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Case Report

Catheter irrigation as an unutilized novelty in the treatment of water-based paint injection injuries – a case illustration

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ABSTRACT

High-pressure injection injuries with paint have long been heralded as a condition requiring timely and aggressive debridement with relatively poor functional outcomes and a significant proportion of patients progressing to require amputation of the involved digit or limb. Catheter irrigation is regularly used in the treatment of common hand infections and wounds. However, this has not been described for the treatment of paint injection injuries. We describe a case of a young painter who sustained an accidental water-based paint injection injury and was successfully treated with minimally invasive surgical debridement augmented by the use of catheter irrigation, despite a delayed presentation. The patient had regained full function of his hand by four months from the index presentation and returned to work. We illustrate how not all high-pressure injection injuries require an extensive incision and that catheter irrigation can be a significant tool to augment a minimally invasive approach.

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Introduction

Paint injection injuries are uncommon in clinical practice, accounting for the paucity of information available in the literature. It is difficult to estimate the true incidence of high-pressure injuries, although the literature suggests 1 in 600 cases in a major trauma center.^{1,2} Given the small entry point wound, both patients and medical professionals may not realize the severity of the injury or the need for rapid escalation of care and treatment. The average delay in presentation is 12 h.³

The consequences of such injuries are severe. Hogan et al. suggested an amputation rate of 30% for high-pressure injection injuries. Even where amputation was avoided, these patients frequently required multiple surgical debridements and were still vulnerable to permanent deficits in function, strength and sensation.⁴ Because of the significance of these outcomes, early recognition and treatment as a surgical emergency has been recommended.^{5,6}

The force from the injection is significant and can range from 3000 to 10,000 psi, or even higher if associated with malfunction of the nozzle.^{1,6–8} With such high pressures associated, soft tissue injury that can occur to the involved structures is significant. Early and aggressive debridement followed by secondary closure is an accepted treatment strategy.⁹

Catheter irrigation for paint injection injuries has also not been described in the literature. A search of the PubMed database using the keywords “paint injection injury” yielded 119 results, of which none described the use of catheter irrigation. We demonstrate the use of a minimally invasive surgical approach to the treatment of a paint injection injury to a digit augmented by catheter irrigation. The patient had full return of function by four months postoperatively.

Case description

A 25-year-old right hand-dominant painter with no comorbidities sustained a high-pressure paint injection injury in an industrial accident. He was setting up a spray-painting machine when he accidentally pointed the jet onto his left hand and pressed the trigger. He released the trigger almost immediately but felt immense pain over his left middle finger. He presented to a peripheral hospital without a hand service prior to being transferred to our center for specialized care.

Examination revealed a small, tender 5 mm puncture wound over the volar radial aspect of the proximal phalanx, with swelling at the proximal phalanx and metacarpophalangeal joint (Figure 1). Small specks of hardened white paint were visualized surrounding the injection point, also visible as foreign bodies on the X-rays (Figure 2). Preoperatively, there was no numbness, and finger 2-point discrimination was intact. The fingertip was well perfused and the digit was not tense, although the range of motion was significantly limited by pain.



Figure 1. Initial presentation of patient, with a 5 mm puncture wound seen over the radial aspect of the proximal phalanx of the middle finger. Swelling is appreciated dorsally.



Figure 2. Paint residue demonstrated on pre-operative X-ray films.

The time from the injury to operative intervention was approximately 18 h, due to delayed presentation and transfer time. The digit was copiously irrigated on arrival to our center. Empirical intravenous antimicrobial therapy and tetanus prophylaxis were provided. Operative intervention was expedited. Debridement of the entry point was performed with an incision made over the volar proximal interphalangeal joint and distal palmar crease. The flexor sheath was opened at the distal palmar crease junction and copious flushing and curettage were performed. No paint was found within the flexor sheath, and care was taken to debride the subcutaneous tissue without devascularising the overlying skin. Hardened white paint was visualized over the entry point and in the tissue underlying this area, although no further track or paint was identified proximally and distally. Intraoperative fluoroscopy was used as an adjunct in the removal of paint, and no gross residual foreign body was visualized on the repeat image post-debridement (Figure 3). An infant feeding catheter was then threaded subcutaneously between the two incisions and knotted distally, with perforations to allow for continuous catheter irrigation in the ward.

Serial wound inspections were performed every two days with a dressing change. On postoperative day 8, the patient complained of pain, and removal of the dressings revealed a small amount of purulent discharge at the catheter entry and exit sites. The patient was taken back to theater on the same day and a repeat debridement was performed. Intraoperatively, subcutaneous purulence was noted over the distal proximal interphalangeal joint wound with infiltrative paint debris over the second web space and encasing the radial digital neurovascular bundle. Excisional debridement of the left middle finger was performed, with foreign material excised (Figure 4), unhealthy tissue debrided and two infant feeding catheters passed from proximal to distal.

Cultures from the index debridement yielded *Stenotrophomonas maltophilia* and *Pseudomonas mendocina*. He had a single temperature spike on postoperative day 2. A set of blood cultures were taken and returned negative. *Stenotrophomonas maltophilia* was repeatedly isolated at the second de-

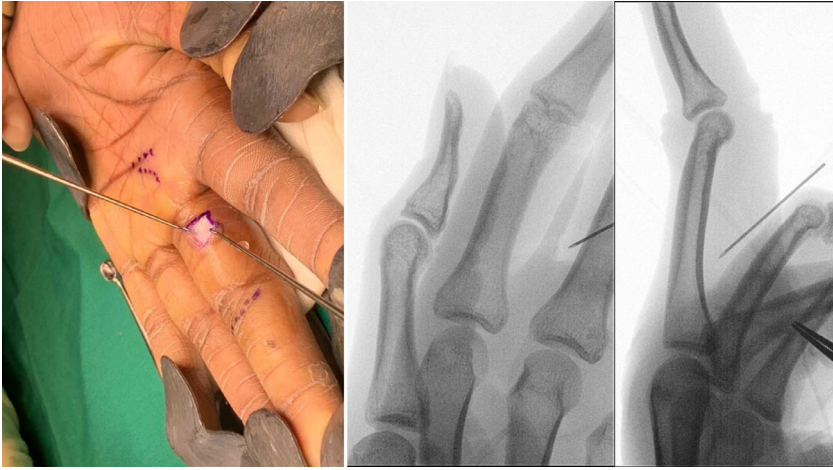


Figure 3. Operative debridement commenced at the injection point. Previously radio-opaque material demonstrated on pre-operative X rays no longer visible post-debridement. Needle on flouroscopy used to demonstrate point of inoculation.

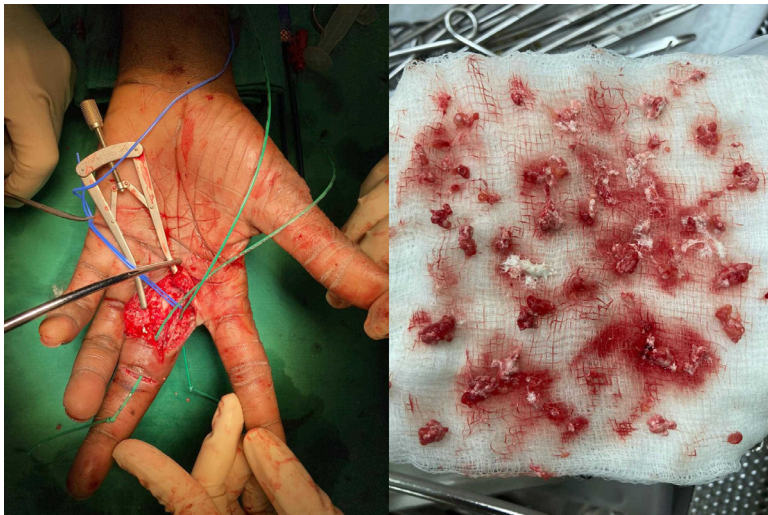


Figure 4. Demonstration of catheter placement intra-operatively and paint debris removed on gauze.

bridement in addition to *Achromobacter* species, with antimicrobial therapy adjusted accordingly with guidance from infectious disease specialists.

Serial wound inspections were performed on the ward daily and dressings changed. Cotton wool was used after a layer of gauze to aid the absorption of the fluid from the continuous irrigation. The catheters were kept *in situ* for six days from the second debridement and removed when the wound appeared consistently clean. The patient was encouraged to perform digital range of motion as much as he could tolerate within the dressings several times a day, and this was also reinforced at the daily rounds. He was discharged at will with small residual wounds on his hand and followed up at outpatient facilities. The wounds healed by granulation and no further procedures were required.

At the one-month review, the wounds had been reduced to a small area of granulation and there was no evidence of ongoing suppuration or inflammation. The patient was noted to have a 30-degree flexion deformity of the middle finger proximal interphalangeal joint (Figure 5).



Figure 5. Small remnant raw wound over the palm 1 month post-operatively. Patient was pain free and digital range of motion was improving.



Figure 6. 2 months post-operatively, wounds had healed with scab and the passive correction of the flexion deformity is demonstrated.

He was referred to the occupational therapist, and stretching exercises and scar massage were reinforced. At two months, the wounds had healed over with scab and a flexion deformity was still present and passively correctible (Figure 6).

By the fourth month, the patient's scars had healed inconspicuously, he was able to make a full fist, grip strength had returned to normal and he had reintegrated into his job as a painter (Figure 7).

Discussion

Pressure injuries are difficult to treat, with significant morbidity to the digit or involved hand. Most patients have incomplete recovery and permanent deficits in the long term, and a significant



Figure 7. Final post-operative function at 4 months post-operatively and a grip strength of 34 kgs, comparable to his right hand.

proportion of patients have primary or secondary amputations. Being a low incidence injury, delayed presentation by the patient is often common. These patients are also usually missed by the triage system that assesses these injuries to be neither life- nor limb threatening, resulting in a significantly longer time to first consultation by a specialist team. Our patient had an 18 h delay from the time he sustained the injury to the time a definitive debridement was performed. Despite the delay, he had a full recovery with two surgical debridements, no requirement for a coverage procedure and return to pre-morbid function. We believe there are several reasons responsible for this.

Volume of injection was low and the plane and depth of penetration were relatively shallow in our patient's instance. The type, amount and temperature of the injected material and the pressure of injection are important prognosticators.¹⁰ The patient released the trigger almost immediately after pressing it, and only a small volume of paint was injected into the digit. X-rays performed demonstrated paint in the subcutaneous tissue, and intraoperatively, there was no breach of the flexor sheath.

Although the neurovascular bundles were surrounded by paint debris, there was no encasement or constriction by the solidified paint that could have caused neurovascular compromise. The skin was not devascularised and small incisions were sufficient to expose the appropriate areas for debridement and irrigation. If the flexor sheath had been breached, the catheter would have been threaded through the sheath to allow for continuous irrigation within the sheath, akin to the treatment of pyogenic infections such as flexor tenosynovitis. While fluoroscopy is a useful and cost-effective adjunct for immediate operative purposes, three-dimensional computer tomography scan after the index debridement when there is more time can also help with subsequent operative planning, as was demonstrated by Niitsuma et.al.¹¹

The role of continuous catheter irrigation of the involved area by means of an infant feeding catheter served two purposes. The first was to limit fulminating infection from bacterial inoculation into the wound, a concept introduced by Dickson-Wright.¹² Continuous dilution of the bacterial bioburden potentially reduced the extent of infection, demonstrated by the limited subcutaneous purulence demonstrated at the second debridement. Infection can cause significant damage to the neurovascular bundles and flexor tendons in delayed paint injection injuries,¹³ and ultimately affect

the recovery prognosis. The second was for the purposes of removing paint debris from the wounds. Given the water-soluble nature of the paint, irrigation of the space where paint precipitated allowed it to be washed out rather than continue to accumulate and coagulate, reducing tissue response and potential tissue damage.

The wound was left open with paraffin gauze dressings changed every two days upon discharge from the hospital. This allowed exudate from the wound to egress and the dressings were light enough to allow for a range of motion and stretching exercises to be facilitated by the therapist. An early and intense post-operative rehabilitation regimen is imperative.¹⁴ The wound healed without complications by one month postoperatively and scar massage was commenced. The patient was also highly motivated and performed the exercises taught to him diligently.

Conclusion

Catheter irrigation is useful tool in the treatment of high-pressure injection injuries, especially where a water-soluble solvent is the perpetrator. Timely recognition, intervention, regular wound inspections and a low threshold for repeat operative intervention, as well as emphasis on maintenance of finger dexterity with a rigorous postoperative rehabilitation regime contribute to a successful outcome.

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Ethical approval

N/A.

Declaration of Competing Interest

Nil.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jptra.2021.08.004](https://doi.org/10.1016/j.jptra.2021.08.004).

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