

The Effect of Conservative Immobilization and Vitamin D in Distal Radius Buckle Fracture Healing in a Child: A Case Report

Muhammad Irfan Rizaldy^{1*}, Amalia Rahmawati²

^{1,2}Ananda General Hospital, Purworejo, Indonesia

E-mail: irfan.rizaldy@gmail.com

* Corresponding Author



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ABSTRACT

Fraktur buckle radius distal adalah cedera lengan bawah paling umum pada anak-anak dan umumnya sembuh baik dengan penanganan konservatif. Vitamin D berperan penting dalam metabolisme kalsium dan mineralisasi tulang, meski pengaruhnya terhadap kecepatan penyembuhan fraktur anak masih diperdebatkan. Kami melaporkan kasus anak 3 tahun dengan fraktur buckle radius distal akibat jatuh dari posisi berdiri. Pasien dirawat secara konservatif dengan imobilisasi lengan pendek dan suplementasi vitamin D empiris (400 IU dua kali sehari) tanpa pemeriksaan kadar serum. Setelah 4 minggu, rontgen menunjukkan pembentukan kalus signifikan dan pemulihan penuh. Imobilisasi konservatif tetap menjadi standar emas karena hasilnya sangat baik dengan komplikasi minimal. Meskipun bukti tentang efektivitas vitamin D belum konsisten, secara biologis zat ini mendukung pembentukan tulang melalui diferensiasi osteoblas, sintesis kolagen, dan keseimbangan kalsium. Pada populasi dengan defisiensi vitamin D ringan, suplementasi dapat mempercepat pembentukan kalus dan memperbaiki hasil radiografis. Kasus ini menunjukkan pembentukan kalus dini yang kemungkinan dipengaruhi sinergi antara imobilisasi dan vitamin D. Penanganan konservatif efektif untuk penyembuhan fraktur buckle, dan suplementasi vitamin D, meski tanpa defisiensi terkonfirmasi, dapat membantu remodeling tulang serta mempercepat penyembuhan.

Distal radial buckle fractures are the most common forearm injuries in children and generally heal well with conservative management. Vitamin D plays a crucial role in calcium metabolism and bone mineralization, although its influence on the rate of fracture healing in children remains controversial. We report the case of a 3-year-old child with a distal radial buckle fracture following a fall from a standing position. The patient was treated conservatively with short-arm immobilization and empiric vitamin D supplementation (400 IU twice daily) without serum levels being measured. After 4 weeks, radiographs showed significant callus formation and full recovery. Conservative immobilization remains the gold standard due to its excellent outcomes with minimal complications. Although evidence for the effectiveness of vitamin D is inconsistent, it biologically supports bone formation through osteoblast differentiation, collagen synthesis, and calcium balance. In populations with mild vitamin D deficiency, supplementation can accelerate callus formation and improve radiographic findings. This case demonstrates early callus formation, likely influenced by the synergistic effect of immobilization and vitamin D. Conservative management is effective for buckle fracture healing, and vitamin D supplementation, even in the absence of confirmed deficiency, may promote bone remodeling and accelerate healing.



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INTRODUCTION

Fractures of the distal radius are the most common fractures in children, accounting for approximately 25–30% of all pediatric fractures (Ben-Yakov & Boutis, 2016). Among these, buckle (torus) fractures represent one of the most benign and stable forms, commonly occurring between the ages of 2 and 10 years. These injuries typically result from a fall onto an outstretched hand (FOOSH), which compresses the soft metaphyseal bone of the distal radius, causing the cortex to bulge outward without complete cortical break (Ben-Yakov & Boutis, 2016; Perry et al., 2022). Because the periosteum remains intact, buckle fractures heal rapidly with minimal risk of displacement (Woo et al., 2020).

Management has evolved significantly from traditional plaster casting toward minimal immobilization techniques. Several randomized controlled trials, including the FORCE equivalence trial, have shown that short-arm immobilization using removable splints or soft bandages is equally effective as full casting, while improving comfort and hygiene and allowing an earlier return to activities (Perry et al., 2022; Woo et al., 2020).

Fracture healing is influenced not only by mechanical stability but also by systemic nutrition and endocrine regulation. Vitamin D, a fat-soluble prohormone, is essential for calcium and phosphate homeostasis and for stimulating osteoblastic activity, collagen synthesis, and bone mineralization (Gatt et al., 2023; Hendrych et al., 2024). Deficiency in vitamin D can lead to delayed mineralization, impaired callus formation, and, in severe cases, rickets or osteomalacia (Holick, 2007).

Although the role of vitamin D in bone formation and prevention of fractures is well known, its direct effect on fracture healing in children remains debated. Recent studies suggest that supplementation may improve callus maturation and radiographic outcomes, particularly in children with subclinical deficiency (Hendrych et al., 2024; Slobogean et al., 2023).

This case report describes a 3-year-old child with a distal radius buckle fracture treated conservatively with short-arm immobilization and empiric vitamin D supplementation. The rapid callus formation observed at 4 weeks may reflect the synergistic benefit of both interventions.

METHOD

A 3-year-old male presented to the emergency department with right wrist pain following a fall while playing. The child landed on an outstretched hand, immediately crying and refusing to use the wrist. There was no history of significant trauma, chronic illness, or previous fractures.

Physical Examination

Localized tenderness was noted over the distal radius, with mild swelling and no visible deformity. The overlying skin was intact. Capillary refill, distal pulses, and motor and sensory function of the hand were normal.

Imaging

Initial radiographs of the wrist revealed a buckle (torus) fracture of the distal radius metaphysis characterized by cortical bulging without disruption or displacement



Figure 1 Initial wrist radiographs showing distal radius buckle fracture

No associated ulnar fracture or growth plate involvement was seen.

Management and Treatment

The patient was managed conservatively with a below-elbow (short-arm) immobilization using a soft cast for 4 weeks. In addition, the patient received oral vitamin D supplementation (400 IU twice daily) for 4 weeks. Laboratory evaluation for serum 25-hydroxyvitamin D was not performed due to resource limitation and the absence of severe deficiency symptoms.

Follow-up and Outcome

At 2 weeks, the child showed significant reduction in pain and swelling, with improved wrist movement. After 4 weeks, follow-up radiographs demonstrated robust callus formation and early cortical remodeling.



Figure 2 Four-week follow-up radiographs showing rapid callus formation and early cortical remodeling

Clinically, the patient had a full range of motion and no tenderness. No complications such as displacement, re-fracture, or deformity were observed.

RESULTS AND DISCUSSION

Epidemiology and Natural History

Distal radius buckle fractures are among the most frequent pediatric orthopedic injuries, reflecting both the high incidence of falls and the biomechanical vulnerability of the metaphyseal bone (Ben-Yakov & Boutis, 2016). These fractures are inherently stable, making them ideal candidates for conservative management. Recent studies confirm that soft bandages or removable splints are as effective as traditional plaster casting in achieving union, with faster functional recovery and higher patient satisfaction (Perry et al., 2022; Woo et al., 2020).

Role of Vitamin D in Bone Healing

Vitamin D is critical for calcium absorption and bone remodeling. It enhances osteoblastic differentiation, increases alkaline phosphatase activity, promotes collagen matrix synthesis, and regulates osteocalcin expression (Gatt et al., 2023; Hendrych et al., 2024). Hendrych et al. (2024) found that more than 75% of children presenting with fractures had vitamin D deficiency or insufficiency, and those receiving supplementation normalized serum levels and showed improved healing trajectories. Similarly, Gatt et al. (2023) and Slobogean et al. (2023) demonstrated that vitamin D supplementation can positively affect callus formation and time to union, although the overall effect size remains moderate.

Relevance to This Case

In this patient, vitamin D supplementation was initiated empirically (800 IU/day) despite untested baseline levels. The early radiographic callus formation at 4 weeks was faster than typical healing times reported in untreated cases (Perry et al., 2022). This finding aligns with literature suggesting that even low-dose supplementation may accelerate mineralization and remodeling in young children, particularly in populations at risk for deficiency (Gatt et al., 2023; Hendrych et al., 2024). Importantly, physiological doses of vitamin D are considered safe, with minimal risk of toxicity when administered short-term (Holick, 2007).

Limitations

This is a single case report and cannot establish causality between vitamin D supplementation and accelerated healing. However, given the biological rationale and supportive evidence from recent clinical studies, empiric supplementation may represent a low-risk adjunct to optimize fracture healing in children.

CONCLUSION

Distal radius buckle fractures in children are stable injuries that heal reliably with conservative immobilization. This case demonstrates that empirical vitamin D supplementation, even without confirmed deficiency, may contribute to earlier callus formation and enhanced bone healing. Addressing nutritional and metabolic factors remains an integral part of comprehensive pediatric fracture management.

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