HIGH-PRESSURE INJECTION INJURIES Vasu Pai

These injuries are rare.

Sound clinical judgment and surgeon experience are important.
It is a surgical emergency

Definition

High-pressure injection injuries occur when equipment capable of achieving pressures sufficient to breach the human skin injects its contents into the human body, most commonly into the hand.
The pressure required to penetrate intact human skin is commonly cited at 7 bar (7 X 10^5 N/m^2) or 100 psi.

Aetiology

High-pressure injuries are commonly incurred by high-pressure guns, which are capable of producing pressures exceeding 2,500 bar (35,500 psi). Most of these guns produce pressures around 2,000 to 12,000 psi.

Grease guns produce pressures of 350 to 700 bar. Spray guns, used in the application of paint, lacquer, semifluid cement, hydraulic fluids, and solvents (paint thinner, turpentine, or gasoline), operate in the range of 200 to 500 bar.

Diesel fuel injectors range from 140 to 400 bar.

Water guns operate between 400 and 550 bar.

Clinical evaluation

1. An accurate history
2. Exact material injected, estimate of volume injected, and distance from gun to extremity.
3. The patient is often inexperienced and has received poor education in proper use and the associated hazards.

4. Documentation: Neurovascular examination
Tendon involvement
The entry wound is often just a small puncture;
Injected material can sometimes exude or is expressible.
Often, pain is not present initially.
In addition, the small size of the entry site might lead inexperienced patients to underestimate the true extent of the injury, resulting in devastating delay or inappropriate treatment
Radiographs are helpful; in cases of air or radio dense materials, safety training was provided for the employee.

Treatment should consist of broad-spectrum antibiotics, tetanus prophylaxis, and in most cases, surgical wide debridement for a true hand emergency. Literature on exact antibiotic regimens and efficacy or evidence is nonexistent. A commonly cited regimen is a first-generation cephalosporin and gentamicin.

Wong

TABLE 1. Classification of Severity and Tailored Treatment Protocol for High-Pressure Injection Injuries by Wong et al[10]

Severity	Nature	Treatment
Mild	Injected material is usually oil	Conservative during initial treatment period
	Relatively low-pressure injection	Close observation with antibiotics coverage
	No treatment delay	± Steroid
	Small area of involvement without proximal extension (confirmed with radiograph)	Prepared for surgery
	Preserve sensation and circulation	
Moderate	Moderate soft tissue involvement	Prompt decompression, wide debridement, open packing
	No treatment delay	± Repeated debridement
	Neurovascular bundles not compromised	Delayed closure
Severe	Injured by paint and solvents From high-pressure spray guns	Prompt decompression and meticulous removal of foreign materials and dead tissue
	Delay in treatment	± Repeated debridement
	Extensive soft tissue involvement with proximal extension	Late reconstruction or staged amputation
	Loss of sensation and poor circulation	Early amputation if indicated

PROGNOSIS

1. Worse in severe injuries
2. Early treatment better the outcome
3. In an analyses of 435 injection injuries distal to the elbow. The typical patient

was male (99%) with a mean age of 34.7 years, with injury to the nondominant (78%) index or middle finger. The overall amputation rate was 30%.

4. From the available data, delay to surgery correlated with amputation rate only for the organic solvents.

5. Debridement within 6 hours had a 38% amputation rate, greater than 6 hours was 58%, and no debridement was 88%.

6. Location of the injury also correlated with amputation; the thumb and palm fared better (15% and 25% amputation rates, respectively).

7. Higher pressures (> 1,000 psi or > 70 bar) correlated with higher amputation rates (43% vs 19%).

SUMMARY

High-pressure injection injuries are devastating injuries that often lead to poor outcomes.

It is thought that prompt diagnosis and emergent surgical intervention may decrease the amputation rate.

Late intervention and injection with more toxic organic solvents (paint, paint thinner, gasoline, automotive undercoating, jet fuel, or oil) are associated with higher amputation rates, especially in cases of an initially ischemic digit.

Debridement needs to be thorough using a wide, extensile exposure. Wound management varies and may consist of loose closure, dressing changes, or negative-pressure wound dressing.

More often than not, a second look is necessary to assess viability and reconstructive options, which include amputation, delayed primary closure, local flaps, and heterodigital or free island flaps.

A new classification system may allow surgeons to monitor clinically mild injection injuries before surgical intervention; that classification needs to be confirmed in more studies. In cases of salvageable digits, follow-up studies document decreased motion and sensation.

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