High-Pressure Water Swelling Sealant Injection Injury to the Hand: a Case Report and Review of the Literature

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Abstract High-pressure injection injuries (HPII) caused by water swelling sealant are rare at present. The patient generally has small-sized skin lesions, and the misleadingly benign presentation may cause delayed treatment at the early stage of management. In addition, radiographic examination may be underestimated. Subsequently, the inadequate surgical intervention may cause tissue necrosis and poor prognosis. Furthermore, the early recognition of water swelling sealant injected into tissue and emergent surgical intervention are the key to successful management for the patient with HPII caused by injecting water swelling sealant to tissue.

Keywords High-pressure injection injuries · Water swelling sealant · Polyurethane · Debridement · Flap

Introduction

Despite the multiple industrial usages of high-pressure guns, injection injuries to hand seldom occur. However, high-pressure injection injuries (HPII) are well known for it can lead to serious injury to the patient. These injuries are gener-

ally underestimated because of the small-sized skin lesion in the hand [1, 2]. Delayed treatment of HPII occurs occasionally due to the misleadingly benign presentation. In fact, high-pressure injection of foreign material into the hand develops severe and sometimes catastrophic consequences. Early recognition and treatment of these injuries are very important as delay may result in compromised function of the palm and fingers or even the amputation of a digit [3]. Poor functional outcome and digital amputation are common. The amputation rate of these injuries without adequate treatment is up to 16–48 % [4, 5]. Generally, HPII mostly involve the non-dominant hand [6–8]. More than 50 % of the injections occur in the index finger. The second most involved region is the thumb and only 10 % of the injections occur in hand, palm, or elsewhere [9, 10]. Overall, prognosis and outcome appears to be related to the substance injected, the pressure exposure, the digit involved, and the time delay to surgical care. According to the literature, the most commonly injected materials in HPII include paint, automotive grease, solvents, diesel oil, air, and water, [11–15]. The long-term sequelae associated with these injuries were related to the tamponade effect occurring from the compression force, the quantity of material injected, and the subsequent outpouring of edema fluid occasioned by the chemical irritation of these substances with the tissues [16]. Furthermore, it is very important to recognize the category of foreign materials injected into the hand and potential surgical urgency. To our knowledge, HPII caused by water swelling sealant is rare and effective treatment for this injury is unclear at present. This substance is a monomer polyurethane material and has expansion characteristics when it comes into contact with water. It may be directly toxic to the tissues and cause a poor prognosis. Here, we report a case of HPII caused by water swelling sealant in an accident. The treatment of such injury is discussed in this article by means of a case report and reviewing the literature.

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Case Report

A 34-year-old, dextrmanual waterproof male worker was injected an amount of water swelling sealant into his left ring finger during a leakage in one pipe of the high-pressure gun in an accident. He reported a small-sized skin lesion and minimal complaints immediately after the trauma. The patient was given tetanus prophylaxis and underwent debridement in emergency department, but over the next several hours developed swelling of the ring finger and increasing pain before referring to our hospital at 1 week after the trauma. Radiograph of the left hand showed marked tissue swelling around the ring finger swelling, bone destruction, and insignificant visualized radiodensities of foreign substance (Fig. 1). The patient underwent emergent surgical exploration, debridement, irrigation, and open tendon sheath release in our hospital. A large amount of polyurethane material clumps was removed, and extensive debridement of all the ischemic tissue was performed (Fig. 2). The patient received antibiotics intravenously for a duration of 5 days after operation. Open tendon sheath release was continued before closing the wound. Subsequently, proximal phalangeal island flap was designed for closure of defect in the ring finger, and it survived at 2 weeks after flap construction (Fig. 3). The amputation of digit was avoided in this patient. However, the ring finger developed contracture at 3 months after operation, with poor function (Fig. 4).

Discussion

HPII result from the introduction of foreign substances into the skin by high-pressure mechanical tools. Patients with HPII

Fig. 1 Radiographs of left finger. Red arrow indicates insignificant visualized radiodense material and blue arrow indicates bone destruction

Fig. 2 Appearance of the solidified polyurethane material

are often young male laborers [17]. The average age of patients with an injection injury is around 36 years [18]. The most common site of injury is in the hand in the majority of the cases; some rare cases of HPII occur in foot and oropharyngeal region [19, 20].

Generally, the patient with HPII have minor initial symptoms, including small puncture wound at the site of injury with minimal complaints of pain. The case in this report also had this manifestation. However, the increasing pain and swelling can develop hours after the injury. It can cause a “septic compartment syndrome” [21] and may lead to tissue necrosis. During the management of HPII, radiographs can demonstrate radiodense material, subcutaneous air, debris, and fractures. X-ray examination can reveal the injected substance or accompanying air in the tissues [22]. Verhoeven N. et al. [18] had suggested that HPII management should include radiographs as well as evaluation for possible infection, tenosynovitis, or abscess. In most cases of HPII, substances injected to tissue are visualized at the site of injury. However, the extent of material in tissues is often underestimated radiographically. In the present report, no significant visualized radiodensity

Fig. 3 Appearance of healed wound at 2 weeks after operation

Fig. 4 Appearance of healed wound at 3 months after operation

was found in the radiograph (Fig. 1). The fact is that large amount of polyurethane material clumps were found and removed during surgical exploration. In addition, bone destruction was also found in the radiograph (Fig. 1). Therefore, radiograph is indispensable for the treatment of patient with HPII caused by water swelling sealant. Bone destruction may be caused by the direct toxic effect of water swelling sealant, ischemic necrosis caused by vascular shield plug or infection. According to the previous report, the injected chemical material can incite significant damage via mechanical impact, inflammatory response, compartment syndrome, ischemia, and by a direct toxic irritant effect [18, 23]. In the present case, the real reason of bone destruction is still unclear at present.

Overall prognosis and outcome appears to be related to the substance. Generally, injections with air, gas, or small amounts of veterinary vaccines can be managed with observation and serial examinations if there is no compartment syndrome. However, injections with other liquid materials require emergent debridement within 6 h and the best outcomes will occur [24]. In this report, a lot of water swelling sealant was injected to his finger. The matrix of water swelling sealant is polyurethane material. Water swelling sealant will solidify and fill the compartment when injected into the tissue. Emergent surgical exploration and debridement are required for a good prognosis. Delayed treatment may cause tissue necrosis needing flap reconstruction. It is necessary to have extensive debridement at the early stage to prevent tissue necrosis, bone destruction, tissue contracture, even subsequent amputation. In this report, the left ring finger contracture may be caused by the direct toxic effect of water swelling sealant to tendon sheath, and inadequate exercise after reconstruction. In conclusion, early recognition of injected substance, radiographs examination, and surgical intervention are the key to successful management for HPII caused by injecting the water swelling sealant to tissue.

Conflict of interest The authors have no potential financial conflicts of interest to report.

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