

Non-operative management of a high-pressure water injection injury to the hand

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ABSTRACT

High-pressure injection injuries to the hand are work-related injuries that can take a devastating toll on the functionality of the affected extremity. Chemical injections are a surgical emergency. Injuries involving only water injection are rarer and have variable management strategies. We report a case of high-pressure injection hand injury due to water only. The patient was managed non-operatively with parenteral antibiotics, narcotics and elevation, with good outcome. We present a review of the literature on high-pressure injection injury.

Key words: hand; injury; high-pressure

RÉSUMÉ

Les blessures à la main par injection à haute pression sont des accidents de travail qui peuvent avoir des effets dévastateurs sur le fonctionnement du membre atteint. Les injections chimiques représentent une urgence chirurgicale. Les blessures découlant d'une injection d'eau seulement sont plus rares et exigent des stratégies de prise en charge variables. Nous présentons un cas de blessure par injection à haute pression à la main droite causée uniquement par de l'eau. Le patient reçut un traitement non chirurgical à l'aide d'antibiotiques parentéraux, de narcotiques et d'élévation du membre atteint. Le patient récupéra avec succès. Nous présentons une revue de la littérature sur les blessures par injection à haute pression.

Introduction

High-pressure injection injuries are an unusual cause of morbidity in the emergency department (ED). They most commonly occur due to work-related industrial accidents in which a high-pressure or hydraulic spray gun is being used. Substances under pressure include paint, gasoline, oil, benzene and grease. These injuries are usually seen on the non-dominant hand of young men. Although the injected materials have the potential to course through tissue planes and cause diffuse destruction, the entry wounds are

often benign in appearance.

Injection injuries due to water alone are rarer than chemical injuries. These are also caused by high-powered spray guns, and may not require surgical management due to the relatively benign nature of the injected substance. It has been proposed that injection injuries due to less toxic substances such as water and freon may be managed conservatively, preventing unnecessary surgical exploration. We present a case of a water-based injection injury to the hand that was successfully managed in a conservative fashion, and the relevant literature is reviewed.

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Case report

A 42-year-old right-handed man presented to the ED approximately 30 minutes after a work-related injury to his left hand from a high-pressure water spray gun. The patient complained of severe pain to the left hand and decreased range of motion in the left 3rd and 4th digits. There was no other associated trauma.

The patient had normal vital signs and was found to have an abrasion of the left distal palmar index finger and a 1.3-cm laceration on the palmar aspect at the base of the left third digit. There was circumferential edema of the 3rd and 4th digits extending proximally to the thenar and hypothenar eminence of the palm. The patient complained of pain with passive range of motion of the affected digits, and the pain was only partially alleviated by elevation. Sensation was grossly diminished, however the distal capillary refill was normal. Results of radiography of the left hand showed extensive soft tissue edema of the 3rd and 4th digits with no associated fracture.

The patient was given cefazolin, ketorolac and morphine sulfate; the left extremity was elevated on two pillows, and consultation with a hand specialist was obtained. The patient was admitted for observation and was continued on parenteral antibiotics and pain medication. The pain and swelling subsided sufficiently after 3 days to allow discharge of the patient with a prescription for oral cephalexin and wound care instructions. On 30-day follow-up, the patient had no appreciable loss of function in the affected hand (including full range of active and passive motion as well as preserved motor and sensory function).

Discussion

The first published cases¹ of high-pressure hand injuries were injuries caused by fuel-injection systems. As technology advanced, more injection injuries with various caustic substances have been reported, although their prevalence is unknown. In the work place, grease, gasoline and paint are common agents found under increased pressure. Less toxic pressurized agents include water, air and low-volume animal vaccines. Spray guns deliver these substances in the range of 2000–15 000 pounds of pressure per square inch (psi), with heavier materials usually requiring the greatest pressure. Grease guns that operate under 5000–10 000 lbs of psi account for 57% of high-pressure injection injuries.² Semi-fluid materials, such as paint, hydraulic fluid, gasoline and turpentine, account for 18% of these injuries,³ and an additional 14% are caused by diesel fuel injectors (under 2000–12 000 psi).⁴

Injection into the hand typically occurs as the operator is trying to steady the jet with the free hand or when trying to clean a plugged nozzle.⁵ Most of these injuries are seen in the non-dominant index finger, although palmar, forearm and foot injuries have also been reported. Most patients are young working men, average age 35, with the majority of injuries affecting the left hand.² Several factors contribute to the severity of the injury, including the material's inherent toxicity, the volume, and the location and pressure under which the substance is delivered. Pressures >7000 psi have been reported to have an amputation rate of 100%.⁶

Because of the limited space available for expansion, digital injection injuries have worse outcomes than injection into other areas.⁷ Injected substances lacerate the skin at the point of contact and course through tissue plains causing acute and chronic inflammatory reactions, as well as ischemia due to vascular compression and secondary infection. Yet the affected limb may appear benign, even when massive subcutaneous tissue damage has occurred. The usual course begins 1 to 2 hours after the injury, with increasing edema followed by discoloration and numbness, which may or may not be accompanied by pain. A granulomatous response to the foreign body takes place over days and weeks. In time the skin may break down and ulcerate, leaving the wound susceptible to bacterial superinfection.⁴

Injection injuries involving toxic chemicals are potential surgical emergencies even if the affected limb has a benign appearance. The overall incidence of amputation for high-pressure injection injuries is about 48%,² with patients who undergo decompression in less than 10 hours after the injury having a lower amputation rate.⁸ Physicians who fail to recognize the likely severity of the underlying injury may inadvertently send the patient home on analgesia without surgical evaluation.

There is a general consensus that treatment of high-pressure injection injuries of all causes should include broad-spectrum antibiotics, tetanus prophylaxis, analgesics, elevation, immobilization and surgical evaluation. Injuries warranting aggressive treatment to save the limb or digit should be sent immediately to the operating room for surgical exploration, debridement and wound lavage. The wound may be left open or loosely sutured.

Treatment with steroids is controversial because their efficacy has not yet been proven. However, glucocorticoids are recommended to reduce inflammation and tissue fibrosis when paint or paint solvents are involved in the injury.⁴

Although injection injuries from paint, oil and other more toxic substances frequently need surgical management, the treatment of less caustic materials such as water,

air and freon remain controversial.^{7,9,10} Poor outcomes of water injuries are likely due to the amount of pressure under which the water is delivered or to contaminants in the water source. Although water injection is normally less toxic to tissue than other substances, there remains a risk of concomitant bacterial infection, which may be seen in up to 20% of cases.¹¹ Contaminants may include gram positive bacteria, fungi, and uncommon organisms such as *Aeromonas hydrophila*. Water-jet devices may be contaminated with sewage or oil lubricants used in the guns.¹¹ Consequently, admission for observation and intravenous antibiotic treatment is necessary regardless of surgical or conservative management.

Conclusion

High-pressure water injection injuries to the hand are uncommon. Treatment of any high-pressure injury warrants surgical evaluation and aggressive early intervention to preserve extremity function and viability. Conservative management of water injection injuries should be initiated, with concern for subcutaneous tissue damage in the presence of possible contaminants from the water or spray gun that would necessitate surgical debridement. Broad-spectrum antibiotics and analgesics should be given, tetanus updated, and the affected limb elevated. Management should include serial examinations of the affected extremity for at least 24 hours before the patient can be discharged on oral antibiotics.

Competing interests: None declared.

References

1. Rees CE. Penetration of tissue by fuel oil under high pressure from a diesel engine. *JAMA* 1937;109:866-7.
2. Schoo MJ, Scott FA, Boswick JA Jr. High-pressure injection injuries of the hand. *J Trauma* 1980;20(3):229-338.
3. Mrvos R, Dean BS, Krenzelok EP. High pressure injection injuries: a serious occupational hazard. *J Toxicol Clin Toxicol* 1987;25(4):297-304.
4. Mizani MR, Weber BE. High-pressure injection injury of the hand: the potential for disastrous results. *Postgrad Med* 2000;108(1):183-90.
5. Vaughn G. Hand Injuries, high-pressure. *eMedicine* Available: www.emedicine.com/emerg/topic226.htm (accessed 2004 Nov 23).
6. Schnall SB, Mirzayan R. High pressure injection injuries to the hand. *Hand Clin* 1999;15:245-8.
7. Christodoulou L, Melikyan EY. Functional outcome of high-pressure injection injuries of the hand. *J Trauma* 2001;50(4):717-20.
8. Stark HH, Ashworth CR, Boyes JH. Paint gun injuries of the hand. *J Bone Joint Surg Am* 1967;49:637-47.
9. Ramos H, Posch JL, Lie KK. High pressure injection injuries of the hand. *Plast. Reconstr Surg* 1970;45:221-6.
10. Chung-Ho P, Dong-Chieh W, Shiong-Pheng H. High-pressure injection injuries of the hand. *J Trauma* 1991;31(1):110-2.
11. Heyworth J. High pressure water jet injuries. Rentajet "Water power for hire" [Internet]. Available: www.rentajet.co.uk/injury.htm (accessed 2004 Nov 23).

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