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Case Report

Management of patients with combined height injury – a case report

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Abstract

Combined musculoskeletal traumas (MST) are complex injuries that can lead to life-threatening conditions and high mortality rates, particularly in men under 45 and women under 35. Recent increases in multiple trauma incidence highlight the need for timely intervention and effective management strategies. The concept of damage control orthopedics emphasizes the importance of stabilizing life-threatening injuries first, followed by staged surgical interventions once the patient's condition is stabilized.

We report a case of a 40-year-old man who sustained multiple MSTs following an 8-meter fall in an elevator shaft. The injuries included a burst L3 vertebral fracture with spinal canal stenosis, multiple limb fractures, and severe foot trauma requiring partial amputation. Initial management involved laminectomy and spinal stabilization, followed by staged fracture fixation and plastic reconstruction of soft tissue defects using adjacent tissue transfer, free skin grafting and high-intensity focused ultrasound (HIFU) therapy.

Postoperatively, the patient developed marginal necrosis of the amputation stump, managed with serial necrectomies and nanosilver dressings. Six months postoperatively, the patient achieved good fracture consolidation, preserved vital tissue flaps, and restored mobility with a walking frame. Despite severe soft tissue damage, the final outcome was considered successful, enabling independent mobility. This case underscores the critical role of a multidisciplinary approach in managing MSTs and highlights the use of advanced techniques, such as HIFU and nanosilver therapy, in optimizing functional and aesthetic outcome.

Keywords

fracture stabilization, injury, local flaps, muscle-skeletal traumas, skin-grafting

Introduction

Combined musculoskeletal traumas (MST) can be life-threatening and may result in lethal outcomes. While falls from heights happened less often compared to other mechanisms of injury, they were associated with a significantly greater risk of death. Despite their lower frequency, falls from elevated positions proved to be more lethal than any other type of injury mechanism.[1] The height from which a person falls is a strong indicator of their overall outcome and likelihood of survival. Although significant progress has been made in trauma care, mortality rates associated with falls from heights have not shown notable improvement. This highlights the critical need for increased

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safety awareness and the implementation of injury prevention programs aimed at minimizing the risk of high-level falls.[2] The role of trauma surgeons in these cases is to assess the extent of musculoskeletal damage and develop an emergency management plan. In the early post-traumatic period, it is crucial to determine whether there are fractures of the pelvis or long tubular bones and to evaluate the severity of accompanying soft tissue injuries.

In cases of combined MSTs, timing of surgical intervention is critical, giving rise to the concept of damage control orthopedics. The initial phase involves emergency measures to address life-threatening conditions and urgent transportation to a critical care unit for cardiopulmonary resuscitation. Definitive treatment is typically delayed until the inflammatory response subsides. The primary goal is to stabilize hemodynamics, control bleeding, and complete other resuscitative measures before proceeding with definitive fracture fixation and subsequent rehabilitation.[3]

Following acute phase management and bone stabilization, attention should shift to soft tissue injuries, which are often accompanied by severe lacerations. Even in cases with minimal tissue loss, trauma and tissue contusion can result in secondary necrosis, exposing bone and external fixator defects. Soft tissue restoration presents a significant challenge for plastic surgeons and often necessitates multiple surgical interventions.

Case report

We present the case of a patient with multiple musculoskeletal injuries sustained after a fall from height, resulting in partial foot amputation due to severe vascular and soft tissue damage. After fracture stabilization, the patient required plastic reconstruction, which included adjacent tissue transfer, free skin grafting, treatment with nanosilver, and scar therapy using high-intensity focused ultrasound (HIFU) thermotherapy.

This case involves a 40-year-old male patient who sustained multiple injuries after falling from a height of 8 meters into an elevator shaft. Following initial emergency care and immobilization, he was transported to the emergency department, where resuscitation measures were performed to control shock. Imaging studies performed according to established protocols revealed the following injuries: L3 burst fracture with spinal canal stenosis, Denis I sacral fracture, proximal third fracture of the right humerus, Monteggia fracture of the left forearm, proximal third fracture of the right tibia, and comminuted fractures of both calves and both heels. After initial assessment and consultation, the patient was admitted to the Intensive Care Unit (ICU) until his general condition and vital signs had stabilized.

Surgical management

In the first stage of surgical treatment, due to the presence of spinal canal stenosis, the patient underwent a laminectomy with subsequent transpedicular stabilization of the fractured lumbar vertebra. The following procedures were performed in the subsequent stages: stabilization of the upper extremities with plate osteosynthesis, stabilization of the sacral fracture using a P-plate, and open reduction with internal fixation (ORIF) of the two pilon fractures. The tibial plateau fracture was treated with precise repositioning of the joint surface and fixation using two plates – lateral and medioposterior ***(Fig. 1)****.*

Due to severe fragmentation and bone loss in the right heel bone, it was not possible to perform fixation in situ with cannulated screws. Concussion and ischemia of the soft tissues led to necrosis of the distal foot and toes, necessitating a trans-tarsal bone amputation ***(Fig. 2)****.*

A local tissue flap was rotated to cover the defect, leaving only a few small, scattered areas on the dorsomedial aspect of the foot uncovered ***(Fig. 3)****.*

Postoperative management

Due to the presence of exposed bone fixators, single-stage closure was not feasible. Conservative treatment was initiated, involving debridement and dressings with nanosilver. Two weeks later, granulation tissue had formed, which was covered with split-thickness skin grafts harvested from the right thigh. The grafts healed successfully ***(Fig. 4)****.*

Marginal necrosis developed in the amputation stump due to compromised vascular supply, necessitating serial necrectomies and staged dressings with nanosilver (Acticoat Flex 3, Acticoat Flex 7). The wound healed spontaneously over three weeks.

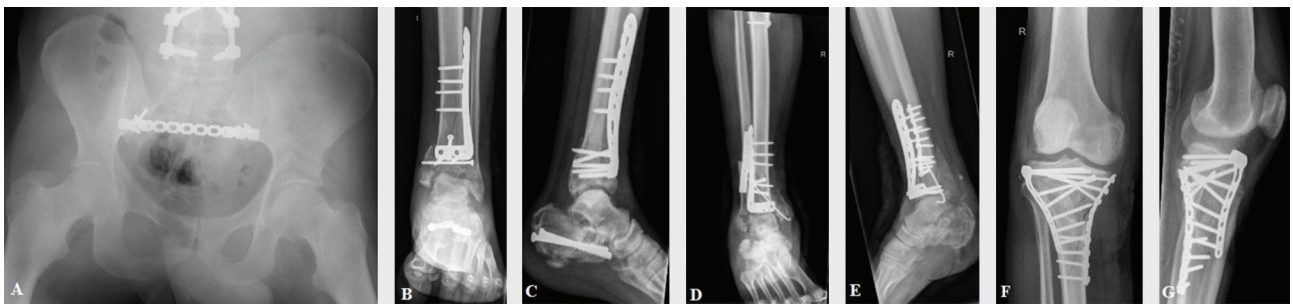

Figure 1. P-plate stabilization of the sacral fracture, metal osteo-synthesis of the two pilon fractures. In this case, trans-tarsal bones amputation was necessary.

Figure 2. The concussion of the soft tissues lead to ischemia and necrosis of the distal foot and the toes.

Figure 3. Amputation, local tissue flap, debridement and nano-silver dressing for the uncovered zones.

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Figure 4. Split-thickness skin grafting.

The patient was followed up clinically and with imaging at three and six months postoperatively. Functional assessments, including pain, range of joint motion, and mobility indicated consolidation of all fractures. In the right ankle joint of the amputated foot, the fracture healed with intra-articular depression, leading to post-traumatic arthrosis as anticipated. The plantar and free skin grafts were viable, and the donor site had healed with complete epithelialization. The patient is currently ambulating using a walker. The treatment outcome in this case is considered successful, as part of the foot in the heel area was preserved, allowing the patient to achieve verticalization and independent mobility using the heel as a weight-bearing point. Despite the severe soft tissue damage and compromised blood supply, the preservation of vital tissue flaps and grafts is considered a very good result. Marginal necrosis, as a complication, was effectively managed, and the outcome included well-healed bone fractures and satisfactory soft tissue coverage, providing the patient with a good quality of life.

Discussion

A large number of height-related injuries are due to workplace accidents or suicide attempts.[4,5,7] The overall condition of the patient prior to the trauma is significant. Comorbidities affecting the cardiovascular or respiratory systems, as well as frequent musculoskeletal injuries, aggravate the patient's general state. Damage to the vascular wall and heart of various etiologies exacerbates hemodynamic impairment after the trauma. This also hinders the recovery from tissue hypoxia during treatment.[6]

For patients with combined traumas, strict adherence to the Damage Control protocol is of paramount importance. This protocol allows for the control of bleeding, suppression of pathological inflammatory response, excision of devitalized tissues, reversal of ischemic-reperfusion damage, and effective pain management.[8] Height-related trauma is characterized by fractures, joint dislocations, and irreversible disorders of the musculoskeletal system.[9] Pulmonary trauma from a height fall leads to lung contusion, damaged blood vessels, and pleural cavity rupture caused by a rib fracture.[10] "Burst" fractures of the spine are a leading cause of disability and hemiparesis in height-related trauma.[11] The tendons of the lower limbs in humans, particularly the Achilles tendon, are designed to withstand significant weight and serve as a primary support for the body. Severe stretching and tension are required to cause damage to them. In height-related trauma, the "saber" impact on this support point of the lower limbs often leads to rupture, more frequently partial. Restoration of anatomical integrity does not always result in functional activity.[12] Definitive fracture treatment is typically performed between days 5 and 15, once circulatory and hemodynamic stabilization is achieved.[13,14] Our experience and literature review suggest that the safe period for definitive fracture fixation is be-

tween days 4 and 6 post-trauma, except in cases involving spinal cord and/or vascular injury, where surgery should be performed within 6 hours of the trauma.[14] During bone fixation, we followed the four principles established by the AO Foundation (Arbeitsgemeinschaft für Osteosynthesefragen): anatomic reduction of the fracture, stable internal fixation with preserved vascularization, and early patient mobilization.[15-17] In this case, the two pilon fractures were managed using the classic approach recommended by Rüedi and Allgöwer: reduction and fixation of the fibula, reconstruction of the tibial articular surface, implantation of bone grafts in cases of joint depression and/or metaphyseal defects, and fixation of the metaphysis to the tibial shaft using a plate.[19] This approach has shown good results according to literature. In a study of 84 pilon fractures, wound complications occurred in 12% of cases, and deep tissue infections in 5%. Approximately 73.7% of the patients reported good functional outcomes for four years post-trauma. In another study by Bourne et al.[18], of 42 high-energy comminuted fractures of the distal tibia, 13% developed deep tissue infections postoperatively. Dillin and Slabaugh[19] reported a 55% rate of wound complications, while Teeny and Wiss[20] found a 37% incidence of wound infections. The condition of the soft tissues in this area is a critical factor in the surgical management of pilon fractures. The complex anatomy and delicate nature of soft tissues in this region make surgical treatment challenging and risky. For soft tissue defects, the Mathes and Nahai classification remains a valuable tool in reconstructive planning.[21] The goal of any reconstruction is to achieve optimal post-traumatic restoration of form and function. Formation of tissue flaps requires good vascular supply. In cases of combined trauma and severe soft tissue contusion, definitive closure may be delayed indefinitely. Reconstruction involves staged wound management, infection control, and debridement.[22] Regional flaps can be used to cover small defects with exposed bone. In our case, it was necessary to close a defect around the foot and ankle.[23] Split-thickness skin grafts (STSG) are often chosen for their quick healing properties and low complication rates.[24] When extensive foot damage with limited local tissue availability occurs, STSG can be used to cover soft tissue defects. Nanocrystalline silver is widely used in wound care due to its strong antimicrobial properties. It serves as an antimicrobial barrier for wounds at high risk of infection or re-infection and is suitable for long-term wound therapy. Following the definitive closure of combined tissue defects, pathological scarring is common. Management includes the use of anti-scar medications and high-intensity focused ultrasound (HIFU) thermotherapy. HIFU is a non-invasive technology that delivers highly localized acoustic energy and is a promising method for scar ablation. It enables rapid ablation with minimal peripheral inflammation.[24] For the first time in Bulgaria, we applied this method to treat extensive scars resulting from burns and injuries.[25] Scar size reduction, depigmentation, and favorable aesthetic outcomes are the primary advantages of HIFU therapy. Combined with anti-scar medications and massage techniques, this method is effective in treating pathological scars. The preservation of functional activity in joints and bones, as well as the ability to walk and move the limbs, is severely limited. Most patients remain disabled for life, often losing part of a limb. The treatment of such types of height-related injuries often yields poor results, as the damage is irreversible and severe.[26] Despite the severe general condition and damage to many organs and systems, cases of patient recovery have been documented. In rare cases like ours, there is even preservation of movement and the ability for the patient to move and care for themselves.[27] The therapeutic approach for these patients is multidisciplinary. Pain is a leading symptom from the onset of the trauma and often continues after the completion of treatment. Even at home, these patients use opioid analgesics and nonsteroidal anti-inflammatory drugs, with a diminishing effect over time. This is primarily due to the significant number of damaged nerves, phantom pain, and other factors.[28]

Conclusion

Combined musculoskeletal traumas are severe, complex, and challenging to manage. Achieving a favorable outcome requires a coordinated, multidisciplinary approach among various medical specialists. The primary goal is to preserve patient mobility and ensure a good quality of life, which guides both the selection of surgical interventions and the timing of procedures. Regarding the functional activity of the musculoskeletal system, a satisfactory postoperative outcome has been observed, enabling the patient to move independently, albeit with the assistance of a cane. The severity of the fractures, their complexity, and the need for stable osteosynthesis necessitated open reduction with internal fixation, resulting in the successful verticalization of the patient.

We achieved stabilization of the spinal column as well as the fractures of the upper and lower limbs using metal implants, leading to the restoration of the range of motion in the affected areas. Despite an antalgic gait caused by the trans-tarsal amputation, we present a case following severe high-impact trauma where the patient retains the ability for self-care and mobility.

Ethics approval and consent to participate

Informed consent was obtained from all subjects involved in the study.

Consent for publication

Written informed consent has been obtained from the patient to publish this paper.

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Availability of data and materials

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Level of evidence IV

Evidence from well-designed case-control or cohort studies.

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Competing interests

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