HIGH-PRESSURE INJECTION INJURY OF THE FINGER - A CASE PRESENTATION

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Abstract

High-pressure injection injuries are uncommon traumas characterized by a great discrepancy between a deceptively small entrance site and the extensive and underestimated subcutaneous tissue injury and destruction. Without early and correct treatment these lesions lead to disability and local extensive destruction. This paper presents a case of high-pressure injection injury to the metacarpal-phalangeal articulation of the finger from industrial paint; the extent of the injury was underestimated at presentation and improperly treated. This case required surgical staged management, with a total time of medical leave of three months.

Keywords: injection, high-pressure, finger, hand.

Introduction

High-pressure injection injuries of the hand are relatively uncommonly diagnosed but true surgical emergencies. They are caused by high-pressure guns emitting jet streams at high pressures (exceeding hundreds of atmospheres); at these pressure levels the injected material is forced through minimally distensible structures of the hand and fingers, spreading along fascia, tendon sheath and neurovascular bundles with significant destructive consequences. The relatively innocuous entrance wound covers the extensive severity of the subsequent lesions.

The most commonly injected materials are: oil, diesel, paint, paint thinner and other solvents, molten metal, wax, air, water [1]. The injected material has deleterious effects in several ways including: direct toxic effect of the involved chemical, ischemia, high-velocity mechanical impact, secondary infection, a significant raise of pressure in the closed palmar or digital space with consequent compartment syndrome [2].

Given the above, the early recognition and treatment of this entity are compulsory as delay may result in significant functional deficit or even amputation [3].

Case report

A 51 year-old man with no particular medical history presented to the Emergency Room of the County Emergency Constanța Hospital with a painful, swollen and discolored right long finger; the patient had sustained an accidental high-pressure injection injury involving industrial paint and mineral oils (used in the industrial ship painting) two hours before. The entrance site was a small puncture wound situated just proximal to the metacarpal-phalangeal joint flexion crease. The x-ray was suggestive of massive soft-tissue swelling, subcutaneous emphysema with radio opacities along the palmar and digital neurovascular bundles.

Figure 1. Subcutaneous emphysema and radio opacities along the palmar and digital neurovascular bundles of the right long finger.

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The diagnosis at admission was "gunshot wound of the right long finger; dorsal subcutaneous emphysema of the hand"; the medical treatment included tetanus prophylaxis and antibiotics (Cefort); the initial surgical treatment (in the General Surgery Department) consisted of wound debridement and decompression via two dorsal incisions; no splinting was applied.

24 hours later, the patient was consulted in the Plastic Surgery Department; the findings at this point were: massive swelling of the right hand, a flexed long finger at the metacarpal-phalangeal joint level, cyanotic and cold skin, no bleeding of the wounds and a sluggish capillary refill.

Figure 2. 24 hours after the injury: massive swelling of the right hand and a flexed long finger at the metacarpal-phalangeal joint level.

After establishing a diagnosis of "severe trauma of the right hand by high pressure injection of paint at the proximal phalanx – metacarpal-phalangeal joint level of the long finger (Modified Hand Injury Severity Score 336)", the surgical wound debridement was resumed thoroughly with large incisions for decompression both palmar and dorsal. At this point a large amount of solidified paint was found as far as the profound arterial palmar arcade and the division of the median nerve. All the necrotic tissue was removed along with the foreign material. The wound was thoroughly irrigated with saline solution, afterwards being left open and dressed; the hand was splinted in functional position. The antibiotic spectrum was enhanced by the addition of Gentamicine and Metronidazole to the therapy.

The evolution was torpid and consequently at 72 hours after the second debridement it was necessary to disarticulate the metacarpal-phalangeal joint of the long finger.

Figure 3. 72 hours after surgery: amputation is triggered by soft tissue viability loss.

Despite the repeated debridement of the wound, due to the continuous extrusion of foreign material deposits, the final coverage of the wound was possible only a month later – via a full thickness skin graft. Afterwards, the evolution was good, with full integration of the graft. The patient initiated an aggressive rehabilitation program with full range of motion of the fingers, good overall hand function and readmission at the previous work place three month after the accident.

Figure 4. Full range of motion at three months post injury permits return to work.

Discussion

It is difficult to estimate the real incidence of the high-pressure injection injuries – there are over one hundred cases described in literature; nonetheless, a group from the University of Colorado estimated an incidence of 1 in 600 hand injuries seen in their emergency department [4]. These data suggest that this kind of injury is relatively common given the widespread use of pressure machinery (the first published case was described by Hesse in 1925)

[5]. These lesions usually occur in the non-dominant hand, more frequently at the level of the index, palm or long finger [6].

The foreign material is injected at high pressure values; moreover, the local morbidity will be influenced by the chemical characteristics of the substance (type, toxicity, volume and viscosity) as well as the injection level. In high-viscosity substances (oils, vaseline) dispersion is less marked compared with more fluid materials [7]; low-viscosity solvents (paint, solvents, paint thinners) produce the most severe inflammatory responses and more damage due to rapid lipid dissolution and destruction of tissues [8]. That is why these lesions are associated with the highest rate of amputation – up to 48% at the finger level. On the other hand, grease and oil-based compounds may lead to oleogranulomas, chronic fistula and extensive scarring with digit function loss.

Factors contributing to digital ischemia are: massive vascular thrombosis determined by volatilization of the injected material, temporary vascular spasm, venous outflow obstruction and digital artery compression secondary to the compartment effect [7]. Chemical toxicity may be more important than ischemia in terms of tissue damage effect; consequently some authors add steroids to the medical therapy in severe cases. Nonetheless if a digit is from the beginning cold and poorly perfused the amputation may be considered as first hand treatment [8].

For this kind of injury the diagnosis is exclusively based on history and clinical findings; except for the routinely indicated x-ray, other investigations are futile; unfortunately, in the presented case, the proper treatment was delayed because the wound was first treated as a gunshot wound, while the local toxicity was very high. The medical treatment associates tetanus shot, analgesia and broad spectrum antibiotherapy. The curative treatment is exclusively and mandatory surgical, practiced in emergency and under general anesthesia – any type of regional or local anesthesia as well as the use of an Esmarch bandage could lead to more ischemia and the dissemination of the injected material [9].

The surgical treatment consists of decompression and debridement – usually in more than one stage – until all the necrotic tissue and foreign material are excised; the wound is irrigated only with saline solutions. Usually the wound cannot be closed by first intention and some reconstructive procedures may be necessary – skin grafts, loco-regional rotated flaps. Postoperatively the hand must be elevated and splinted in functional position. An extensive program of rehabilitation must be kept in order to prevent joint stiffness [10]. In order to restore the function of the hand/digit other secondary reconstructive procedures may be used – capsulotomies, neurolysis, tenolysis [11].

Conclusions

The high-pressure injection injuries represent true surgical emergencies.

The severity of the lesion is determined by: the entrance level, the resistance of the structures involved, the anatomy of the region, the physical-chemical properties of the injected substance (type, viscosity, volume), the pressure of injection.

The diagnosis for the high-pressure injection injuries is entirely based on history and clinical findings; the level of entrance will determine the dissemination path.

A prompt and well conducted surgical treatment along with a thorough follow-up and a well-established rehabilitation program are due steps for an optimal functional result achievement.

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