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Bilateral Calcaneal Stress Fractures in a Military Recruit Associated with Vitamin D Deficiency: A Case Report

Michael S Gruber*, Thomas Stumpner*, Martin Bischofreiter, Thomas Ziegler, Simon Recheis, Reinhold Ortmaier

Department of Orthopaedic Surgery, Ordensklinikum Linz Barmherzige Schwestern, Vinzenzgruppe Center of Orthopaedic Excellence, Teaching Hospital, Paracelsus Medical University Salzburg: 4020 Linz, Austria

Corresponding Author:** ***Michael S Gruber & Thomas Stumpner, *Department of Orthopaedic Surgery, Ordensklinikum Linz Barmherzige Schwestern, Vinzenzgruppe Center of Orthopaedic Excellence, Teaching Hospital, Paracelsus Medical University Salzburg: 4020 Linz, Austria*

Abstract

This case report describes a 19-year-old male recruit, who suffered from stress fractures of both calcaneal bones due to significantly reduced vitamin D3 levels. Complete bone healing was achieved following vitamin D supplementation and a single dose of denosumab.

1. Introduction to Bilateral Calcaneus Stress Fractures

Stress fractures are common, particularly among military recruits[1,2], however bilateral calcaneal stress fractures are rare occurring at a rate of only 0.35 per 10,000 person-years [3]. Risk factors include the repetitive impact and high force loading associated with activities such as running and marching. Due to the absence of consistent symptoms and history indicative of an acute injury, stress fractures are often misdiagnosed and may not appear on plain radiographs. In fact, only about 15% of stress fractures are visible on conventional x-rays[3]. Magnetic resonance imaging can be crucial for diagnosis, its availability may be limited.

Calcium intake, alcohol consumption, and smoking can impact the incidence of stress fractures in military personal[4]. In 2008, Lappe et al. showed that calcium intake is directly related to the prevention of stress fractures in female military recruits[1]. Controversely, alcohol consumption and smoking contribute to decreased bone density and higher risk of stress fractures[5,6].

A critical factor in stress fractures among military recruits is concentration of vitamin D3, which has a vital function in bone remodeling and fortification. The production of biologically active vitamin D metabolites is stimulated by direct UV radiation on the skin. Reduced outdoor activity in younger individuals—often due to academic pressures and increased use of electronic devices—leads to decreased vitamin D production and may contribute to the higher incidence of stress fractures, especially in young male recruits [7,8].

Carswell et al. showed that Vitamin D-level are directly correlated with bone stress injury[9]. However, there is a lack of extensive literature on this particular injury pattern. This case report is the first to link bilateral calcaneal stress fracture with vitamin D deficiency, without focusing exclusively on postmenopausal women or osteoporotic patients undergoing fluoride treatment as previously described[10,11].

2. Case Report: Bilateral Calcaneus Stress Fracture in a Military Recruit

We present a case study of a 19-year-old military trainee who developed stress fractures in both heels during a military march. He was previously in good overall health with no history of musculoskeletal issues. He had recently quit smoking (previously smoked 2 packyears) and had started using nicotine pouches.

The patient reported heel pain right after marching for 3 km while carrying a backpack of 65 kg. Despite pain, he continued to participate in further military exercises on the same day but later required Pain medication that evening as the pain intensified.

After experiencing moderate discomfort for three weeks and consistently taking nonsteroidal anti-inflammatory drugs, his health deteriorated, prompting a visit to the military doctor. He reported severe neck pain, chills, and a high body temperature of 39.2°C. Additionally, he mentioned experiencing pain in both ankle joints. The physical assessment indicated a positive calcaneal squeeze test in both heels, more pronounced on the left side. X-rays of both ankles showed regular joint surface articulation and revealed no fractures or calcaneal tendon osteophytes.

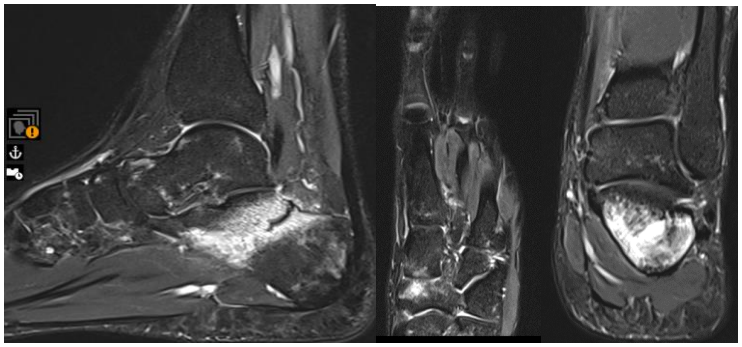
Subsequent tests revealed a vitamin D deficiency at 15.6 ng/ml (normal range: 30-80 ng/ml) and borderline low levels of parathormone at 16.1 pg/ml (normal range: 15-65 pg/ml). He was started on supplementation with 800 IU of vitamin D daily and advised to remain non-weight bearing in a wheelchair, along with thrombosis prophylaxis using low molecular weight heparin. Despite the improvement in symptoms from the viral infection, pain in hindfeet persisted, prompting an MRI.

3. Diagnostic Imaging and Initial Management

The MRI findings revealed a non-displaced fracture in the middle third of the left calcaneus, accompanied by significant bone marrow edema. Minor bone marrow edema was also detected in the talar head, navicular bone, and medial cuneiform. On the right side, a non-displaced trabecular fracture was observed in both the calcaneus and talus, along with bone marrow edema. Additionally, extensive bone marrow edema was present in the second metatarsal, while minor bone marrow edema was noted in the cuneiform bones and third metatarsal. (Fig. 1.)

The patient remained non-weight-bearing in a wheelchair, with thrombosis prevention and non-steroidal pain management continued. Three weeks after the initial MRI, a follow-up X-ray showed two small areas of increased bone density in the right calcaneus, along with signs of a chronic stress fracture characterized by discrete thickening of the cortical bone in the upper part of the right calcaneus.

A



B

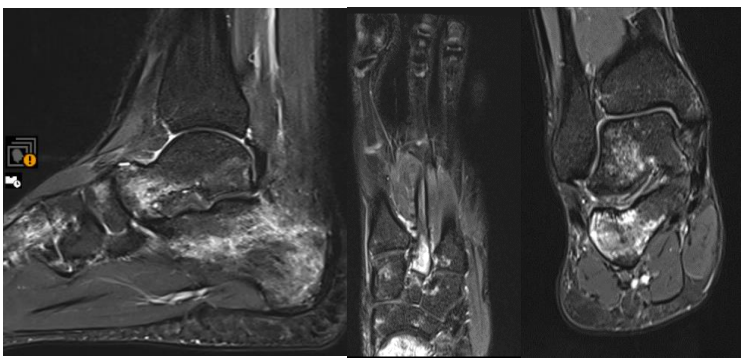


Figure 1

A. *Left side – Non-displaced fracture of the calcaneus with surrounding bone marrow edema; minor bone marrow edema in the talar head, navicular bone, and medial cuneiform.*

B. *Right side – Non-displaced trabecular fracture in the calcaneus and talus with bone marrow edema; extensive bone marrow edema in the second metatarsal; minor bone marrow edema in the cuneiform bones and third metatarsal.*

4. Inpatient Investigation and Treatment

The patient was re-admitted to a civilian hospital for further evaluation and treatment. Blood tests revealed persistently low vitamin D levels (15.6 ng/ml – norm 30-80ng/ml) decline in parathormone PTH 12.1 pg/ml norm (15-65) pg/ml) and elevated bone turnover (Beta

Crosslaps 1.38 ng/ml- norm < 0,58ng/ml). Inflammatory markers, kidney and liver function parameters, protein electrophoresis, and sex hormone levels were all within age-appropriate normal ranges. Skeletal scintigraphy showed no signs of systemic bone disease.

With other causes ruled out, vitamin D deficiency and the resulting disruption in bone metabolism were determined to be the sole explanation for the calcaneal stress fractures and delayed healing. Vitamin D supplementation was increased to 6,000 IU per day for 12 weeks, along with daily calcium (1,500 mg calcium carbonate and 400 IU cholecalciferol).

Two weeks after initiating high-dose vitamin D therapy and achieving normalized serum levels, a single dose of Denosumab (60 mcg s.c.) was administered to suppress osteoclast activity.

Five weeks after the initial MRI, a follow-up scan was performed (see Figure 2). It showed a reduced edema but persistent trabecular fracture lines on the right side. On the left side, the calcaneal fracture remained, with reduced edema in the calcaneus, talus, and second metatarsal.

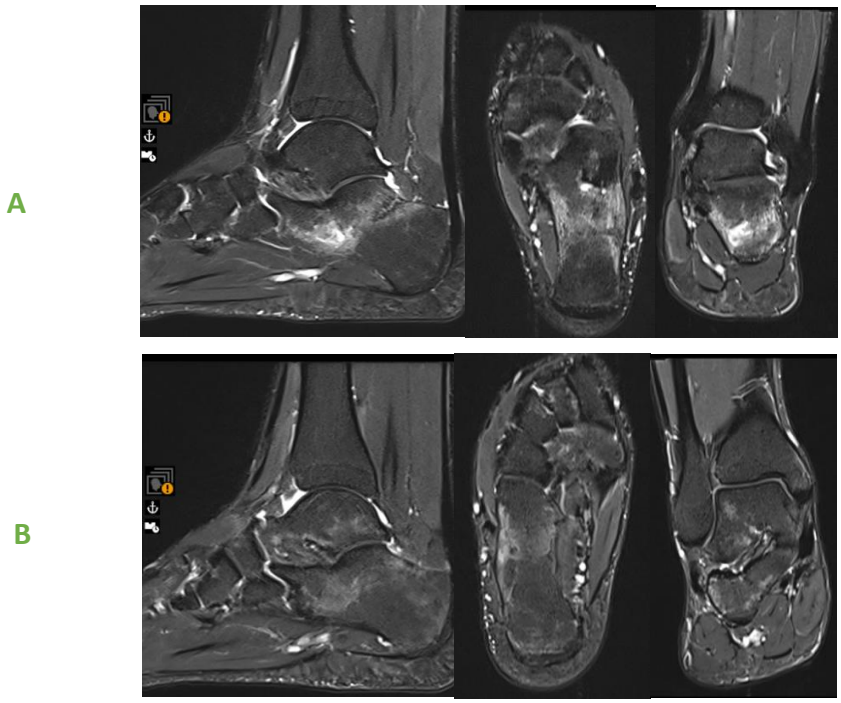


Figure 2

A *Left side – Persistent calcaneal fracture; reduced edema in the calcaneus and talus*

B *Right side – Significant reduction in edema; persistent trabecular fracture line.*

The patient started partial weight-bearing as tolerated using walker boots and crutches. By the 12-week follow-up, all blood parameters were within normal range with vitamin D levels improved to 56.4 ng/ml. Vitamin D and calcium supplementation were adjusted to 1000 mg calcium per day and 12.000 IU Vid D3 per week. The load was gradually increased to full weight-bearing in standard shoes over the next 2 weeks.

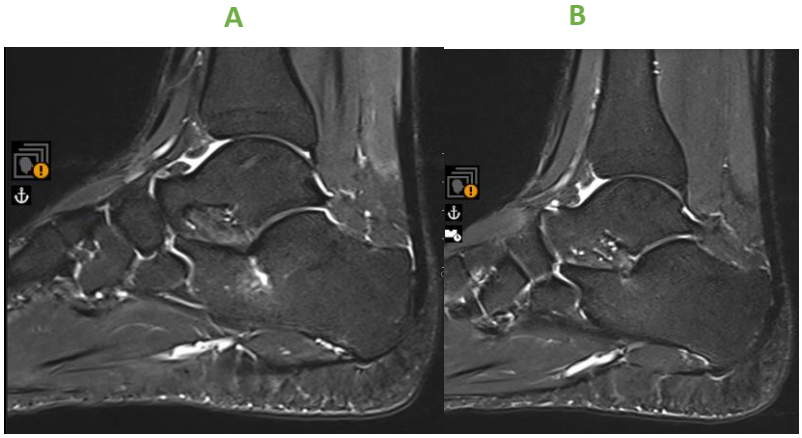


Figure 3. *A left side, B right side*

MRI Scans at 14 weeks showed complete fracture healing with minimal residual edema in the left calcaneus (Fig. 3)

Once fully mobile, outpatient lab tests will be conducted to monitor crosslaps, vitamin D, and calcium levels. If these values remain within normal ranges during full mobility, supplementation of vitamin D and calcium should be gradually reduced.

5. Discussion of influence of Vitamin D levels on stress fractures and importance for military recruits

Stress fractures were first described by army physician Breithaupt in 1855 [12]. They occur due to repeated excessive loading or overuse, combined with the bone's inability to adapt to mechanical stress. When bone resorption outpaces bone formation during remodeling, the resulting imbalance weakens the bone, leading to micro-cracks that may develop into fractures under persistent load. Stress fractures are more commonly found in the weight-bearing lower extremities, with a predominance in highly active populations such as athletes or military personnel [13]. While calcaneal stress fractures are less frequent than metatarsal, tibial, or fibular fractures, bilateral cases may be linked to metabolic diseases such as hyperparathyroidism or osteopenia[14,15]. Additionally, long-term use of certain medications like carbamazepine or methotrexate has been associated with bilateral calcaneal stress fractures[16,17].

Metabolic diseases associated with bilateral calcaneal stress fractures are hyperparathyroidism, osteopenia and diamond blackfan anaemia, Vitamin D deficiency has also been considered a potential contributing factor. [18–20]. Risk factors for stress fractures can be categorized into modifiable and non-modifiable factors. Addressing modifiable factors such as physical fitness, pathological gait patterns, and nutritional status—including vitamin D levels—offers opportunities for preventive intervention. On the other hand, identifying non-modifiable risk factors, such as female gender and advanced age, is essential for recognizing high-risk groups, even though these factors cannot be altered through interventions[13,21].

In recent years, there has been growing interest in the role of vitamin D in stress fracture incidence, particularly among military recruits[5,21,22]. Effect of vitamin D and calcium supplementation on stress fracture incidence in military personnel has been thoroughly studied by Lappe et al. and others[23] Beyond its effect on bone metabolism research has also explored the positive effect of vitamin D on immune response during Marine Corps basic training[1,24,25].

Given the established association between vitamin D deficiency and an increased risk of developing stress fractures, further research is warranted. Preventive measures ensuring adequate Vitamin D levels have already been implemented within military services. Evidence suggests that improving nutritional status, particularly maintaining sufficient vitamin D levels, could potentially reduce the incidence of stress fractures not only among military personnel but also in the general population.

6. Recommendation drawn from this case

The presence of bilateral stress fractures necessitates evaluation for underlying metabolic disorders.

Vitamin D deficiency may contribute to the development of stress fractures, whereas maintaining adequate vitamin D levels can reduce the risk.

Routine screening for vitamin D deficiency and appropriate supplementation, if necessary, could benefit young recruits and help minimize the risk of stress fractures.

7. Disclosures

The authors received no funding connected to this case report. MSG, TS MB, TZ, SR and RO declare that they do not have a conflict of interests. Informed written consent was obtained from the patient.

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