Scalpellum
JOURNAL OF SURGERY & CLINICAL RESEARCH

Case Report

Management of Hypovolemic Shock in Crush Injury of Lower Leg: Case Report

Richardo Winara[1*], Muhammad Wiranata[1], Rahman Baihaki[1], Samira Amanda[1], Muhammad Ihsan[1], Sharfina Audrey[1], Muhammad Nurdiansyah[1]
[1]Department of Surgery, Faculty of Medicine, Riau University, Arifin Achmad Hospital, Pekanbaru, Riau

*Corresponding author: richardowinara01@gmail.com

Abstract

Multiple crush injuries are very important to be treated immediately, as an external force that involves muscle necrosis, soft tissue edema, and compartment syndrome should have an accurate diagnosis and timely intervention for limb salvage. Early therapy, such as resuscitation and correction of life-threatening electrolyte imbalance and renal failure. A 19-year-old male who was a pedestrian was admitted to the emergency room after being hit from behind by a car 5 hours before admission. The physical examination showed an open wound with multiple right lower leg fractures, followed by active bleeding. The patient also felt pain; the VAS score showed scores of 9, paresthesia, pallor, pulseless, paralysis, and poikilothermia were shown during investigation. Also, the patient has hypovolemic shock grade 3. A proper primary survey and initial fluid management are a vital part of saving someone's life during massive blood loss in a crush injury. Definitive surgical management in combination with fluid resuscitation was essential to keep hemodynamic stats within normal limits and prevent further tissue damage. A multidisciplinary care and causative therapy in combination with prompt recognition is essential. A comprehensive primary survey is essential to rapidly identify and control sources of massive hemorrhage, thereby reducing the risk of hypoperfusion-induced acute kidney injury. Prompt resuscitation with appropriate fluids and blood products plays a crucial role in restoring circulatory volume, maintaining distal tissue perfusion, and preventing ischemic complications.

Keywords: Case Report, Crush Injury, Hemodynamic, OREF, Physiotherapy

OPEN ACCESS
Submitted: 30 July 2025
Revised: 08 November 2025
Accepted: 18 November 2025
Published: 24 December 2025

Corresponding author
Richardo Winara
richardowinara01@gmail.com

Academic editor
Darmawi

Data Availability Statement
All relevant data are within the paper and its Supporting Information files.

Copyright
2025 Richardo Winara, et al
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Introduction

Crush injury refers to prolonged compression or direct high-impact trauma to body parts, most commonly the extremities, leading to soft tissue destruction, muscle necrosis, edema, and potential neurovascular compromise.[1,2] These injuries frequently occur from high-energy events such as motor vehicle collisions, industrial accidents, and natural disasters, with approximately 74% involving the lower limbs.[2,3] Major complications include compartment syndrome, hypovolemic shock, acute kidney injury, and in severe cases, crush syndrome.[1] Prompt recognition and early management are critical to reduce morbidity and mortality.[3] Essential strategies include early diagnosis, aggressive debridement, and temporary fixation to preserve limb function.[1] In complex cases with multiple open fractures and extensive soft-tissue loss, clinicians often face the decision between limb salvage and amputation, where the Mangled Extremity Severity Score (MESS) serves as a valuable guide.[4] Management priorities include volume resuscitation, decompression of compartment pressure, and correction of hyperkalemia and

metabolic acidosis through systemic alkalinization.[1] Additionally, the risk of infection in open crush injuries necessitates prophylactic antibiotics and tetanus immunization as part of initial care.[5] This case highlights the importance of early resuscitation, timely surgical intervention, and evidence-based decision-making in achieving optimal clinical and functional outcomes, in accordance with SCARE 2025 guidelines.[6]

Case

A 19-year-old male pedestrian was admitted to the emergency department after being hit from behind by a car 5 hours before admission. The patient's right lower leg was trampled by another car. There were no signs of loss of consciousness or projectile vomiting during the accident. He felt pain in his right leg with ongoing bleeding and bone exposure. The patient was then transferred to the primary healthcare facility for further investigation and prompt therapy. The general practitioners implemented resuscitation due to an estimated 1650 ml blood loss, then referred the patient to the emergency department of the general hospital for more multidisciplinary care and causative management. Wound dressing and wide-spectrum antibiotic Ceftriaxone 1gr/IV, Omeprazole 40mg/IV, Tranexamic acid 500mg/IV, Ketorolac 3%/IV were installed during transport. The patient then arrived in a somnolent condition. A primary survey was obtained, and the airway and cervical spine motion remained stable. There was no sign of abnormal breathing during the examination. SpO2 evaluation showed 96%. During the relevant examination on the injured, are an active bleeding, shortening, deformity, pallor, muscle spasm, the Thompson test was found positive, and bone exposure was found on the right lower leg with VAS 9.

Direct pressure was applied using a sterile dressing to stop the bleeding. The patient indicates a grade III hypovolemic shock condition, with blood pressure shows 89/55 and a heart rate of 137. Fluid resuscitation was performed to stabilize the patient's hemodynamics The mini neurological examination showed an isochoric pupil, physiologic reflexes were (+/++), predominantly decreased on Achilles reflex examination. Sensoric responses are decreased to scores of 1, and motoric responses are decreased to 2. There were no other injuries found. Laboratory examination revealed an elevated white blood level.

Secondary survey revealed no history of allergy or prolonged medication use. The patient had a history of Chronic Obstructive Pulmonary Disease (COPD) for 2 years. The patient was reported with an open wound on the right lower leg with active bleeding. The wound was visible, and bone was protruding from the wound (**Figure 1**). The pain is also getting worse, and loss of tactile sensation specifically found on the tip of the right lower leg.

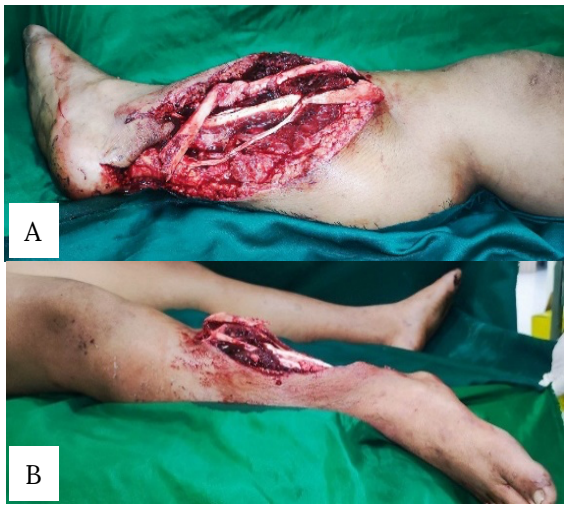
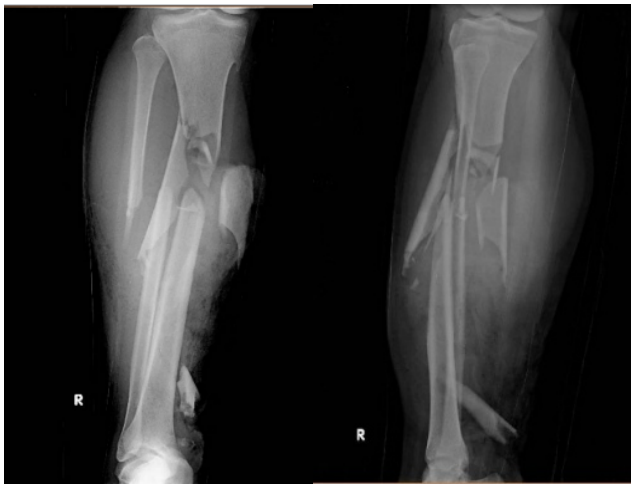


Figure 1. Medial view of the injury (A), Lateral view of the injury (B)

Open wound sized 9 cm on the right lower leg, revealing a complete open comminuted fracture with the proximal and distal fragments distracted with a highly contaminated wound. Capillary refilling time >2 seconds with a weak pulsation of the dorsalis pedis artery, and there was compartment syndrome during palpation. This examination was classified as Gustilo-Anderson grade III C. Radiology assessment pointed out a complete comminuted fracture on the right tibia and fibula (**Figure 2**).



(A) (B)

Figure 2. Cruris X-ray AP view (A), Lateral view of right cruris X-ray (B)

Fracture screening following the 4R procedure (recognize, reduce, retention, rehabilitation) implemented as an early assessment of fracture. Reducing deformity (rotation, angulation, shortening)

was performed based on the anatomical line. Immobilization using two splints placed on the inferior and lateral side of the injury. Patient then transported the patient to the operating room while wide wide-spectrum antibiotic administered. Ceftriaxone 1 g/IV, gentamycin 160 mg amp/IV, ketorolac 30 mg amp/IV, omeprazole 40 mg/IV, tranexamic acid 500 mg/IV.

Open Reduction External Fixation (OREF) was installed on the patient's leg (**Figure 3**). Distal neurovascular assessment revealed a normal palpable dorsalis pedis artery with capillary refilling rime (CRT) of 1 second. After stabilization, patient was transferred to the ward. Follow-up examination shows an improvement in the patient towards a better condition and no signs of infection. Patient was discharged and returned to the orthopedic clinic after 7 days for further evaluation. The patient was advised to perform certain maneuvers, such as lying, standing, and personal care. There was still some mobilization limit, especially standing up and doing personal care; the patient was still unable to carry a heavy object.

Figure 3. Post debridement and OREF installation

During the first week, wound condition was evaluated using FADI and EQ-5D. Both test revealed a good functional outcome. The FADI score was 30, and EQ-5D score was 0.3, and the VAS score decreased to 3. After a month after surgery, both scores showed a great improvement, where the FADI score increased to 52 and EQ-5D was 0.4. After two months of observation score also shows an improvement; the FADI score increased to 68, but EQ-5D did not show any improvement. After three months post-surgery, the score increased just a little better, FADI increased to 79, and EQ-5D to 0.5. After a four-month evaluation, there was a slight limitation on the patient while carrying heavy weights. The FADI maximum score is 104, or if we convert to a percentage, the score will be 100%. Based on our evaluation of the patient's condition post-surgery, the score is always improving.

Discussion

Despite being a common consequence of high-energy trauma, lower limb crush injury has the biggest percentage (74%) with open fractures and soft tissue degloving, which remain clinically challenging to manage due to the variability in tissue damage and infection risk.1 Therefore, early recognition of vascular integrity and appropriate classification of injury severity, such as using the MESS score and Gustilo-Anderson system, is essential to guide treatment decisions. Alanazi et al. perform shock management using NaCl 3% due to its benefits, such as giving a favorable effect to the Mean Arterial Pressure (MAP) and an inflammatory agent with lower volume. The study explains that the use of NaCl 3% and limited use of a colloid can decrease mortality.22 In our case, the patient is suffering from grade III hypovolemic shock with unstable hemodynamics. We implement resuscitation to correct electrolyte imbalance by using the shock formula (20 x 47 kg body weight divided by 15 minutes). After that, we continue to use 2.040 ml fluid/24 hours using the Holiday Sugar formula as fluid maintenance.

In this case, a 19-year-old male patient was referred to our emergency department approximately 5 hours after a traffic accident, presenting with a crush injury to the right lower leg. The trauma resulted in open, comminuted, displaced, and compromised neurovascular status fractures of the midshaft of both the right tibia and fibula (Gustilo-Anderson grade III C), along with a large open degloving wound on the medial and lateral aspects of the right lower leg. Gustilo Anderson is a classification for investigating an open fracture. It consists of III type. Firstly, type I was an open wound with crepitus with a size not larger than 1 cm. Type II, open fracture with a size of 1-10 cm long in combination with bone exposure. Type III Gustilo Anderson is divided into 3 classes. Class IIIa is when the open fracture is larger than 10 cm, but the surrounding soft tissue still exists to cover the exposed bone. Type IIIb is a condition where the surrounding soft tissue is lost and is unable to close the wound. IIIc is when the skin, soft tissue, and bone are expanded to infiltrate the neurovascular structure.

Conclusion

An investigation regarding crush injury is crucial; a thorough examination in combination with an adjunct test is able to detect an abnormal structure. Certain measurement tools, such as VAS, FADI, MESS, and GCS, can detect and summarize a patient's injury. The fluid

resuscitation was challenging during transport. its important to prevent early complications due to neurovascular injury by using multidisciplinary and causative therapies. The use of OREF in a comminuted fracture pattern may help bone realign with the anatomical structure.

Ethics approval

Arifin Achmad Regional Hospital has exempted ethical approval from reporting this case. Written informed consent for publication was obtained from the patient, and the patient agreed to be included in our case, including the image without name.

Acknowledgments

All authors equally contributed to case identification, manuscript drafting, and revision.

Competing interests

The authors have no conflicts of interest to declare.

Funding

This case report did not receive any specific grant from public, commercial, or not-for-profit funding agencies.

Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

References

1. Dimitriou N. Basics of Trauma Management: Crush Injuries. In 2021. p. 299–309.
2. Long B, Liang SY, Gottlieb M. Crush injury and syndrome: A review for emergency clinicians. Am J Emerg Med. 2023;69:180–7.
3. Portela RC, Roney N. Crush injury. In: Emergency Medical Services. John Wiley & Sons, Ltd; 2021. p. 294–8.
4. Abdo EM, Farouk N, ElImam SE, Elshinawy WE, Abdelhafez AA, Hamza M, et al. Mangled Extremity Severity Score in the Assessment of Extremity Injuries – Is it Reliable? Vasc Endovascular Surg. 2023;57(5):445–50.
5. Balkan, İlker İnanç, & Hakyemez, F. S. Antimicrobial Prophylaxis and Infection Control Precautions in Patients with Crush Injury. Cerrahpaşa Medical Journal, 47(1), 38–41.
6. Kerwan A, Al-Jabir A, Mathew G, Sohrabi C, Rashid R, Franchi T, Nicola M, Agha M, Agha RA. Revised Surgical CAse REport (SCARE) guideline: An update for the age of Artificial Intelligence. Premier Journal of Science 2025:10;100079
7. Sever MŞ, Katı YA, Özkaya U. Destructive disasters, trauma, crush syndrome, and beyond. Vol. 57, Acta Orthopaedica et Traumatologica Turcica. AVES; 2023. p. 306–14.
8. Resad Ferati S, Ganta A. Classification of open tibia fractures: the rationale for a new classification system. OTA International. 2024;7(4S).
9. Loja MN, Sammann A, DuBose J, Li CS, Liu Y, Savage S, et al. The mangled extremity score and amputation: Time for a revision. Journal of Trauma and Acute Care Surgery. 2017;82(3).
10. Shalini A, Singh D, Dachipalli S, Maddu S, Ram L. The Validity of the Mangled Extremity Severity Score Scoring System for Lower Limb Vascular Trauma in a Tertiary Care Center. Indian Journal of Vascular and Endovascular Surgery. 2020;7(2).
11. Minehara H, Maruo A, Amadei R, Contini A, Braile A, Kelly M, et al. Open fractures: Current treatment perspective. OTA International. 2023;6(3S).
12. Matsuo T, Thompson AL, Yuan BJ, Suh GA. The Latest Approaches to Fracture-Related Infection. Curr Infect Dis Rep. 2025;27(1):15.
13. Akrivos VS, Koutalos A, Stefanou N, Koskiniotis A, Arnaoutoglou C. Crush injury and crush syndrome: a comprehensive review. EFORT Open Rev. 2025;10(6):424–30.
14. Nambi GI, Salunke AA, Thirumalaisamy SG, Babu VL, Baskaran K, Janarthanan T, et al. Single stage management of Gustilo type III A/B tibia fractures: Fixed with nail & covered with fasciocutaneous flap. Chinese Journal of Traumatology. 2017;20(2):99–102.
15. Briggs M, Closs JS. A Descriptive Study of the Use of Visual Analogue Scales and Verbal Rating Scales for the Assessment of Postoperative Pain in Orthopedic Patients. J Pain Symptom Manage. 1999;18(6):438–46.
16. Garratt A, Stavem K. Comparison of EQ-5D-3L and 5L versions following operative fixation of closed ankle fractures. Quality of Life Research. 2022;31(7):2071–82.
17. Zovko Omeragić V, Tanović E, Mešanović E, Pecar M. FADI EVALUATION OF THE EFFECTS OF KINESITHERAPY AFTER ANKLE FRACTURE. Acta Clin Croat. 2023;62(2):270–6.
18. You DZ, Schneider PS. Surgical timing for open fractures: Middle of the night or the light of day, which fractures, what time? OTA International. 2020;3(1).
19. Hoff WS, Bonadies JA, Cachecho R, Dorlac WC. East Practice Management Guidelines Work Group: Update to Practice Management Guidelines for Prophylactic Antibiotic Use in Open Fractures. Journal of Trauma and Acute Care Surgery. 2011;70(3).
20. Ahuja PR, Akhuj A, Yadav V, Gulrandhe P, Ambekar AP. Managing Complex Foot Crush Injuries: A Case Report. Cureus. 2024 Jan 19;16(1):e52572.
21. Alanazi MM, Alshammiri MFS, Alotaibi TO, Alharthi FH, Aljohani OA, Algethami AM, Alharthi MH, Aljebreen FA, Salih EMA, Dhailan MKA, Alnajim LA, Alharbi FA. Hypovolemic shock in critically ill patient's early identification and impact of fluid resuscitation strategies and outcomes. IJMDC. Online First: 21 Sep, 2025.