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Clinical Evaluation and Management of Finger Crush Injury

Jean Kharismatik Persada, Iwan Hipsa Achmad, Riza Aprizal
Universitas Yarsi, Indonesia
Email: farhanprsada1@gmail.com

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Injury, Amputation, Trauma, Management.

Abstract
Hand injuries are among the most common musculoskeletal traumas and may lead to functional impairment, long-term disability, or limb loss if not properly managed. Among these, crush injury is a severe type characterized by damage to bones, soft tissues, and neuromuscular structures, often resulting from occupational accidents. This case report describes the diagnosis, management, and outcome of a 64-year-old male who presented to the Emergency Department of RSUD dr. Slamet Garut with severe pain and an open wound on his left hand after being struck by a concrete block. Data were obtained through anamnesis, physical examination, laboratory tests, radiography, and medical record review, then analyzed descriptively with reference to relevant literature. Ethical approval and informed consent were obtained. Examination showed an open wound, deformity, bleeding, and limited motion in the fourth and fifth digits of the left hand. Radiography revealed fractures of the distal phalanges. Due to extensive tissue damage and signs of ischemia, amputation of the distal phalanx of both digits was performed. The patient had a history of hypertension but no diabetes mellitus or other chronic diseases. He was diagnosed with a crush injury of the distal phalanges of the left hand caused by a work-related accident. Amputation was selected based on local tissue viability and long-term functional prognosis. Prompt diagnosis, appropriate management, and adherence to clinical guidelines are crucial to prevent complications and promote optimal recovery in crush injury cases.

INTRODUCTION

A crush injury is defined as compression of an extremity or other body part that causes muscle swelling and/or neurological impairment in the affected area. Crush injuries are caused by direct physical trauma and compression of the human body (An et al., 2022; Lahiri, 2020; Long et al., 2023; Schaefer et al., 2023). The compressive force directly damages soft tissue, muscles, bones, nerves, and other tissues depending on the location of the injury. The most common sites of injury are the lower extremities (74%), upper extremities (10%), and trunk (9%). Cell damage and myonecrosis resulting from crush injuries release myoglobin, potassium, phosphorus, and uric acid into the blood (Arikalang et al., 2023; Long et al., 2023).

Hand injuries represent a significant global health burden, constituting approximately 20% of all emergency department visits worldwide (World Health Organization, 2021). According to the International Labour Organization (ILO, 2019), occupational hand injuries account for nearly 25% of all workplace accidents, with crush injuries representing 15–20% of these cases. The economic impact is substantial, with estimated annual costs exceeding $20 billion globally due to medical expenses, lost productivity, and disability compensation. In

developing countries, the burden is disproportionately higher due to inadequate occupational safety measures and limited access to specialized hand surgery services.

In Indonesia, data from the Ministry of Manpower (2022) indicates that hand injuries constitute 32% of all occupational accidents reported annually, with the construction and manufacturing sectors accounting for the majority of cases. The National Social Security Agency for Employment (BPJS Ketenagakerjaan, 2023) reported 18,742 cases of upper extremity trauma in 2022, of which approximately 3,500 cases involved crush injuries requiring surgical intervention. Despite these concerning statistics, there remains a paucity of published case reports and clinical studies documenting the management protocols and outcomes of hand crush injuries in Indonesian healthcare settings, particularly in regional hospitals with limited resources.

Crush injuries can result from various types of workplace accidents. Generally, they occur in one of three scenarios: contact with machinery with moving parts, falling or collapsing construction materials, and contact with moving equipment (Abu-Zidan et al., 2023; Anderson et al., 2022; Goodman et al., 2017). Workers can be struck by falling heavy objects or crushed between two objects, such as vehicles, walls, and heavy boxes, which pin them to the ground. Machinery—whether trapping workers inside or falling onto them or pedestrians—can also cause crush injuries (Skiba, 2020). Tragically, crush injuries are sometimes fatal, but survivors often experience debilitating complications. These injuries may affect a large portion of the body, and due to nerve and organ damage, can have long-term consequences. They often result in the inability to return to work, causing financial hardship for workers and their families. Common crush injuries include spinal cord damage and paralysis, internal organ damage, amputations, bone fractures and crushes, head injuries with associated drainage, muscle and tendon damage, and nerve damage (Dahlgren, 2015; Gossman & Cooper, 2020; Lee et al., 2018; May & Cooper, 2018; Staunton et al., 2022).

Therefore, it is important to describe crush injury cases occurring in the field to provide a deeper understanding of the clinical characteristics, treatment options, and considerations in medical decision-making. Case reports serve as a means of sharing clinical experiences and can operate as references for other healthcare professionals facing similar situations. This study aims to report a case of a crush injury to the hand resulting from a work-related accident, including clinical manifestations, supporting examination results, and medical intervention in the form of a distal phalanx amputation. This report seeks to underscore the importance of rapid evaluation, appropriate management, and functional considerations in determining optimal therapy for patients with crush injuries.

Previous case reports have documented various management approaches for hand crush injuries. Ahmad & Heng (2018) presented a series of cases emphasizing the potential for limb salvage through microsurgical reconstruction, reporting successful outcomes in 73% of cases with MESS scores <7. Conversely, Kee et al. (2024) highlighted the challenges of occult compartment syndrome in crush injuries, demonstrating that delayed diagnosis can necessitate amputation even in initially viable extremities. Lahiri (2020) published comprehensive guidelines recommending a systematic approach using objective scoring systems to standardize decision-making. However, these studies were predominantly conducted in tertiary centers

with advanced microsurgical capabilities, and their applicability to resource-limited settings remains unclear.

A critical gap exists in the literature regarding the application of objective assessment tools such as the Mangled Extremity Severity Score (MESS) specifically for distal phalanx crush injuries in the Indonesian context. While MESS has been extensively validated for major extremity trauma, its utility in guiding treatment decisions for isolated finger injuries—where functional outcomes differ significantly from proximal limb trauma—has been less systematically explored. Furthermore, most published cases focus on salvage attempts, with limited documentation of cases where amputation was selected as the primary treatment, along with the clinical reasoning behind such decisions.

The novelty of this case report lies in several aspects. First, it provides detailed documentation of the systematic application of MESS scoring to guide decision-making in distal phalanx trauma within an Indonesian regional hospital setting, demonstrating its practical utility beyond major limb injuries. Second, unlike previous reports that emphasized reconstruction efforts, this case explicitly demonstrates the clinical reasoning and objective criteria supporting primary amputation, contributing to balanced literature on both salvage and amputation approaches. Third, it addresses the gap in Indonesian clinical literature by documenting occupational hand crush injury management with transparent discussion of resource limitations, treatment rationale, and functional outcomes based on American Medical Association (AMA) impairment guidelines.

This case report aims to describe the clinical presentation, management, and evidence-based assessment using the MESS score in a severe fingertip crush injury, while demonstrating the application of objective criteria in clinical decision-making between limb salvage and amputation in a resource-limited setting. Furthermore, it documents a multidisciplinary management approach encompassing emergency care, surgical intervention, and rehabilitation planning, thereby providing educational value for healthcare professionals and delivering practical clinical guidance.

The broader benefit of this report is its contribution to improving the quality of care by encouraging the development of standardized protocols for the management of occupational hand injuries in regional hospitals. Implications for clinical practice emphasize the importance of systematic assessment using a validated scoring system, while in occupational health, the report highlights the need for improved workplace safety and better access to hand surgery services. Policy-wise, these findings can support the development of national guidelines for hand trauma management and training programs for healthcare professionals.

RESEARCH METHOD

This study employed a descriptive case report design to systematically document and analyze the clinical presentation, diagnostic evaluation, therapeutic intervention, and outcome of a patient with occupational hand crush injury. The case report methodology was selected as it allows for detailed examination of rare or instructive clinical scenarios, providing valuable insights into diagnostic reasoning, treatment decision-making, and application of clinical guidelines in real-world practice settings (Rison, 2013). The case involved a 64-year-old male patient who presented to the Emergency Department of Dr. Slamet Garut Regional Hospital on August 8, 2024, with a chief complaint of pain and an open wound on his left finger.

Data were obtained through interviews (history taking), physical examinations (primary and secondary surveys), supporting examinations (routine laboratory tests, radiographs), and a review of medical records related to the procedures and therapies administered. Data were analyzed descriptively by comparing the patient's clinical findings with relevant theories and literature regarding crush injuries, medical management, and indications for amputation. This study received ethical approval from the Dr. Slamet Garut Regional Hospital Ethics Committee and informed consent from the patient for publication of his medical data as a case report, while maintaining patient confidentiality.

RESULTS AND DISCUSSION

A 64-year-old male patient, Mr. DS, arrived at the emergency room of Dr. Slamet Garut Regional Hospital on August 8, 2024, at 2:00 PM WIB (Western Indonesian Time) complaining of a wound on his left finger that had been present for approximately three hours prior to admission.

The patient worked as a construction worker and suffered a work-related accident while lifting a concrete block measuring approximately 1 x 0.5 x 0.3 m, which then fell onto his left hand for four seconds at 11:00 AM WIB. After receiving initial treatment, including wound cleaning and dressing at the Limbangan Community Health Center, the patient was referred to Dr. Slamet Garut Regional Hospital due to limited equipment. His medical history revealed that he had been diagnosed with hypertension two years prior, but had not been taking regular medication. There was no history of diabetes mellitus, heart disease, allergies, trauma, or chronic illness in the family.

On primary survey, the patient's airway was normal, with clear speech without snoring or gurgling. Respirations were adequate at 25 breaths per minute, and chest movement was symmetrical. Circulation revealed a regular pulse of 118 beats per minute, blood pressure of 140/80 mmHg, a CRT of <2 seconds on the healthy finger, and external bleeding on the left hand. The patient was conscious and compos mentis with a GCS of 456, and an open wound was found on the left finger without other injuries.

On secondary examination, the patient appeared moderately ill with vital signs of blood pressure of 260/140 mmHg, pulse of 76 beats per minute, respiratory rate of 22 breaths per minute, temperature of 36.6°C, SpO_2 of 99%, and a pain scale of 8. A general examination of the head, neck, thorax, and abdomen was within normal limits. A local examination of the left upper extremity revealed an open wound measuring 2 x 10 x 0.5 cm with uneven edges, a bony base, deformity, active bleeding, a CRT of >2 seconds, cool skin that was tender to touch, and limited range of motion due to pain. On the right extremity, an open wound measuring 4 × 2 × 0.2 cm was found with a muscle base, deformity, skin flap, bleeding, CRT > 2 seconds, positive tenderness, warm skin, and limitations of active and passive ROM.

Figure 1. Clinical photo of the patient.

Supporting examinations showed laboratory results (blood count, PT/INR, and GDS) within normal limits. A radiological examination of the left hand showed a crush injury with fracture lines on the distal phalanges of the fourth and fifth digits.

Figure 2. X-ray of the patient's left hand.

Based on these findings, the patient was diagnosed with a crush injury to the distal phalanx of the fourth and fifth digits of the left hand. The patient received medication therapy consisting of cefotaxime 2 x 1 g IV, ketorolac 2 x 20 mg IV, ranitidine 2 x 50 mg IV, and wound care. The patient subsequently underwent amputation of the distal phalanx of the fourth and fifth digits of the left hand on August 7, 2024. The following is the patient's post-operative documentation:

Figure 3. Clinical photo of a post-operative patient

Discussion

The hand is a complex structure consisting of skin, nerves, blood vessels, tendons, joints, and intrinsic muscles, tightly packed within a confined space. This anatomical complexity makes the hand highly susceptible to functional disability following trauma, including crush injury. In this case, the patient sustained an injury from a concrete slab falling from a height of approximately 1 meter while working as a construction worker. This injury mechanism aligns with the theory that crush trauma to the hand generally involves multiple structures, including bone, soft tissue, and neurovascular systems (Kee et al., 2024; Skiba, 2020). The combination of direct compression force (estimated >500 N based on the mass and impact velocity of the concrete block) and prolonged tissue compression (4 seconds) resulted in both immediate structural disruption and ischemic injury due to vascular compromise. Clinically, the patient's condition meets the definition of a crush injury, which is local tissue damage due to direct pressure, without systemic manifestations such as crush syndrome (characterized by myoglobinuria, hyperkalemia, and acute kidney injury). This suggests that the patient's injury is more local than systemic.

Anatomically, the dorsum of the hand has minimal soft tissue cushioning, making it relatively susceptible to fracture following high-energy blunt trauma. In this case, the crushing of the distal phalanges of the left fourth and fifth digits is consistent with the mechanism of being crushed by a heavy object, causing bone damage with deformity, open wounds, and ischemia. Complementary examinations confirmed the clinical findings with comminuted and displaced distal phalanx fractures in both digits, classified as Gustilo-Anderson Type IIIA open fractures due to adequate soft tissue coverage despite extensive injury. This condition illustrates the spectrum of crush injuries, ranging from soft tissue damage to comminuted fractures, as reported in the literature (Ahmad & Heng, 2018). Thus, the patient's clinical findings are consistent with the trauma mechanism and injury pathophysiology described in the theory.

Table 1. Mangled Extremity Severity Score (MESS)

Variabel	Kategori	Skor
Skeletal / Soft Tissue Injury	Low energy (stab: simple fracture, "Civilian" GSW)	1
	Medium energy (open or multiple fracture, dislocation)	2
	High energy (close- range shotgun or military GSW, *crush injury*)	3
	Very high energy (above + gross contamination, soft tissue avulsion)	4
Limb Ischemia	Pulse reduced or absent but perfusion normal	1*

An objective approach was used to determine treatment, using the Mangled Extremity Severity Score (MESS) as shown in Table 1. The patient's score was 7, reflecting a high-energy injury mechanism, signs of ischemia with cold extremities and CRT >2 seconds for over 3 hours, normotensive status, and age >50 years. This score equals the threshold for amputation (MESS ≥7), and therefore, the decision to perform amputation was deemed appropriate based on established evidence.

The literature indicates that reconstructive surgery can still be considered with a score <7, with reported salvage rates of 85-90% (Johansen et al., 1990; Howe et al., 1987). However, with a score ≥7, the prognosis for limb salvage is poor (<10% success rate), making amputation a rational choice to prevent further complications including chronic infection, prolonged rehabilitation, multiple revision surgeries, and persistent pain (Lahiri, 2020). Unlike the cases reported by Ahmad & Heng (2018), where microsurgical reconstruction was successful in patients with MESS scores of 5-6, younger age (<40 years), and access to specialized hand surgery units, our patient presented with factors unfavorable for salvage: advanced age (64 years), prolonged ischemia time (>3 hours from injury to definitive treatment), significant tissue loss precluding adequate coverage, and limited availability of microsurgical expertise at our facility.

In this case, amputation was performed to achieve several clinical objectives: 1. Source control: Remove devitalized tissue to prevent ascending infection and sepsis. 2. Definitive wound closure: Enable primary healing without need for complex reconstruction. 3. Pain management: Eliminate ischemic and crushed tissue causing severe pain. 4. Functional preservation: Maintain optimal function of the remaining viable hand by avoiding prolonged immobilization and multiple surgeries. 5. Economic considerations: Minimize total treatment costs and duration of disability for the patient

In addition to surgery, medication therapy played a crucial role. The patient received cefotaxime, ketorolac, and ranitidine. Cefotaxime was chosen due to its broad spectrum against Gram-negative bacteria (including Pseudomonas and Enterobacter species), which frequently contaminate wounds in construction trauma involving soil exposure (Lahiri, 2020). The empiric coverage was appropriate given the high risk of infection in Gustilo-Anderson Type IIIA open fractures, which carry 10-25% infection rates even with optimal management. Ketorolac, as an NSAID, was given for postoperative pain management and to reduce inflammation through cyclooxygenase inhibition, while ranitidine served as a gastroprotective agent to prevent NSAID-induced gastric irritation and ulceration. This regimen represents a multimodal approach to addressing the risk of infection, pain, and gastrointestinal complications that often accompany post-trauma patients (Lahiri, 2020). Alternative analgesic options such as opioids (tramadol, morphine) were reserved for breakthrough pain to minimize risks of dependency and adverse effects.

Table 2. Outcomes of post-amputation patients based on AMA guidelines

Condition	Percentage of Disabilities	Description
Amputation of 1 finger (other than the thumb)	10–15%	Mild loss of grip strength, still able to adapt
Amputation of 2 fingers	20–30%	Significant decline in grip function, adaptation requires therapy
Amputation of 3 fingers	40–50%	Difficulty grasping large or small objects

Condition	Percentage of Disabilities	Description
Amputation of 4 fingers (remaining only the thumb)	55–65%	Can only perform large pinching movements
Amputation of the thumb	25–40%	Severe loss of pinching and fine grasping function
Loss of all fingers	70–80%	Loss of hand function as a manipulation tool

Source: (AMA, 2009)

From a rehabilitation perspective, patients who undergo two-finger amputations experience functional disability in approximately 20–30% of cases, according to the AMA Guidelines. Therefore, follow-up therapy is essential to optimize hand function and quality of life. Recommended rehabilitation includes hand physiotherapy, including range-of-motion (ROM) exercises and muscle strengthening, occupational therapy to help patients adapt to daily activities using new methods, and sensory re-education to retrain finger sensitivity. This comprehensive approach aims to maintain patient independence, minimize joint stiffness, prevent complications such as neuromas, and mitigate the psychological impact of hand function loss.

Overall, this case emphasizes the importance of a systematic evaluation of hand crush injuries through history taking, physical examination, supporting tests, and the use of objective scores such as the MESS. The decision to amputate the patient was based on severe tissue damage, ischemia, and a high MESS score, which is clinically consistent with the literature. Appropriate management includes a combination of surgery, pharmacotherapy, and a long-term rehabilitation program to maximize hand function recovery and the patient's quality of life.

CONCLUSION

This case report presents the systematic clinical evaluation and management of a severe finger crush injury in a resource-limited Indonesian hospital. A 64-year-old construction worker sustained Gustilo-Anderson Type IIIA open fractures of the distal phalanges of the fourth and fifth digits following a high-energy crush mechanism. Application of the Mangled Extremity Severity Score (MESS), yielding a score of 7, provided an objective basis for performing amputation rather than attempting limb salvage, supported by findings of extensive tissue damage, prolonged ischemia, and advanced age. Comprehensive management—including emergency stabilization, antibiotic prophylaxis, multimodal analgesia, and surgical intervention—effectively addressed infection risk and non-viable tissue while adhering to trauma protocols. Future research should prospectively validate MESS and related scoring systems for isolated digital injuries, assess long-term functional and psychosocial outcomes between amputation and reconstruction, and develop context-specific clinical and rehabilitation protocols for resource-limited settings to improve patient recovery and guide national hand trauma policy.

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