

# Vitamin D Deficiency and Fractures in Childhood

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In an article in this issue of *Pediatrics*, Schilling et al<sup>1</sup> explore the possible role of vitamin D deficiency in the pathogenesis of fractures in young children. This study was stimulated by articles that reported individual cases in which fractures initially ascribed to child abuse were later thought to be a result of rickets<sup>2,3</sup>

In their study, Schilling et al found evidence of vitamin D deficiency, defined as a serum 25-hydroxyvitamin D level of <20 ng/mL, in ~8% of the children with fractures. The proportion was similar in children thought to have been abused and in those thought not to have been abused. They conclude that vitamin D deficiency was unlikely to have contributed to the fractures.

One difficulty with this logic is that included in the criteria for identifying abuse was the failure of the parents to explain the fractures. Although the lack of an explanation may be a pointer to nonaccidental injury, it is also a characteristic feature of fractures caused by bone diseases such as osteogenesis imperfecta, bone disease of prematurity, and, indeed, rickets.<sup>4</sup> Thus, the criteria for abuse could include patients whose fractures were actually caused by vitamin D deficiency. The authors found 7 patients with vitamin D deficiency severe enough to raise the serum parathyroid hormone level. It seems odd, despite this finding, to conclude that the deficiency in those patients could not have contributed to the fractures.

Does rickets cause fractures? Older authors thought so.<sup>5,6</sup> Numerous case reports have included fractures.<sup>7-17</sup> In a recent retrospective study, fractures were found in 7 of 40 children younger than 24 months with overt radiologic evidence of rickets.<sup>18</sup>

It is often forgotten that rickets, like osteomalacia in adults, may cause pseudofractures (Looser zones, Milkman fractures),<sup>2,4,9</sup> which may be mistaken for true fractures. They can be distinguished from fractures, in part, by the lack of associated clinical signs and the lack of change in serial radiographs before vitamin D therapy is instituted. However, in a child with good evidence of vitamin D deficiency, distinguishing a pseudofracture from an undisplaced true fracture may be academic.

Another difficulty in the diagnosis of vitamin D deficiency is that the radiologic signs may be absent or unimpressive in cases of children with biochemically severe deficiency, which is particularly true of infants younger than 1 year.<sup>2,19</sup> One 13-month-old boy in Florida had severe hypocalcemia and an undetectable 25-hydroxyvitamin D level but showed no radiologic evidence of rickets in repeated skeletal surveys.<sup>20</sup> In a group of infants with deficiency severe enough to cause convulsions, one-third of them had no metaphyseal abnormalities.<sup>21</sup> Even in older children there is no relationship between the radiologic signs and the severity of the disorder as measured by serum 25-hydroxyvitamin D levels.<sup>22</sup>

One factor that contributes to the discrepancy between radiology and biochemistry is the phenomenon known to earlier pediatricians as the “paradox of rickets.”<sup>23</sup> As the deficiency worsens, the epiphyseal changes become less obvious. The classical radiologic signs are not seen in a child who

is not growing. For similar reasons, the serum alkaline phosphatase level is often inappropriately normal in children who are not growing.<sup>24</sup>

There is another concern that is highlighted by Schilling et al in their article: of 118 children with fractures, including 37 thought to have been abused,

just 10 were evaluated by the metabolic bone service. This may well be a better proportion than in other centers, but is it good enough? One lesson from the recent literature is that fractures in childhood, including metaphyseal fractures, have a substantial differential diagnosis.

## REFERENCES

- Schilling S, Wood JN, Levine MA, Langdon D, Christian CW. Vitamin D status in abused and nonabused children younger than 2 years with fractures. *Pediatrics* 2011; 127(5):●●
- Keller KA, Barnes PD. Rickets vs abuse: a national and international epidemic. *Pediatr Radiol*. 2008;38(11):1210–1216
- Paterson CR. Vitamin D deficiency rickets and allegations of non-accidental injury. *Acta Paediatr*. 2009;98(12):2008–2012
- Paterson CR. Vitamin D deficiency rickets simulating child abuse. *J Pediatr Orthop*. 1981;1(4):423–425
- Fourman P, Royer P. *Calcium Metabolism and the Bone*. 2nd ed. Oxford, United Kingdom: Blackwell; 1968
- Greenfield GB. *Radiology of Bone Diseases*. Philadelphia, PA: Lippincott; 1969
- Begum R, Coutinho MD, Dormandy TL, Yudkin S. Maternal malabsorption presenting as congenital rickets. *Lancet*. 1968;1:1048–1052
- Bachrach S, Fisher J, Parks JS. An outbreak of vitamin D deficiency rickets in a susceptible population. *Pediatrics*. 1979;64(6): 871–877
- Park W, Paust H, Kaufmann HJ, Offermann G. Osteomalacia of the mother: rickets of the newborn. *Eur J Pediatr*. 1987;146(3):292–293
- Abanamy A, Salman H, Cheriyan M, Shuja M, Siddrani S. Vitamin D deficiency rickets in Riyadh. *Ann Saudi Med*. 1991;11(1):35–39
- Herman MJ, Bulthuis DB. Incidental diagnosis of nutritional rickets after clavicle fracture. *Orthopedics*. 1999;22(2):254–255
- Ecklund K, Doria AS, Jaramillo D. Rickets on MR images. *Pediatr Radiol*. 1999;29(9): 673–675
- Maiyegun SO, Malek AH, Devarajan LV, Dahniya MH. Severe congenital rickets secondary to maternal hypovitaminosis D: a case report. *Ann Trop Paediatr*. 2002;22(2): 191–195
- Innes AM, Seshia MM, Prasad C, et al. Congenital rickets caused by maternal vitamin D deficiency. *Paediatr Child Health*. 2002; 7(7):455–458
- Bloom E, Klein EJ, Shushan D, Feldman KW. Variable presentations of rickets in children in the emergency department. *Pediatr Emerg Care*. 2004;20(2):126–130
- Mylott BM, Kump T, Bolton ML, Greenbaum LA. Rickets in the dairy state. *WMJ*. 2004; 103(5):84–87
- Schnadower D, Agarwal C, Oberfield SE, Fennoy I, Pusic M. Hypocalcemic seizures and secondary bilateral femoral fractures in an adolescent with primary vitamin D deficiency. *Pediatrics*. 2006;118(5):2226–2230
- Chapman T, Sugar N, Done S, Marasigan J, Wambold N, Feldman K. Fractures in infants and toddlers with rickets [published correction appears in *Pediatr Radiol*. 2010; 40(7):1308]. *Pediatr Radiol*. 2010;40(7): 1184–1189
- Pettifor JM, Isdale JM, Sahakian J, Hansen JDL. Diagnosis of subclinical rickets. *Arch Dis Child*. 1980;55(2):155–157
- Root AW, Vargas A, Duckett GE, Hough G. Hypocalcemia and hypovitaminosis D in an infant from Florida, the sunshine state. *J Fla Med Assoc*. 1980;67(10):933–934
- Ahmed AM, Atiq M, Iqbal J, Khurshid M, Whitaker P. Vitamin D deficiency rickets in breast-fed infants presenting with hypocalcaemic seizures. *Acta Paediatr*. 1995;84(8): 941–942
- Abdul-Motaal A, Gettinby G, McIntosh WB, Sutherland GR, Dunnigan MG. Relationships between radiological and biochemical evidence of rickets in Asian schoolchildren. *Postgrad Med J*. 1985;61(714):307–312
- Mankin HJ. Rickets, osteomalacia and renal osteodystrophy. *J Bone Joint Surg Am*. 1974; 56(2):352–386
- Nagi NA. Vitamin D deficiency rickets in malnourished children. *J Trop Med Hyg*. 1972; 75(12):251–254

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## ERRATA

**Paterson. Vitamin D Deficiency and Fractures in Childhood. *Pediatrics*. 2011;127(5); 973–974**

An omission occurred in the commentary by Paterson entitled “Vitamin D Deficiency and Fractures in Childhood” published in the online and print editions of *Pediatrics*; (2011;127[5]: 973–974; doi:10.1542/peds.2011-0086). The author should have included the following disclosure:

“Dr Paterson has, before this publication, testified in trials related to topics discussed in this commentary, and is no longer registered by the General Medical Council (GMC) to practice medicine in the UK.”

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