

Case Report

Open Access, Volume 6

Impending compartment syndrome following industrial hand injection injury: A case report

Abdul Rehman^{1*}; Muzamil Aslam Chaudhary⁴; Muhammad Yahya Khan¹; Saeed UR Rehman²; Syeda Zoya Chishti²; Raja Ansar Hameed²; Fazeelah Bibi³

¹Department of Emergency Medicine, St. Luke's General Hospital, Kilkenny, Ireland.

²Department of Internal Medicine, St. Luke's General Hospital, Kilkenny, Ireland.

³Department of Internal Medicine, Pakistan Institute of Medical Sciences Hospital, Islamabad, Pakistan.

⁴Department of Emergency Medicine, WWL NHS Foundation Trust, UK.

*Corresponding Author: Abdul Rehman

Department of Emergency Medicine, St. Luke's
General Hospital, Kilkenny, Ireland.
Email: abdul.ar721@gmail.com

Received: Jul 11, 2025

Accepted: Aug 07, 2025

Published: Aug 14, 2025

Archived: www.jcimcr.org

Copyright: © Rehman A (2025).

DOI: www.doi.org/10.52768/2766-7820/3736

Abstract

High-pressure injection injuries, though deceptively benign on initial appearance, can result in significant morbidity due to deep tissue involvement and rapid progression to compartment syndrome. We report a case of 64-year-old male quarry worker who sustained a high-pressure injection injury from a power washer to his middle finger of his right dominant hand. Despite a small entry wound, he developed extensive soft tissue swelling, crepitus, and signs suggestive of early finger compartment syndrome. Radiography revealed subcutaneous emphysema. Prompt diagnosis, early hand and plastic surgical consultation and intervention were critical in initiating appropriate management and preventing long-term functional disability.

Keywords: High pressure injury; Hand trauma; Compartment syndrome; Power washer injury.

Introduction

High-pressure injection injuries of the hand are uncommon but potentially limb-threatening conditions often observed in industrial settings. Such injuries frequently present with minimal external signs but have potential to rapidly evolve into compartment syndrome, tissue ischemia, necrosis, and even amputation if not promptly diagnosed and managed. These injuries however pose a diagnostic challenge due to their deceptively minor superficial wounds. This case emphasizes the importance of early recognition and imaging by emergency physicians and prompt specialist referral in the management of high-pressure injection injuries.

Case presentation

A 64-year-old male, quarry worker, presented to our emergency department, complaining of swelling and severe pain in his right hand, two hours after sustaining an accidental injury

to the middle finger of his right dominant hand while operating a power washer at his workplace. His past medical history was significant for well-controlled hypertension.

On examination, a 4 mm puncture wound was noted on the antero-lateral aspect of the volar surface of proximal phalanx of his right middle finger. However, no exit wound was observed. The wound was dry, with no active bleeding or discharge. There was noticeable erythema and fusiform swelling involving the entire middle finger (Figure 1). Palpable crepitus was present which extended into the hand, and passive and active movements of the third metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints were severely restricted and painful. Capillary refill was brisk, and distal neurological examination was intact.

An intravenous (IV) line was secured, and the patient received parenteral analgesia, prophylactic antibiotic and a tet-



Figure 1: 4 mm entry wound with erythema and fusiform swelling involving the entire right middle finger.



Figure 2: Plain radiographs showing subcutaneous air tracking within the compartments of the finger and hand.

anus booster. Plain radiographs of the right hand and middle finger demonstrated subcutaneous air tracking within the compartments of the finger and hand, suggestive of a high-pressure injection injury (Figure 2). Given the clinical findings of tense swelling, severe pain with passive motion, and radiological evidence of air in tissue planes, a presumptive diagnosis of impending compartment syndrome was made.

Urgent consultation with the hand and plastic surgery team was obtained for further evaluation and definitive management. Physical milking out of water and air bubbles out of wound was attempted prior to surgery. Our patient subsequently underwent digital decompression through finger fasciotomy, performed by hand surgeon using bilateral midline incision. On physical exam post-surgery, sensation, blood flow, and color returned to the finger. The patient was ultimately admitted to the hospital, and he made an uneventful recovery.

Discussion

High-pressure injection injuries of the hand, while uncommon, represent true surgical emergencies due to the deceptively benign appearance of the initial wound contrasted with the potential for devastating outcomes [1]. These injuries are characterized by the forcible entry of substances—commonly grease, paint, or water—into soft tissues under pressures exceeding 2,000 psi, causing mechanical tissue disruption and rapid spread along fascial planes. Our patient's constellation of findings—rapid swelling, severe pain on passive movement, fusiform digit swelling, and crepitus—met criteria for a presumptive diagnosis of impending compartment syndrome, even in the absence of overt neurovascular compromise. These signs are critical, as clinical diagnosis should not be delayed pending confirmatory tests when compartment syndrome is suspected [2].

Though, the type of injected material affects prognosis, but timing of intervention is a more critical determinant of outcome. The type of injected product and its cytotoxicity are the also most important prognostic factors in this type of injury. Paints, solvents, paint thinner, plastic, lubricants, fuels, grease, cement, and hydraulic fluids are some of the substances that can be injected. The injection of water, air, or small quantities of veterinary vaccine usually induces minimal inflammatory response and generally has a good prognosis. It can be managed non-surgically with close observation if compartment syndrome is not present. On the other hand, turpentine and other organic solvents frequently used in an industrial context as diluents, dry cleaning, and paint thinners to oil-based paints are highly cytotoxic since they dissolve fats and lead to tissue liquefaction, offering an overall poor outcome and a 40% risk of amputation. Solvents have a low viscosity and a fast distribution along the tissues. The amputation rate is significantly higher following injuries involving oil-based paints than following water-based paints. Other products like lubricants, wax, grease, and graphite usually do not provoke a very intense inflammatory response but can lead to chronic granulomas. Secondary infection is often polymicrobial and occurs when tissue necrosis is present. Prophylactic antibiotic therapy is recommended to reduce the risk of infection. Infection is relatively uncommon, because the injected material is usually an organic chemical that does not support bacterial growth. Nevertheless, when a patient presents to the emergency department several days after the initial

injury, suspicion should be raised, for example, in cases of flexor tenosynovitis. If the temperature of the injected solvent is very high, then it accentuates the injury by burning the underlying soft tissues and skin. Water, although non-toxic, poses particular danger due to its high volume and low viscosity, allowing for extensive tissue penetration and pressure buildup. This can rapidly lead to compartment syndrome and tissue necrosis if not promptly addressed [2]. In our case, rapid onset swelling, crepitus, and pain with passive motion raised immediate concern for this complication. Our patient's presentation is comparable to a case reported by Verhoeven and Hierner [3], in which a patient sustained a high-pressure water injection injury to the hand and developed rapidly progressing swelling, pain, and subcutaneous emphysema. Like our patient, the wound appeared deceptively minor on the surface, but required urgent surgical debridement due to extensive underlying tissue involvement. The key difference is that our patient presented earlier—within two hours—allowing for prompt diagnosis and surgical referral, likely preventing further complications. Radiographs are critical in such settings, not only to rule out any radio-opaque foreign bodies, fractures but also to detect subcutaneous emphysema—an important diagnostic clue [4]. The classic signs of compartment syndrome—pain out of proportion to exam, pain with passive stretch, pallor, paresthesia, and pulselessness—often emerge late, making early recognition of subtle signs like crepitus and swelling essential [5].

Early surgical intervention has been shown to significantly improve outcomes. In a systematic review, delays beyond 6–8 hours were associated with a higher rate of necrosis and amputations, particularly in water and solvent-based injection injuries [6]. Our patient's early presentation, accurate clinical assessment, and urgent referral likely played a critical role in preventing progression to necrosis or amputation. This case reinforces findings from similar reports, emphasizing that even low-toxicity materials like water can cause severe compartment syndrome due to mechanical effects [1,3,4,6]. Occupational settings such as quarry work pose particular risks due to the high-pressure tools in use and the tendency to underestimate seemingly minor wounds. Feldman et al. described a pediatric patient who sustained a similar injury from a power sprayer. Due to delayed presentation, the child developed a severe infection requiring prolonged hospital care. Our case, by contrast, underscores the importance of early recognition and highlights the favorable outcome that can be achieved when intervention is not delayed [7]. A systematic review by Schnall et al. emphasizes that while grease and paint-based injuries often involve chemical toxicity, water injection injuries—though chemically benign—carry high risk of compartment syndrome due to hydrostatic dissection along tissue planes. This aligns with our case, where water from a power washer caused extensive subcutaneous air and swelling despite the absence of caustic substances [8].

Additionally, the study by Hogan and Ruland, which reviewed 42 patients with high-pressure injection injuries, found a 30% amputation rate—particularly among those who presented late or received delayed surgical care. This further illustrates the importance of early diagnosis and management, as demonstrated in our case [9]. The pathophysiology involves mechanical disruption of tissue, vascular injury, and inflammatory response. Injected materials spread rapidly along tissue planes, increasing compartmental pressure and compromising perfusion. Water, in particular, poses a significant risk due to its high volume and low viscosity, facilitating extensive tissue penetration and ede-

ma formation. Moreover, secondary infection is a frequent concern, particularly when the injury introduces environmental or workplace contaminants, as is likely in quarry settings [9]. Other differential diagnoses at presentation should include cellulitis, necrotizing fasciitis, gas gangrene or simple traumatic puncture wounds. However, the rapid onset of swelling and crepitus, in conjunction with severe pain on passive motion, should alert clinicians to the possibility of a compartment syndrome. The presence of subcutaneous emphysema seen on radiography further supports this diagnosis. It is crucial to distinguish these injuries from simple lacerations to avoid delays in definitive care. Management of such injuries must be prompt and aggressive in a busy emergency department. Early recognition is important based on history and physical exam. Early administration of broad-spectrum antibiotics should be done due to the polymicrobial risk in contaminated water exposure. Urgent relevant surgical consultation is paramount for potential fasciotomy or debridement. Studies have shown that delays beyond 6–8 hours in surgical management can lead to irreversible ischemic damage, tissue necrosis, and amputation rates exceeding as high as 50% in some case series [10]. Hence, even in the absence of overt signs of neurovascular compromise, high clinical suspicion warrants early intervention.

Conclusion

High-pressure injection injuries are surgical emergencies that require a high index of suspicion despite their initially innocuous appearance. This case underscores the importance of thorough clinical assessment, timely clinical suspicion, early imaging, and prompt specialist consultation to prevent devastating complications such as compartment syndrome, necrosis and digital amputation. While previous literature supports the severity of such injuries, our case contributes an example of successful early recognition and management in a high-risk occupational setting. High pressure injuries from water may appear benign but spreads rapidly in tissue. Delay worsens outcome, even with less toxic material.

Declarations

Conflicts of interest: All the authors declare that they have no conflicts of interest.

Funding: No funding was received for this case report.

Consent: Informed consent was obtained from the patient for publication.

References

1. Hogan CJ, Ruland RT. High-pressure injection injuries to the upper extremity: a review of the literature. *J Orthop Trauma*. 2006; 20: 503–11.
2. Kaufman HD. High-pressure injection injuries. *J Trauma*. 1976; 16: 726–30.
3. Verhoeven N, Hierner R. High-pressure injection injuries of the hand: an often underestimated trauma: case report with study of the literature. *Strategies Trauma Limb Reconstr*. 2008; 3: 27–33.
4. Neal NC, Burke FD. High-pressure injection injuries. *Injury*. 1991; 22: 467–70.
5. Feldman KW, Moores A, Taylor J, Feldman JA. Hand injuries related to high-pressure water spray: case report and discussion. *Pediatr Emerg Care*. 2001; 17: 41–2.

-
6. Copeland GE. High-pressure injection injuries of the hand. *J Bone Joint Surg Am.* 1974; 56: 1041–6.
 7. Feldman L, Goldberg M, Nahir AM. High-pressure injection injury of the hand in children. *J Hand Surg Am.* 2001; 26: 444–7.
 8. Schnall SB, Mamczak CN, Holbrook HS. High-pressure injection injuries: a case report and systematic review. *Hand (N Y).* 2020; 15: 145–9.
 9. Hogan CJ, Ruland RT. The spectrum of high-pressure injection injuries to the hand. *Plast Reconstr Surg.* 2006; 117: 86e–92e.
 10. Whitesides TE, Haney TC, Morimoto K, Harada H. Tissue pressure measurements as a determinant for the need of fasciotomy. *Clin Orthop Relat Res.* 1975; (113): 43–51.