peripheral blood samples were obtained from toddlers for measuring the level of 25(OH) VD3. The blood samples were first labelled (indicating the general information of each patient) and then sent to the laboratory of Shahid Bahaonar hospital. The serum levels of 25(OH) VD3 in blood samples were measured using the ELISA kit (Monobind; CA, USA). Based on the type of kit employed, the vitamin D concentrations of less than 20 ng/ ml and from 21 to 29 ng/ ml were judged to be the "deficiency" and

"insufficiency" of vitamin D, respectively, while the concentrations above 30 ng/ ml appeared to be "sufficient". The results of the tests and other variables (i.e., the tibial fracture location [including proximal, middle, and distal fractures], as well as the fracture pattern [including comminuted, spiral, oblique, and transverse fractures]) were given in relevant tables. Data were analyzed in SPSS-20 software using the Kolmogorov-Smirnov test (for the quantification of data distribution), descriptive statistical tests (to measure frequency, mean, and standard deviation (SD) values), Chi-square test, one-way ANOVA, Kruskal-Wallis test, and independent t-test. The relationship between variables was investigated through Pearson's correlation coefficient. The results with a p-value less than 0.05 (typically ≤ 0.05) were considered to be statistically significant.

Results

Out of all 30 patients included in the study, the number of males was 1.5 times that of females, and most toddlers were at the age of over 28 months. Tibial shaft fractures were the most common type of fracture in toddlers, while distal fractures were observed only in 4 (13.3%) toddlers. There was no proximal tibial fracture in the participants. And finally, transverse and spiral fractures accounted for 80% and 20% of all fractures, respectively (Table 1). The mean serum concentration of vitamin D in toddlers was 31.6 ± 6.1 ng/ ml, ranging from 25 to 39 ng/ ml. The level of vitamin D in females and those aged lower than 27 months was higher than that in males and those aged over 27 months, but the difference between these groups was not statistically significant. The mean serum level of vitamin D in patients with tibial shaft fracture and those with spiral tibia bone fracture was lower than that in patients with distal and traverse tibial fractures, but the difference between these two groups was not found to be statistically significant (Table 2).

Table 1: Demographic variables		
Variable	Frequency - mean	% - SD
Gender		
Female	12	40
Male	18	60
Age		
Mean	3.30	3.34
18-27 months	24	80
28-36 months	24	80
Location of fracture		
Tibial shaft	26	86.7
Distal fracture	4	13.3
Pattern of fracture		
Traverse	24	80
Spiral	6	20

Table 2: The nexus between the level of vitamin D and demographic variables			
Variable	Serum level of vitamin D		p-value
	Mean	SD	
Gender			
Male	30.5	7.21	0.239
Female	33.25	3.91	
Age			
18-27 months	32.16	1.83	0.807
28-36 months	31.45	6.87	
Location of fracture			
Tibial shaft	31.07	6.38	0.244
Distal fracture	35	3.46	
Pattern of fracture			
Traverse	32.12	6.12	0.361
Spiral	29.5	6.5	

Discussion

The present study revealed that there is no significant correlation between the serum concentration of vitamin D and the likelihood of tibial fracture in toddlers aged 18 to 36 months referred to this medical center. A similar study by Parvaresh et al. in Kerman⁽⁸⁾ on toddlers of the same age reported the mean serum concentration of vitamin D of 36.9 ng/ ml, indicating no significant difference between the two studies.

In a study by Karpinski et al., 100 hospitalized children aged 3 to 18 years with low-impact fractures were compared with 127 controls who were hospitalized for other non-fracture reasons. The concentration of vitamin D in patients with fractures was lower than that of control patients. Furthermore, there was no

significant difference in the concentration of vitamin D between females and males. However, the concentration of vitamin D in patients was found to be significantly different between various seasons, with vitamin D levels that were observed to be higher in the spring than in the summer⁽⁹⁾. Notably, Karpinski et al. investigated a different age group in which the patients with fractures were compared with other controls. In the present study, the mean level of vitamin D was higher in females than in males, but the relationship between the two groups was not statistically significant. In addition, the present study did not investigate the concentration of vitamin D in different seasons of the year.

Anderson et al. evaluated the association of vitamin D intake and serum levels with

fracture risk in children less than 6 years of age in Toronto (Ontario, Canada) from May 2009–April 2013. A total of 206 cases with fractures in the upper or lower limbs were recruited from May 2009–April 2013 and matched to 343 controls. The relationship between the level of vitamin D and fracture risk was not statistically significant. However, children consuming vitamin D supplements had a significantly lower fracture risk. The study conducted by Anderson et al. was a case-control study and recruited a larger population than the present study. Additionally, their study did not specifically determine the exact location of the fracture⁽¹⁰⁾. Rosello et al. investigated and measured the concentration of vitamin D in 192 girls (mean age of 11.4 months) and 188 boys (mean age: 12 months) from 2005 to 2007. A total of 40 cases of vitamin D deficiency were found, including 22 cases in girls (mean age: 11.8 months) and 18 cases in boys (mean age: 12.1 months), for which there was no evidence of fracture (as confirmed by radiology images) and none of these participants had a previous experience of fracture. In agreement with the present study, Rosello et al. reported that the prevalence of fractures with vitamin D deficiency was zero and the changes in rickets were negligible, indicating no significant relationship between the level of vitamin D and increased fracture risk⁽¹¹⁾. Rostami et al. (2017) compared 30 children (2 to 14 years) with fractures in both forearm bones who were referred to the Imam Hussein Hospital Medical Center in Tehran with controls. The results revealed no statistically significant association between the level of vitamin D and forearm fracture, age, and gender of children aged 2-14 years⁽¹²⁾. Contrary to the present study, Saglam et al. reported that vitamin D deficiency is higher in patients with forearm fractures than in healthy participants. However, the present study showed that vitamin D deficiency has no significant relationship with tibial fracture. Nonetheless, there was no significant difference in serum levels of calcium, magnesium, phosphorus, ALP, and PTH

between the intervention and control groups. Contrary to the present study, there reported a significant correlation between the level of vitamin D and the increased likelihood of fractures⁽¹³⁾.

Conclusion

The present study had some limitations, including the small study population and no controls to match the study variables. The study targeted a special group of toddlers referred to the university center in a warm region in Southeast (SE) Iran, but it did not specify whether toddlers use breast milk or other alternatives. However, taking note of the paucity of studies carried out in line with this, the present study revealed a significant association between vitamin D level and its deficiency with an elevated risk of tibia bone fracture in toddlers between 18-36 months.

Prospects

Future studies are recommended to be carried out over longer periods, target a larger statistical population, match the study variables with healthy controls, and reflect the results in connection with various seasons of the year.

Conflict of interests

The authors whose names are listed immediately below certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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