

CASE REPORT

A unique case report of a high-pressure paint injection injury of the hand with associated carbapenemase resistant *Pseudomonas aeruginosa* infection

Kurt Barger^{1,*}, Ryne Jenkins¹, Bruce Weng², Juston Fan¹, Loren Tholcke¹, and Michael French¹

¹Orthopaedic Surgery, Riverside University Health System Medical Center, Moreno Valley, CA, USA, and

²Infectious Disease, Riverside University Health System, Moreno Valley, CA, USA

*Correspondence address. 14319 Blue Bonnet Lane, Moreno Valley, CA 92555, USA. Tel: +1-850-541-2351; Fax: +1-228-200-5204;

E-mail: kurt.barger@ruhealth.org

Abstract

High pressure injection injuries to the hand should not be taken lightly as urgent surgical debridement is required to ensure favorable outcomes. Empiric antibiotic administration is recommended; however, few studies focus on the secondary infection risk associated with these high pressure injection injuries. We present a rare case of a patient presenting with carbapenem resistant *Pseudomonas aeruginosa* following a high pressure paint gun injury of the thumb. Urgent surgical debridement with administration of broad-spectrum antibiotic coverage for both gram-negative and gram-positive bacteria is recommended. The injection of foreign materials can cause extensive tissue damage and immunosuppression facilitating growth of opportunistic bacteria that are often rare in healthy adults. We advocate for obtaining cultures at initial debridement to optimize treatment in these unique and rare injection injuries. Concerns should be raised as carbapenem resistant bacteria become more prevalent in the community.

INTRODUCTION

High pressure injection devices such as paint or grease guns can cause penetration of the skin and damage to tissues beneath. Rare cases have shown foreign material traveling as far as the axilla and mediastinum [1]. The extent of injury is generally dependent on multiple variables, including the type of chemical, injection pressure, quantity of material, site of injection and time to presentation [2]. A high pressure injection injury is considered a surgical emergency and irrigation and debridement (I&D) is recommended within 6 h [3]. Despite aggressive treatment, amputation rates range from 22 to 48% [1].

Over 100 case reports of high pressure injection injuries have been described, however few studies focus on infection secondary to the injury [4]. Microbes that are native flora of the skin are the primary cause of soft tissue infection in trauma patients. The majority of these infections are caused by *Staphylococcus aureus*, beta-hemolytic streptococci and *Clostridium spp* [5]. We present the rare case of a patient presenting with carbapenem resistant *Pseudomonas aeruginosa* following a high pressure paint gun injury of the thumb. No study to date has demonstrated this type of infection in this patient population.

Received: March 27, 2020. Revised: April 26, 2020. Accepted: April 29, 2020

Published by Oxford University Press and JSCR Publishing Ltd. All rights reserved. © The Author(s) 2020.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com



Figure 1: Initial injury; presentation of injection site 30 h after initial injury.

CASE DESCRIPTION

We present a case report of a 27-year-old male who sustained a high pressure injection injury with latex based paint to his right thumb secondary to a device malfunction. The patient was initially seen by providers at an outside facility and discharged

on oral antibiotics. However, he presented at our facility 30 h after the initial injury with the inability to move his thumb due to significantly increased swelling and pain. Upon initial inspection, there was a 1-ml penetrating injury to the distal thumb (see Fig. 1). Initial X-rays demonstrated a radiopaque substance at the distal end of the right thumb coursing proximally without invasion of the tendon sheath (see Fig. 2A and B). The patient underwent emergent surgical incision, irrigation and debridement of the underlying tissues (see Fig. 3). Cultures were taken at the time of surgery and grew carbapenemase resistant *Pseudomonas aeruginosa* after 2 days. The patient was prescribed amoxicillin/clavulanate and ciprofloxacin for 7 days to provide appropriate coverage of the organisms isolated. The patient returned to clinic 1 week later where expressible paint material was found draining from the wound (see Fig. 4). The patient was admitted to the hospital and underwent a second I&D. Cultures taken at this time were negative for bacterial growth. The patient was discharged on amoxicillin/clavulanate and ciprofloxacin for 10 days. At 4 months, the wound was well healed with no signs of infection (see Fig. 5).

DISCUSSION

We presented a unique case report where a patient presented 30 h after a high pressure injection injury. Cultures taken during initial incision, irrigation and debridement of the wound grew carbapenemase resistant *Pseudomonas aeruginosa*. Due to the limited number of reported cases of high pressure injection injuries and associated infections, we believe that more research is needed to determine the most appropriate management for these types of injuries.

The type of material injected plays a pivotal role in the severity of high pressure injection injuries and has been determined to be the single most important prognostic factor [1]. The injected material can cause a catastrophic inflammatory response resulting in tissue necrosis. Oil-based paint has been



Figure 2: Initial injury radiographs; anterior-posterior (A) and lateral (B) radiographs of initial injury showing radiopaque material at the distal phalanx.



Figure 3: Initial irrigation and debridement; white paint can be seen invading the soft tissue, photo taken intraoperatively.



Figure 4: One-week post-op following initial I&D; white paint can be seen draining from surgical incision, photo taken at 1 week follow-up.

reported as one of the most toxic and severe with profound ischemia and rapid development of necrosis [3,6]. Additionally, animal studies have shown the induced inflammatory response secondary to the injected material ultimately results in an inhibition of the body's ability to fight infection. This facilitates the growth of opportunistic bacteria such as *Pseudomonas* spp and *Enterobacteriaceae* found either natively or from injected materials.

Few studies discuss secondary infections associated with high pressure injection injuries. Literature supports the use of



Figure 5: Follow-up; surgical wound seen healing well 14 weeks after second I&D.

antibiotics however only one study has provided this recommendation based upon bacterial isolates from wound cultures. The study showed 47% of wound cultures were positive, with gram-negative bacteria found in 58% of isolates [7]. Microbial contamination was seen in 42% of patients in a review in 2006 by Hogan [3]. Most of these infections were polymicrobial and occurred even with the administration of antibiotics. Amputation rates in injuries with positive intraoperative cultures were identical to those with negative cultures [3]. A case report of a paint injection injury to the index finger reported cultures with gram-negative bacteria with the growth of *Citrobacter freundii*, *Morganella morgani* and *Proteus vulgaris* [8]. Other reports have demonstrated *Enterobacteria* following a high pressure paint injury; however, carbapenem resistance was not noted [7]. Carbapenem resistance has rapidly grown since its first reporting in literature in 1996 and has now become a major public health concern. Carbapenem antibiotics are often used as last resort and mortality from a carbapenem resistant bacteria strain is as high as 50% [9]. Infections by carbapenem resistant bacteria are predominantly obtained in the hospital setting; however, community acquired infections have increased in prevalence with percentages ranging from 5.6 to 10.8% in the USA. Various mechanisms of resistance have been observed including outer membrane porin changes altering intracellular drug concentration [10].

Steroid use following injection injuries have been shown to be beneficial in case reports; however treatment protocols vary, and no clinical trial has been conducted in this patient population. With the evidence of multidrug resistant organisms, such as carbapenem resistant *Pseudomonas aeruginosa* presented in our case report, steroids may be contraindicated in the treatment of high pressure injection injuries. Although steroids may help suppress the initial inflammatory response to injected materials, steroid use may significantly hinder the

body's ability to fight infection and administration should be cautioned [2].

In conclusion, high pressure injection injuries can lead to disastrous outcomes when not treated emergently with antibiotics, irrigation and debridement. With the emergence of multidrug resistant organisms, cultures should be obtained at initial debridement to provide optimal treatment against isolated organisms. Concerns should be raised as carbapenem resistant bacteria become more prevalent in the community, as evident by this case report.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

FUNDING

None.

REFERENCES

1. Amsdell SL, Hammert WC. High-pressure injection injuries in the hand: current treatment concepts. *Plast Reconstr Surg* 2013;132:586–91.
2. Verhoeven N, Hierner R. High-pressure injection injury of the hand: an often underestimated trauma: case report with study of the literature. *Strateg Trauma Limb Reconstr* 2008;3:27–33.
3. Hogan CJ, Ruland RT. High-pressure injection injuries to the upper extremity: a review of the literature. *J Orthop Trauma* 2006;20:503–11.
4. Lozano-Calderón SA, Mudgal CS, Mudgal S, Ring D. Latex paint-gun injuries of the hand: are the outcomes better? *Hand* 2008;3:340–5.
5. Rodríguez-Villar S, Kennedy RC, Dall'Antonia M, Menichetti CP. Management of industrial high-pressure fluid injection injuries (IHPFII): the water jetting association (WJA) experience with water driven injuries. *Eur J Trauma Emerg Surg* 2019;45:507–15.
6. Failla JM, Linden MD. The acute pathologic changes of paint-injection injury and correlation to surgical treatment: a report of two cases. *J Hand Surg Am* 1997;22:156–8.
7. Mirzayan R, Schnall SB, Chon JH, Holtom PD, Patzakis MJ, Stevanovic MV. Culture results and amputation rates in high-pressure paint gun injuries of the hand. *Orthopedics* 2001;24:587–9.
8. Yazar M, Gül Z, Günenç A, Yazar S, Kozanoğlu E. High pressure paint gun injury of the index finger: a case report. *Plast Aesthetic Res* 2015;2:350.
9. Kelly AM, Mathema B, Larson EL. Carbapenem-resistant Enterobacteriaceae in the community: a scoping review. *Int J Antimicrob Agents* 2017;50:127–34.
10. Santajit S, Indrawattana N. Mechanisms of antimicrobial resistance in ESKAPE pathogens. *BioMed Res Int* 2016;2016:2475067.