Non-union of a Tibial Plafond Fracture in a COVID-Positive Patient: A Case Report

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Learning Point of the Article:

This case highlights the potential impact of COVID-19 on fracture healing and non-union development.

Abstract

Introduction: Several studies have proposed a relationship between the coronavirus disease 2019 (COVID-19)-induced cytokine storm and prohibitive effects on the musculoskeletal system, including increased risk of fracture, osteoporosis, and impaired bone healing. To our knowledge, this is the first known case report involving a fracture non-union concomitant with COVID-19 infection and apparent cytokine storm.

Case Report: A 47-year-old male presented with an open pilon fracture of the left ankle after falling off a 6-foot ladder. At his 4-month post-operative follow-up, the patient attempted to ambulate without his cam boot for the 1st time, causing acute displacement of his poorly healed tibia fracture. A non-union laboratory workup demonstrated elevated inflammatory markers indicative of septic non-union; however, the patient also tested positive for severe acute respiratory syndrome coronavirus 2 at this time. Because of this, antibiotic treatment was not initiated due to suspicion of a cytokine storm. One month later, the patient's inflammatory markers had decreased and he underwent revision surgery.

Conclusion: This case underscores the potential impact of COVID-19 on fracture healing and the importance of vigilant monitoring and differential diagnosis in managing non-union in COVID-19-positive patients.

Keywords: Pilon fracture, tibial plafond fracture, delayed union, non-union, coronavirus disease 19, cytokine storm, revision.

Introduction

Since the emergence of the coronavirus disease 2019 (COVID-19) in 2020, a robust body of literature has developed to analyze the virus and its rippling effects on the human body and society. Despite this, few studies have explored the relationship between COVID-19 infection and fracture healing.

It has been established that patients infected with COVID-19 can develop a cytokine storm in response to the virus, thereby affecting the patient's immunological response [1, 2]. A cytokine storm involves the loss of regulatory control of pro-inflammatory cytokine production, leading to hyperinflammation that may impair a patient's healing ability and prognosis [3]. Two cytokines of particular interest are interleukin (IL)-6 and IL-1, which are known to play a crucial role in fracture healing pathways [4]. Altering physiologic production of these cytokines may impair the body's ability to heal fractures. There have been numerous reports describing COVID-19's effects on the processes of fracture management, but few articles have investigated the impact of COVID-19 in the context of fracture non-union. Here, we present a unique case of a tibial plafond non-union with an associated COVID-19 infection at 4 months post-operative. Informed consent was provided by the patient

Access this article online

Website: www.jocr.co.in

DOI: https://doi.org/10.13107/jocr.2025.v15.i02.5210

Author's Photo Gallery


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Submitted: 17/11/2024; Review: 27/12/2024; Accepted: January 2025; Published: February 2025

DOI: https://doi.org/10.13107/jocr.2025.v15.i02.5210

Figure 1: Initial injury radiographs of the left ankle including (A) anteroposterior, (B) mortise, and (C) lateral views demonstrating an intraarticular, displaced, comminuted tibial plafond and distal third fibular fracture.

before the development of this report.

Case Report

A 47-year-old male with no prior orthopedic history presented to the emergency department (ED) with an open fracture of the left ankle after falling off a 6-foot ladder. On presentation, a 4 × 2 cm anteromedial ankle wound with venous bleeding was noted, along with mild numbness to the great toe. His foot was warm and well-perfused, and his bilateral lower extremities were soft and compressible. A positive saline load test of the left ankle indicated involvement of the joint. Initial radiographs taken in the ED demonstrated a severely comminuted distal tibial plafond fracture with significant shortening and valgus angulation and an associated transverse distal third fibular shaft fracture (Fig. 1). The patient was COVID-19-negative at this time. Approximately 3 h after presentation, the patient was taken to the operating room for irrigation and debridement with the application of an ankle-spanning external fixator. Three weeks later, once the patient's soft tissues were amenable for definitive fixation, the patient underwent formal open reduction and internal fixation (ORIF) of the tibia and fibula. He was subsequently discharged home on post-operative day 2.

At the patient's 2-week follow-up, his incisions were well-healed without signs of drainage, dehiscence, or infection. He was instructed to remain non-weight-bearing and to begin passive stretching with home exercises. Three months post-operation, radiographs demonstrated complete union of the fibula but minimal healing of the tibia, particularly in the metaphyseal region (Fig. 2). At this time, he was encouraged to begin intermittent weight-bearing to increase mechanical stimulation and promote bone healing at the fracture site. At his 4-month follow-up, the patient reported being able to fully weight bear and ambulate with the assistance of crutches and a cam boot. Radiographs taken at this visit demonstrated no additional healing of the tibial metaphysis (Fig. 3a and b). During his evaluation in the clinic, the patient attempted to ambulate without the assistance of the cam boot for the first time and immediately heard a "pop" and felt pain in the affected ankle. Additional radiographs were taken, showing acute worsening of tibial fracture alignment (Fig. 3c and d). The patient was scaled back to toe-touch weight-bearing, and a non-union lab workup was ordered, demonstrating: Thyroid-stimulating hormone and Vitamin D within normal limits, slightly elevated liver enzymes and glucose, erythrocyte sedimentation rate (ESR) = 20, and C-reactive protein (CRP) = 21. The patient also presented with COVID-19 symptoms at this visit, which further complicated his differential. An infectious cause of non-union was considered due to the open nature of his initial injury; however, given that he tested positive for COVID-19, we did not proceed with antibiotic treatment due to suspicion of hyperinflammation secondary to a cytokine storm. One month later,

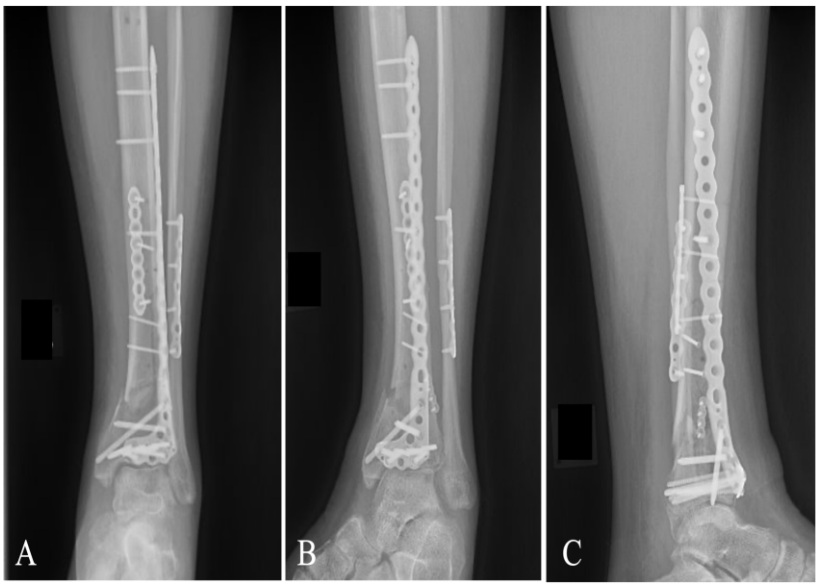

Figure 2: Three month post-operation radiographs of the left ankle including (A) anteroposterior, (B) mortise, and (C) lateral views demonstrating healing of the fibular fracture with minimal healing of the tibial metaphysis despite well-maintained tibial alignment.

Figure 3: Four month post-operation pre-ambulation radiographs of the left ankle including (A) anteroposterior and (B) lateral views demonstrating well maintained tibial alignment and intact hardware but minimal further healing of the tibial metaphysis. Four month post-operation post-ambulation radiographs including (C) anteroposterior and (D) lateral views demonstrating acute displacement of the tibial fracture with apex anterior angulation, hardware intact.

repeat labs revealed his CRP and ESR had decreased to 3.1 and 13, respectively. Given the new lab findings, we were confident that the elevation of inflammatory markers was due to the patient's underlying COVID-19 infection. We then felt comfortable proceeding with revision ORIF of his pilon non-union 1 week later.

The patient's immediate post-operative course after revision surgery was uneventful. The patient began ankle range of motion exercises at 2 weeks but remained non-weight-bearing until 6 weeks. Six-week post-revision radiographs demonstrated maintained tibial alignment compared to the immediate post-operative revision imaging and maturation of the bone autograft placed during the revision procedure (Fig. 4). Six months post-revision, the patient had returned to normal activities of daily living and partial work hours without complaint. Imaging from this visit revealed slight increased healing and callus formation relative to prior radiographs, however, two screws had broken in the medial plate (Fig. 5). Since the patient was doing well clinically, it was decided to reevaluate in 3 months. The patient was also given a bone stimulator at this visit to further encourage bone healing. Nine months post-revision, the patient had been ambulating without limitation, increased pain, or swelling and had returned to work full-time without restrictions. Repeat imaging demonstrated increased sclerosis and consolidation of the bone graft site, and the orthopedic implant appeared stable without further breakage or loosening (Fig. 6).

Discussion

In this case, the algorithm for treating this patient's non-union was altered in the setting of a COVID-19 infection. The patient's non-union workup demonstrated acute elevation of CRP and ESR as well as elevated liver enzymes and glucose. Given the initial open pilon fracture with subsequent non-union and inflammatory labs concerning a septic non-union, the treating surgeon was left with a difficult decision of whether to move forward with the staged treatment of the septic non-union or wait for resolution of the COVID-19 infection and normalization of labs. The latter treatment course turned out to be appropriate in this case, as the patient had satisfactory functional outcomes considering the severity of his initial injury. Although the exact timeline of this patient's COVID-19 infection is unknown, it falls within reason to assume that his infection was detrimental to the healing process at 4 months post-operation. This case serves as a reminder of the importance of maintaining a broad differential for septic non-union cases until the cause of infection is known, as improper diagnosis could lead to unnecessary costs, treatment, and poor prognosis.

In the wake of the pandemic, surgical centers and hospitals limited their capacity for elective surgeries, forcing surgeons to revise their treatment algorithms to lower the risk of viral spread [5]. As a result, much of the literature discussing the impact of COVID-19 on orthopedic patients has focused on the indirect effects of the pandemic on the management of fracture care. For example, pandemic-related reductions in outpatient follow-up

Figure 4: Six weeks post-revision radiographs of the left ankle including (A) anteroposterior and (B) lateral views demonstrating well-maintained tibial alignment with intact hardware. Autogenous bone graft placed during the revision surgery appears to be maturing. There is some increased bony callus formation over the lateral aspect of the tibia.

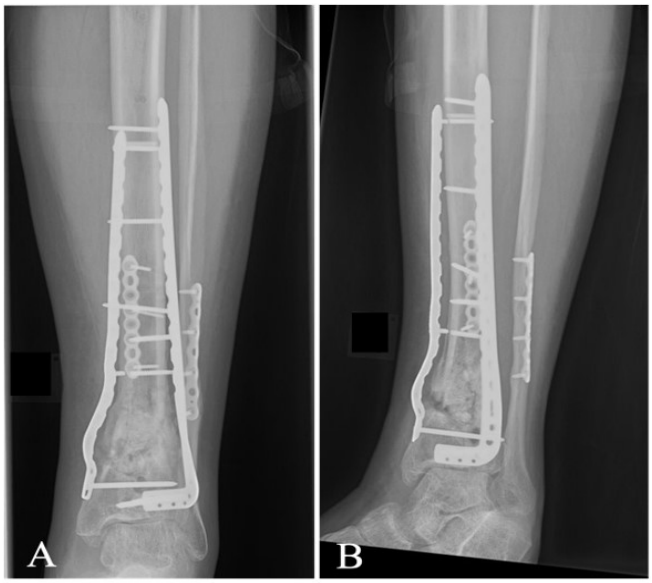

Figure 5: Six months post-revision radiographs of the left ankle including (A) anteroposterior and (B) mortise views demonstrating slight increased healing and callus formation relative to prior radiographs. The medial plate demonstrates a proximal and distal screw which have broken.

visits have been attributed to cases like proximal humerus non-union requiring specialized treatment [6]. More recently, however, researchers have raised concerns about a potential link between COVID-19 and bone metabolism with implications for fracture healing. Mi et al. demonstrated that COVID-19 infection can lead to the overexpression of miR-4485, which suppresses osteogenic differentiation and impairs fracture healing capacity. Targeting Toll-like receptor four may offer a potential avenue for enhancing fracture healing and combating osteoporosis in COVID-19 patients [7]. A 2022 review by Veronesi et al. proposed the many effects that a COVID-19-induced cytokine storm can have on musculoskeletal tissues, highlighting mechanisms that could lead to worsening of musculoskeletal pathology or altered regenerative potential [8]. In addition to the pro-inflammatory state associated with a cytokine storm, heightened risks of prolonged immobility, and malnutrition in orthopedic trauma patients can further contribute to impaired healing. Furthermore, acute bone loss following COVID-19 infection has been documented in mice, emphasizing the importance of investigating musculoskeletal effects and long-term bone health in COVID-19 patients to mitigate fracture risks [9].

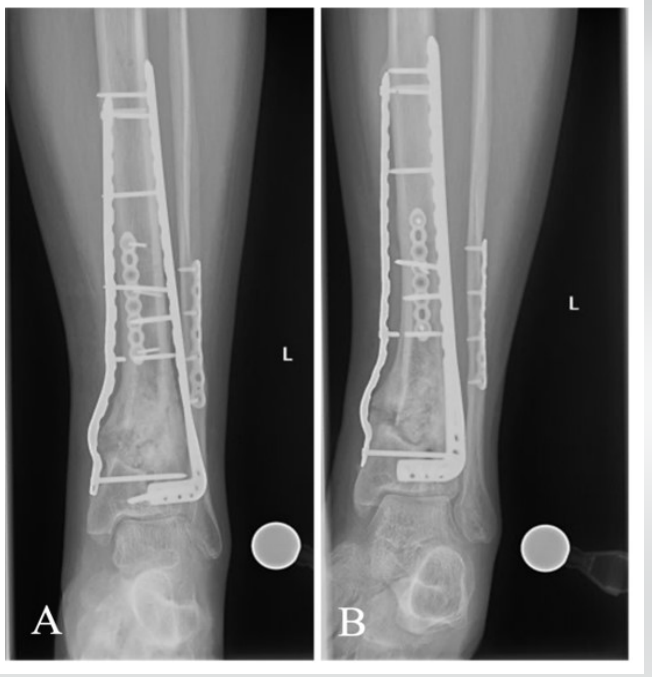

Figure 6: Nine months post-revision radiographs of the left ankle including (A) anteroposterior and (B) mortise views demonstrating further consolidation of the graft site with no further hardware failure.

Conclusion

Despite emerging evidence to suggest an association between COVID-19 infection and impaired bone healing, it has not been confirmed whether COVID-19 increases the risk of non-union after fracture repair [10]. This case raises suspicion of COVID-19 as a cause of non-union and supports the importance of vigilant monitoring of COVID-19-positive patients through regular follow-up, radiographic imaging, and inflammatory laboratory markers. Further research is needed to comprehensively understand the effects of COVID-19 on bone

health and fracture non-union, facilitating the development of targeted interventions to mitigate its potential detrimental effects.

Clinical Message

Clinicians should maintain a broad differential diagnosis when encountering non-union and consider the effects of systemic infections like COVID-19 on bone healing processes.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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Conflict of Interest: Nil
Source of Support: Nil

Consent: The authors confirm that informed consent was obtained from the patient for publication of this case report

How to Cite this Article

Singleton A, Mancuso II AJ, Eaddy SG, Phillips S. Non-union of a Tibial Plafond Fracture in a COVID-Positive Patient: A Case Report. Journal of Orthopaedic Case Reports 2025 February;15(2): 11-15.