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Comprehensive management of a grade 3a open femoral shaft fracture with infected non-union using fibular graft: A case study

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Abstract
Background: Open fractures of the femoral shaft, particularly Grade 3A types, present complex challenges necessitating meticulous management strategies to mitigate complications and achieve successful outcomes. This case report describes the comprehensive management of a Grade 3A open femoral shaft fracture complicated by infected non-union in a 50-year-old male following a motor vehicle accident.
Case Presentation: The 50-year-old male presented to the Emergency Department following a motor vehicle accident. His chief complaint was a Grade 3A open fracture of the right femoral shaft. Initial treatment involved emergent debridement and temporary stabilization with an external fixator to minimize infection risk and maintain fracture alignment. Subsequent interventions included plate and screw fixation with bone grafting to promote healing. However, implant failure and infected non-union necessitated reoperation, including osteotomy and external fixation, augmented with a bone spacer and antibiotics. Long-term follow-up revealed successful resolution of infection, restoration of limb function, and progressive bone healing with physiotherapy. Challenges such as implant failure and infection recurrence were managed through staged surgical interventions and vigilant monitoring.
Discussion: Despite initial setbacks such as implant failure, the staged surgical interventions, including debridement, osteotomy, and bone grafting, coupled with rigorous postoperative care, led to substantial improvement in the patient's condition, highlighting the critical role of multidisciplinary collaboration and adaptive treatment strategies in achieving favorable outcomes.
Conclusion: This case underscores the importance of a multidisciplinary approach integrating surgical expertise, evidence-based interventions, and rigorous postoperative care in achieving favorable outcomes for complex femoral shaft fractures. Continued research and clinical innovation are crucial to further refine treatment strategies and optimize outcomes in similar challenging scenarios.

Keywords: Open fracture, femoral shaft, Grade 3A, infected non-union, osteotomy, bone graft, multidisciplinary approach

Introduction

Open fractures of the femoral shaft present complex clinical scenarios, demanding meticulous management strategies to mitigate potential complications and achieve successful outcomes. These fractures, particularly Grade 3A types, characterized by significant soft tissue damage with adequate bone coverage, pose considerable challenges due to the delicate balance required in addressing both the skeletal injury and the associated soft tissue trauma. Prompt and comprehensive treatment approaches are imperative to minimize the risk of infection, promote optimal bone healing, and restore functional limb integrity [1].

Historically, the management of open femoral shaft fractures has evolved significantly, driven by advancements in surgical techniques, implant technology, and understanding of fracture biology. Initial interventions typically involve emergent debridement of contaminated soft tissues and fracture fragments to reduce the risk of infection and establish a conducive environment for subsequent healing processes. Temporary stabilization through external fixation serves as a crucial interim measure, allowing soft tissues to recover while maintaining the alignment and length of the fractured femur [1].

In recent years, internal fixation methods, such as the use of plates and screws, have gained prominence as primary treatment modalities for open femoral shaft fractures. These techniques offer enhanced biomechanical stability and facilitate early mobilization, thus accelerating the rehabilitation process. However, despite advancements in surgical techniques and implant design, complications such as implant failure and infection remain significant challenges in the management of these fractures [2].

Infected non-union represents one of the most formidable complications encountered in the treatment of open femoral shaft fractures. This condition arises from a combination of factors, including persistent infection, compromised vascularity, and inadequate fracture stabilization. Addressing infected non-union necessitates a multifaceted approach, incorporating thorough debridement of necrotic tissues, targeted antibiotic therapy, and augmentation of bone healing with grafting techniques [2].

Osteotomy, a surgical procedure involving the deliberate cutting of bone, emerges as a valuable tool in the armamentarium for managing complex femoral shaft fractures. By realigning the fracture site and optimizing biomechanical parameters, osteotomy facilitates the resolution of malunion and restores limb function. When combined with external fixation, osteotomy provides a versatile method for achieving precise fracture reduction and promoting biological healing [3].

Through a comprehensive review of the literature, this case study seeks to contextualize the management of a Grade 3A open femoral shaft fracture complicated by infected non-union within the broader landscape of orthopedic trauma care. By elucidating the underlying principles and evolving treatment paradigms, we aim to contribute to the collective

knowledge base and inform clinical decision-making in similar challenging scenarios.

Case Illustration

A 50-year-old male patient presented to the Emergency Department of Karangasem General Hospital, Bali, in November 2022. The patient arrived following a motor vehicle accident and was diagnosed with a Grade 3A open fracture of the right femoral shaft. Upon examination, a 2x2 cm open wound was observed on the right thigh, with the bone visibly exposed through the wound. X-ray imaging showed a comminuted fracture of the right femoral shaft, indicating the presence of multiple bone fragments (Figure1). The primary diagnosis was a Grade 3A open fracture of the right femoral shaft.

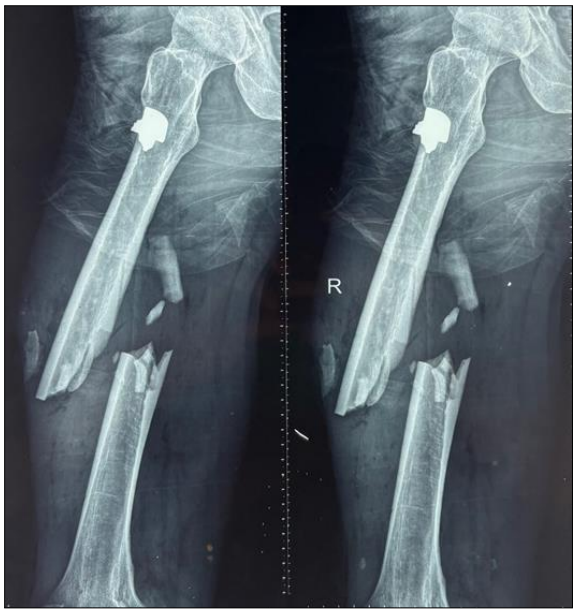

Fig 1: X-ray imaging showing a comminuted fracture of the right femoral shaft indicating the presence of multiple bone fragments upon the patient arrival.

The patient was managed with debridement of the fracture and applying an external fixator (Figure 2). This approach was employed to maintain temporary stability and to minimize the risk of infection in the soft tissue and bone.

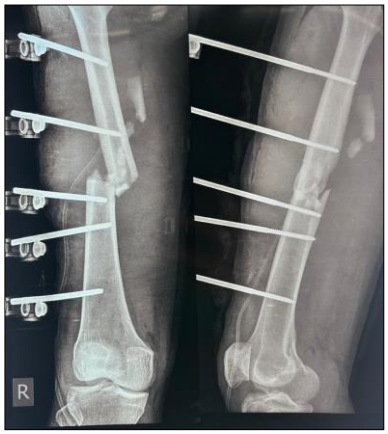

Fig 2: X-Ray of external fixation for the patient

Three weeks after the initial management and application of the external fixator, the wound on the right thigh appeared to have healed, with no exudate, pus, or bleeding observed. In early December 2022, the external fixator was removed, and a plate and screw were applied for further stabilization (Figure 3). Additionally, a bone graft was added to stimulate callus formation. The patient continued with outpatient care and began a physiotherapy program.

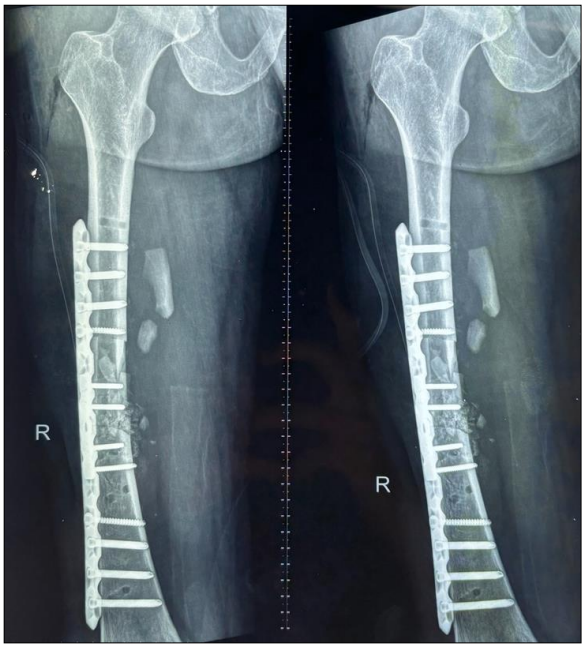

Fig 3: Advanced stabilization after external fixator replacement

Eight months after the plate and screw placement and bone graft (August 2023), the patient reported pain in the right thigh and stiffness in the right knee. Maximum flexion and extension of the knee were not achieved. A wound appeared on the thigh, revealing a protruding screw. X-ray imaging showed implant failure and minimal callus formation (Figure 4).

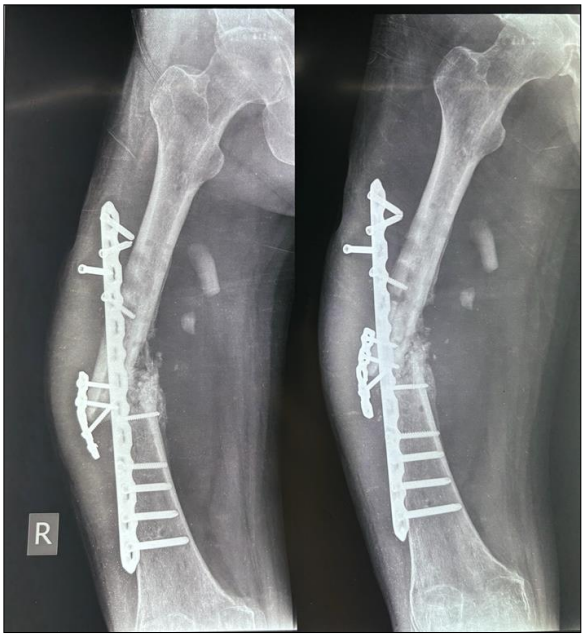

Fig 4: X-ray imaging showed implant failure and minimal callus formation

In late August 2023, due to the worsening condition, the patient underwent reoperation (Figure 5). The plates and screws were removed, and debridement of the fracture area

was performed. During the procedure, pus production and minimal callus formation were noted. The patient was diagnosed with infected non-union. Additionally, areas of the bone appeared yellowed and damaged. An osteotomy was performed on the femur, and external fixation was applied using pins and bars. A bone spacer with bone cement and antibiotics was placed in the bone gap to manage the infection and promote healing. An osteotomy was performed by cutting the femur approximately 2.5 cm proximal and distal to the fracture. The fracture area was thoroughly irrigated, and debridement was carried out on the surrounding tissues. External fixation was applied to maintain stability and preserve the length of the femur.

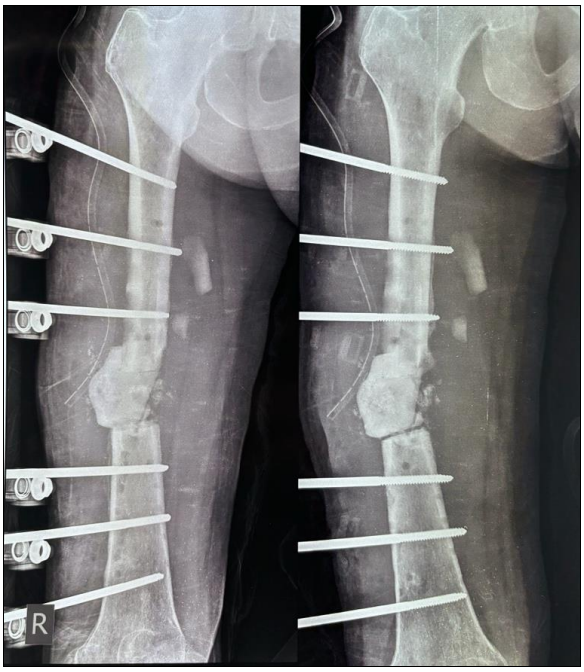

Fig 5: X-Ray of the patient undergoing reoperation

Two months postoperatively, the wound had begun to heal with no exudate or pus observed. The patient reported no longer experiencing pain in the thigh. Subsequently, the patient's treatment continued with the reapplication of plate screws and the insertion of a fibular graft (Figure 6).

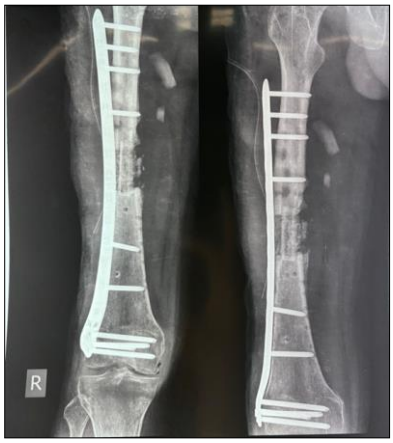

Fig 6: X-Ray of the reapplication of plate screws and the insertion of a fibular graft

Following improvement in the infection status, the pins and bars of the external fixator were removed, and the bone spacer was extracted. No pus production was observed in the surrounding bone and soft tissue. A fibula graft approximately 6 cm in length was harvested and implanted in the gap where the bone spacer had been placed. The fracture was then stabilized with a locking plate and screws. Broad-spectrum antibiotics were continued postoperatively.

One month postoperatively, the patient's wound was dry with no exudate, pus, or bleeding observed around the surgical site. The patient resumed physiotherapy to strengthen the thigh muscles and restore optimal range of motion (ROM). X-rays showed no callus formation at the fracture site, but the graft position remained stable (Figure 7).

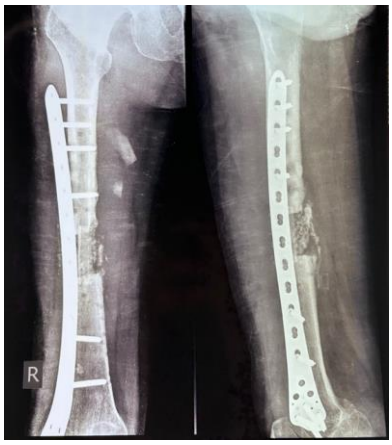

Fig 7: X-ray showing no callus formation at the fracture site and the stable graft position

Three months postoperatively, the patient achieved knee flexion greater than 60 degrees with minimal pain. The surgical wound appeared well-healed with no signs of infection. X-rays showed initial callus formation at the fracture site (Figure 8). Physiotherapy continued, and the patient mobilized with non-weight bearing using two crutches.

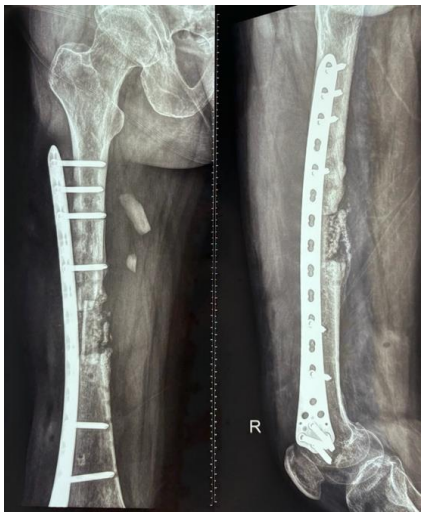

Fig 8: X-Rays showing stable graft position and callus formation at the fracture site

By May 2024, approximately six months postoperatively, the patient achieved knee flexion greater than 90 degrees and could sit comfortably. There were no signs of infection around the thigh and surgical wound. X-rays demonstrated increased callus formation at the fracture site.

Discussion

The management of Grade 3A open femoral shaft fractures, especially when complicated by factors such as infection and non-union, necessitates a nuanced approach informed by both clinical expertise and evidence-based practices. Drawing upon the insights gleaned from the literature review, we can elucidate several key considerations and strategies relevant to the discussion of this case [4].

Central to the successful management of complex orthopedic injuries is the collaborative involvement of a multidisciplinary team comprising orthopedic surgeons, infectious disease specialists, microbiologists, and physiotherapists. This interdisciplinary approach enables comprehensive evaluation, tailored treatment planning, and holistic patient care throughout the continuum of treatment.[4]

In cases of implant failure and infected non-union, surgical revision and debridement are cornerstone interventions aimed at addressing the underlying pathology and promoting favorable outcomes. Extensive debridement of necrotic tissues and contaminated implants is imperative to eradicate sources of infection and create a conducive environment for subsequent healing processes [5].

Osteotomy emerges as a valuable surgical adjunct in the management of complex femoral shaft fractures, particularly in cases of malunion and limb deformity. By strategically repositioning the bone segments and restoring anatomical alignment, osteotomy facilitates the correction of biomechanical abnormalities and promotes optimal healing. Furthermore, when combined with external fixation, osteotomy allows for precise fracture reduction and stabilization while preserving soft tissue viability [5, 6].

The use of bone grafts represents a fundamental strategy in promoting bone healing and addressing osseous defects in cases of infected non-union. Autologous bone grafts, harvested from the patient's own body, offer biological compatibility and osteogenic potential, facilitating the regeneration of bone tissue. Additionally, the incorporation of bone graft substitutes, such as demineralized bone matrix and bone morphogenetic proteins, provides an adjunctive means of enhancing osteogenesis and accelerating the healing process [6, 7].

Optimal rehabilitation plays a pivotal role in maximizing functional outcomes and promoting long-term limb function following orthopedic surgery. A structured physiotherapy program, tailored to the individual patient's needs, focuses on strengthening the surrounding musculature, restoring range of motion, and facilitating gradual return to weight-bearing activities. Close collaboration between orthopedic surgeons and physiotherapists ensures a coordinated approach to postoperative rehabilitation, thereby optimizing patient recovery and minimizing the risk of secondary complications [4].

Long-term monitoring and follow-up are essential components of postoperative care in patients with complex femoral shaft fractures. Regular clinical assessments, radiographic evaluations, and laboratory investigations enable the early detection of potential complications, such as implant loosening, infection recurrence, or delayed union. Timely intervention and proactive management strategies are crucial in mitigating adverse outcomes and promoting sustained patient well-being over the course of recovery [4, 8].

The management of Grade 3A open femoral shaft fractures complicated by infected non-union necessitates a comprehensive and multidisciplinary approach, integrating surgical expertise, evidence-based interventions, and diligent postoperative care. By synthesizing insights from the literature review and contextualizing them within the framework of this case study, we underscore the importance of tailored treatment strategies, vigilant surveillance, and collaborative teamwork in achieving favorable patient outcomes and restoring functional limb integrity. Through continued research and clinical innovation, we strive to further refine our understanding and refine our approaches to optimize the care of patients with complex orthopedic injuries [4-8].

Conclusion

The timely and effective management of open fractures is crucial to prevent complications such as infection and to promote healing. This case underscores the importance of a multidisciplinary approach in treating complex fractures. Despite initial challenges, including infection and implant failure, the staged surgical interventions and comprehensive postoperative care, including physiotherapy, facilitated significant improvement in the patient's condition. Continuous monitoring and adaptation of the treatment plan were essential to achieve the best possible outcomes for the patient.

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