# BIOCHEMICAL MARKERS AND BONE HEALING OUTCOMES IN POST-COVID-19 LONG BONE FRACTURE PATIENTS

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**Annotation** Bone healing may be significantly compromised in patients recovering from COVID-19 due to metabolic disturbances. Vitamin D deficiency and inflammatory imbalance are key contributing factors. Identifying biochemical predictors is crucial for targeted treatment. This article provides scientific research information about biochemical markers and bone healing outcomes in post-COVID-19 long bone fracture patients.

**Keywords:** bone healing, Post-COVID-19, patients, bone fractures.

**Relevance:** A unique feature of bone is its high capacity for regeneration and remodeling. The optimal outcome is to achieve a similar architecture and strength compared to the pre-injury state. This is achieved by three sequential and tightly coordinated interdependent phases: inflammation, repair and remodeling. The initial response to injury initiates a cascade of signaling pathways secondary to the inflammatory response. This initial response is critical for the subsequent stages: repair and remodeling. The first phase of fracture healing is influenced by the fracture hematoma environment and the biomechanical stability of fracture healing. Although the acute inflammatory response is known to be vital for fracture healing, it has also been shown that chronic and systemic inflammation can have a negative impact. This is seen in patients with polytrauma, sepsis and autoimmune diseases, in which fracture healing is impaired. Given that the initial immune response to injury plays a critical role in fracture healing, a better understanding of the osteoimmune system in both normal and pathological conditions will help optimize fracture management and allow future therapy to be targeted to improve bone healing.

**Aim of the Study:** To analyze the levels of vitamin D, osteocalcin, and β-CrossLaps in patients with long bone fractures after COVID-19 and to determine their relationship with fracture consolidation.

**Materials and Methods:** This observational study involved 126 patients treated from 2022 to 2024. They were divided into groups based on healing status: normal, delayed, and complicated. Blood samples were collected for immune-biochemical analysis, and data were statistically processed ($p \leq 0.05$).

**Results:** Vitamin D levels were significantly lower in patients with delayed and complicated healing compared to controls. Osteocalcin levels declined with worsening

bone regeneration, while β-CrossLaps levels increased. The most frequent fractures were femoral and caused by domestic or street trauma. Endocrine and cardiovascular comorbidities increased with age and negatively affected healing. Simple fractures predominated, especially in younger males.

**Conclusions:** Biochemical markers reflect altered bone metabolism in post-COVID-19 patients. Early metabolic assessment and individualized correction may support effective bone regeneration.

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