

Effect of vitamin D in fracture healing in a child: case report

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Abstract

Summary In this report, we describe the effect of vitamin D and calcium supplementation on fracture healing in a young boy with a hypovitaminosis D who had a radius refracture. The radiographic evaluation of the callus formation shows a clear effect of vitamin D on fracture healing in absence of additional variables.

Introduction Fracture healing restores the tissue to its original physical and mechanical properties and it involves a complex multistep process that involves response to injury, intramembranous bone formation, chondrogenesis, endochondral bone formation, and bone remodeling. All this process is influenced by a variety of systemic and local factors. It is generally assumed that vitamin D plays an intimate role in healing fractures; however, very little data exists on how it does.

Case Report In this report, the authors describe the effect of vitamin D and calcium supplementation on fracture healing in a young boy with a hypovitaminosis D who had a radius refracture.

Conclusions Our case report suggests that the hypovitaminosis D is a possible cause of inadequate fracture healing and refracture in children and it shows a clear effect of vitamin D supplementation on callus formation in the absence of additional variables.

Keywords Vitamin D · Fracture healing · Hypovitaminosis D · Fracture

Introduction

Vitamin D is a fat-soluble vitamin that is essential for maintaining normal calcium metabolism. Vitamin D₃ (cholecalciferol) can be synthesized by humans in the skin upon exposure to ultraviolet-B radiation from sunlight, or it can be obtained from the diet.

Fracture healing restores the tissue to its original physical and mechanical properties and it involves a complex multistep process that involves response to injury, intramembranous bone formation, chondrogenesis, endochondral bone formation, and bone remodeling. All this process is influenced by a variety of systemic and local factors. It is generally assumed that vitamin D plays an intimate role in healing fractures; however, very little data exists on how it does [1–3]. In literature, there are some studies on animal models that show a positive effect of vitamin D on fracture healing [4–10] while there are very few reports on humans [11, 12] and no data on the role of vitamin D and calcium treatment in fracture healing are currently available in children.

In this report, the authors describe the effect of vitamin D and calcium supplementation on fracture healing in a young boy with a hypovitaminosis D who had a radius refracture.

Case report

We report a case of a 9-year-old boy that 2 months after a radius metaphyseal fracture had a refracture due to a low-energy trauma. After the second fracture, the patient was subjected to blood test to exclude the presence of abnormalities of bone metabolism. The only alteration highlighted in blood tests was the presence of 25(OH) vitamin D level of 22.2 ng/mL (n.v 30–100 ng/ml) while the calcium level was normal. The hypovitaminosis D was treated with a vitamin D (200 UI/day) and calcium (1 g/day) supplementation.

Both the radius fractures were treated in the same way with a long arm cast (to avoid pronosupination) for 1 month. The

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Fig. 1 On the *top*: X-rays of the first fracture treatment. On *low*: refracture treatment with use of vitamin D and calcium supplementation. We can see the difference in callus formation between the two fractures:

patient was subjected to an x-ray check 7 and 14 days after the fracture and after the cast removal (35 days).

The influence of the supplementation of calcium and vitamin D in the callus formation was retrospectively evaluated comparing the radiographic images of the two radius fractures from time zero to the cast removal after 35 days (Fig. 1).

Discussion

This case allows us to evaluate the efficacy of the supplementation with vitamin D₃ and calcium in fracture healing because we have the chance to eliminate most of the possible source of mistake: (a) we have the same patient with the same fracture, with the same treatment (long arm cast for 35 days); (b) the only difference between the first fracture (control) and the second one is related to the vitamin D blood level. In the first fracture (control), the reparative process occurred in a condition of relative hypovitaminosis (22.2 ng/mL), while in the refracture, it occurred with a calcium and vitamin D₃ supplementation started 3 days after the trauma.

As we can see from the radiographs, the first radius fracture was not completely healed after 35 days and for that reason the wrist was immobilized for further 15 day while the refracture was completely healed at the cast removal (after 35 days).

Comparing the callus between the two fractures, we can see that the supplementation with calcium and vitamin D is associated with a big endosteal and periosteal callus formation while the presence of a hypovitaminosis D is associated to an insufficient reparative process with a poor callus formation (Fig. 2).

Animal studies documented that low vitamin D levels led to suboptimal fracture healing and the administration of vitamin D accelerated initial fracture callus mineralization [4–10]. In vitro studies show that vitamin D, in conjunction with

the first healed in a condition of relative hypovitaminosis while the second healed with a calcium and vitamin D₃ supplementation

vitamin K, stimulates the transformation of fracture site stem cells to bone building osteoblasts [2].

There are very few studies on the effects of vitamin D and calcium supplementation in humans. Vitamin D status has been also shown to be an independent predictor of functional recovery after hip fracture [11].



Fig. 2 Radiographic evaluation of the callus formation after 35 days in the first fracture (a, b) and in the refracture (c, d). Comparing the callus between the two fractures we can see that the supplementation with calcium and vitamin D is associated with a big endosteal and periosteal callus formation while the presence of a hypovitaminosis D is associated to an insufficient reparative process with a poor callus formation

Eschle et al. in 2011 reviewed the benefits of vitamin D supplementation in fracture healing [3]. The authors found only two human studies, and only one, published by Doetsch in 2004, is focused on fracture healing [12, 13]. In this study, the authors performed a randomized double-blind placebo controlled trial in humans to investigate the effect of vitamin D and calcium supplementation on the healing process of human osteoporotic proximal humerus fracture. They demonstrated a positive influence of vitamin D₃ and calcium supplementation on fracture healing in women with reduced bone mass [13]. There are not any studies regarding the effects of vitamin D supplementation on fracture healing in children.

In contrast with the lack of data there regarding the role of vitamin D in fracture healing in humans, a study published in 2010 highlighted the presence of a very high prevalence of low serum levels of vitamin D among patients undergoing orthopedic surgery [14]. Of 723 patients reviewed, 43 % had insufficient serum vitamin D levels, and, of these, 40 % had deficient levels.

We can conclude that:

- There is a huge gap in our knowledge of the role of vitamin D in fracture healing in humans, especially in children. Our case report suggests that the hypovitaminosis D is a possible cause of inadequate fracture healing and refracture in children and it shows a clear effect of vitamin D supplementation on callus formation in the absence of additional variables
- Further study is needed to properly evaluate the effect of calcium and vitamin D on fracture healing.

Conflicts of interest None.

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