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A Rare Case of a Second-Degree Chemical Burn due to Successive Contacts of Acidic Wart Removal Solution and Paint Solution

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ABSTRACT

Introduction: Chemical burns are an uncommon form of burn injury, accounting for 2.1% to 6.5% of all burn centre admissions. We presented one rare case of a second degree chemical burn due to successive contacts of acidic wart removal solution and paint mixture solution.

Case: A 38-year-old male with chemical burn on both feet due to reckless usage of a self-purchased wart removal solution, and accidental contact with paint mixture solution. Our surgeon author diagnosed a superficial partial thickness (second-degree) chemical burn on this patient, and performed surgical debridement followed by hyaluronic-enhanced silver sulfadiazine topical dressing to provide antimicrobial protection to the wound and topical petrolatum-based ointment to maintain moist environment for the wound and the periwound. Our team also gave Ceftaroline, a cephalosporin for serious infections of the skin and tissues below the skin, intravenously.

Result: One day after the surgical procedure, the wound dimensions were slightly more extensive than the initial size due to extensive debridement and necrotomy. All wounds produced no or minimal exudate, showed no slough nor pus inside the granulation area, and no swelling nor maceration in the periwound area. The fifth day after the surgical procedure, the wound on the lateral side of patient's right foot was almost completely covered by epithelialization. The wound on the sole of patient's right foot was about 70-80% covered by epithelialization, and the wound on the sole of patient's left foot was also about 70% covered by epithelialization.

Discussion: Topical solution for wart removal consists of many chemicals' agents (i.e. salicylic acid and acetic acid) and its application should strongly be under guidance and monitoring by physician due to its potential to harm human bodies and trigger chemical burn injury in varying degrees. Paint mixture is usually safe, risks no or minimal harms when in contact with skin, however it can provide a more difficult scenario and consequently a more extensive cleansing during the wound debridement procedure. Immediate decontamination and adequate dilution through massive irrigation is a major determinant of burn severity after chemical injury. Application of 1% silver sulfadiazine topical antibiotics enhanced with 0.2% hyaluronic acid for moisturizer displayed significant improvement for the burn wound healing.

Conclusion: Knowing exactly what type of chemical substance in contact with the skin and tissues that caused the chemical burn injury is as equally important as the comprehensive management itself. For acidic burn injuries, a proper and sometimes extensive necrotomy procedure is mandatory to provide a good tissue regeneration.

KEYWORDS: chemical burn injury, acidic burn injury, salicylic acid, acetic acid, wound healing

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INTRODUCTION

A burn is defined as damage to the skin and underlying tissues caused by heat, chemicals, or electricity. Each year in the United States about 450,000 people receive medical attention for burn injuries.[1] Chemical burns are an uncommon form of burn injury, accounting for 2.1% to 6.5% of all burn center admissions.[2] According to the 2015 National Burn Repository report of the American Burn Association, chemical injuries represented 3.4% of patients admitted to participating hospitals over the 2004 to 2015 period[1-2]. Most chemical burns are unintentional injuries, but chemicals can also be used as a form of assault, abuse or self-harm. The severity of a chemical burn is reduced by prompt recognition and reducing the duration of contact.[2]

In Indonesia, burns caused approximately 195,000 deaths annually. Latest data regarding burns in Indonesia was obtained from the Ministry of Health (published in 2014), which revealed that burns was ranked 6th in unintentional injuries in Indonesia with a total of 0.7%. We found that chemical caused burn in 11 subjects (2.7%) and most subjects in the adults group (10 subjects) which is the age group where people are working and are exposed to more hazardous situations.[3]

It is quite a harsh reality to know that knowledge of the potential harm of chemical agents in the household setting is still very low. Like any other types of burn injuries, severity of chemical injuries are in relation with of duration of exposure or contact. What differs chemical burn injuries from the thermal ones is that chemical exposure may still be lingering when patients already in an emergency room in contrast with thermal injuries, which are typically produced by shorter term of exposure to intense heat and relatively quickly to be extinguished. Considering that particular fact, we think it is important to undersand exactly what type of chemical substance in contact with the skin and tissues that caused the burn injury as an equally important part of the comprehensive management of chemical burn injuries.

CASE

A 38-year-old male presented to our Emergency Department with chemical burn on both of his feet after 5 days using a self-purchased wart removal solution. He also recalled one day before visiting the hospital, his bare feet accidentally stepped on paint mixture solution. Patient expressed moderate-severe burning pain throughout his soles, with visual analogue pain scale (VAS) of 5 to 6. Patient acknowledged he had no diabetic, hyperlipidaemia or hypertension condition and no histories of smoking, malignancies or surgeries. General examination showed patient in good and stable haemodynamic state, alert, not in shortage of breaths nor fever, and indicated no significant pathological conditions. His body mass index (BMI) is 25.

Local physical examination of our patient's right foot showed an ulcerative wound on the lateral side with irregular shape and measured 12 centimeters x 5 centimeters with a depth of 2 centimeters, with paleness area surrounded the wound. Raw measurement of the wound bed estimated 65% of granulation tissue and 35% necrotic tissue that adherent to the underlying tissue. The heel of the right food showed thick and hardened layers of skin with darker tone and many cracks visible, presumably it developed earlier as the skin tried to protect itself against repeated friction. Further evaluation identified fluctuation under the skin. (See Figure 1)

Fig 1. The lateral side and the sole of patient's right foot at the time of admission. Please notice a pale surroundings and an area of blackish non-vital skin, a characteristic feature of acid burn.

Physical examination of his left foot showed a round-shaped ulcerative wound at the heel, measured 8 centimeter in its diameter, with paleness area surrounded the wound. Raw measurement of the wound bed estimated 70% necrotic tissue and 30% granulation tissue. The surrounding skin appeared hyperaemic and maceration. No other significant clinical signs like paraesthesia, pallor or coldness detected on both legs and feet. (See Figure 2)

Fig 2. Sole surface of patient's left foot at the time of admission. Please notice an area of blackish non-vital skin, a characteristic feature of acid burn.

Our surgeon author performed further clinical assessment and wound management procedures in operating room. The healthy granulation tissue was carefully preserved, the unhealthy tissue was taken out along with the non-vital skin and the central necrotic tissue. During further examination on the right heel, fluid accumulation was identified and confirmed after incisions being made. (Figures 3 and 4). Debridement procedures included cleansing with a large volume of normal saline (NaCl 0.9%), all the aforementioned steps were also performed for the left foot lesion. (See Figure 5)

Fig 3. Surgical debridement of compromised skin tissue of right plantar surface.

Fig 4. Incision on right heel to evacuate the exudate, followed by debridement, trimming and removing the problematic skin, and irrigation with large volume of sterile saline.

Fig 5. Surgical debridement of damaged skin tissue of left sole. Pictures show blackish remnants of non-vital skin, a characteristic feature of acid burn, which later would be excised as well.

Post-surgical care included application of hyaluronic-enhanced silver sulfadiazine topical dressing to provide antimicrobial protection to the wound and maintain moist environment for the wound and the periwound. We also added petrolatum-containing tulle sheets on top of the wounds to facilitate non-adherent dressing changes. In term of infection control, we gave Ceftaroline, a cephalosporin for serious infections of the skin and tissues below the skin, intravenously. We followed his post-surgery conditions meticulously, and observation of wound-related condition such as granulation, epithelialization, slough presentation, and discharge, was conducted on weekly basis.

Fig 6. Application of hyaluronic-enhanced silver sulfadiazine topical dressing (Burnazin® plus), and petrolatum-containing tulle to facilitate non-adherent dressing changes.

RESULT

One day after the surgical procedure, the patient had his first post-surgical evaluation. The wound on the lateral side of patient's right foot was irregularly shaped and measured 12 centimetres long, 8 centimetres wide (previously 5 centimetres) and 1 centimetre deep (previously 2 centimetres). Its wound bed was 100% covered by healthy granulation tissue, and epithelialization was visibly identified along the wound edges. The wound on the sole of patient's right foot was irregularly shaped and measured 7 centimetres long, 5-6 centimetres wide and 1 centimetre deep. Its wound bed was 100% covered by healthy granulation tissue, and epithelialization was visibly identified along the wound edges. The wound on the sole of patient's right foot was round- shaped, measured 8 centimeter in its diameter and 1 centimetre deep. Its wound bed was 100% covered by granulation.

Wound dimensions were slightly more extensive than the initial size due to extensive debridement and necrotomy. Reduction of wound depth was a result raising process of granulation tissue. All wounds produced no or minimal exudate, showed no slough nor pus inside the granulation area, and no swelling nor maceration in the periwound area. (See Figure 7). The surgeon continued the daily wound management with hyaluronic-enhanced silver sulfadiazine topical dressing, and sent the patient home along with supplies of oral antibiotics and analgetics, detailed instructions on how to properly manage his wounds, and how to keep both feet away from weight bearing for 1 week.

Fig 7. Post-surgery day 1, all of the wounds on right and left foot showed fast healing with the granulation, epithelial tissue and minimal exudate.

The fifth day after the surgical procedure, the patient had his second post-surgical evaluation. The wound on the lateral side of patient's right foot was almost completely covered by epithelialization. The wound on the sole of patient's right foot was about 70-80% covered by epithelialization, leaving a small area of granulation tissue with no exudates at the center of it. The wound on the sole of patient's left foot was also about 70% covered by epithelialization; the anterior half was completely covered and the posterior half still had, a small area of granulation tissue with no exudates at the center of it, measured 3 centimetres in diameter. (See Figures 8). The periwound was adequately moist and healthy. Unfortunately, the patient discontinued his follow-up evaluation after his second visit.

Fig 8. Post-surgery day 5, all wounds showed significant improvements.

DISCUSSION

Chemical burn injuries, like other types of burn injuries, require a long-term treatment program due to the complexity of the clinical course. Patients of chemical burn injuries need accurate treatment beginning with the initial injury and acute life-sustaining measures, clinical stabilization processes including best intensive care treatment and conservative and surgical wound management and reconstruction, followed by long-term rehabilitation.[4]

Contact to chemical substances cause injury in four ways[1,2]: absorption through the skin and mucous membranes, oral ingestion, inhalation, and a combination of any of the aforementioned three (i.e., a scald burn with chemicals in the water). Each way has its own specific clinical outcome.

More than 25,000 chemical substances are commonly used in the industry, agriculture, house cleaners and others, and many of them have been identified as having the potential risk of causing burn injuries. Toxic chemicals react with the skin, may not be easily removed, and thereby continue to cause injury for an extended time. The severity of a chemical burn injury is determined by[1,2,5]: its concentration, its quantity of burning agent, its duration of contact, its depth of penetration and its specific mechanism of action. The severity of a chemical burn is reduced by prompt recognition and reducing the duration of contact.[5]

The primary assessment and ABCDE of trauma, secondary assessment of general condition, and all general principles of trauma and burn care apply in the same way to chemical burns.[6] First aid measures for chemical burns involve several aspects such as: removal of the chemical agent, treatment of the systemic toxicity if any and side-effects of an agent, general support, special considerations for specific agents if appropriate, local care of the burn (if it is relevant at this stage, depending on the nature of the chemical involved, i.e., fluor hydric acid).[6,7]

Treatment of burn injuries depends on the size and the depth of the burn (See Figure 9), and the same goes for any chemical burn injuries of the foot. Superficial thickness burn injury of the foot that shows signs of local inflammation without significant damage to epidermal layer will heal spontaneously after a while, and pain reliever is the only medication for such condition. For partial thickness burn injury of the foot, significant damage to epidermal and some part of dermal layer takes place, for which reepithelialisation may repair the damaged skin structure in certain extent (depending on the size of the wound area), while wound closure surgical procedure is required for bigger wound size. For full thickness burn injuries of the foot, damage to epidermal and the whole depth of dermal layer takes place, for which reepithelialisation cannot be expected to repair the damaged skin structure and wound closure surgical procedure is mandatory. If the burn victim shows systemic haemodynamic disturbance, intravenous fluid therapy is required. Aside pain relieving medication, edema management like leg elevation, multiple daily dressings with frequent observation as well as commonly used topical antibiotics and splinting of the foot usually used as part of the therapeutic program. Prophylactic systemic antibiotics is recommended if empiric studies sanction the fact and should not be applied routinely but case by case.[8]

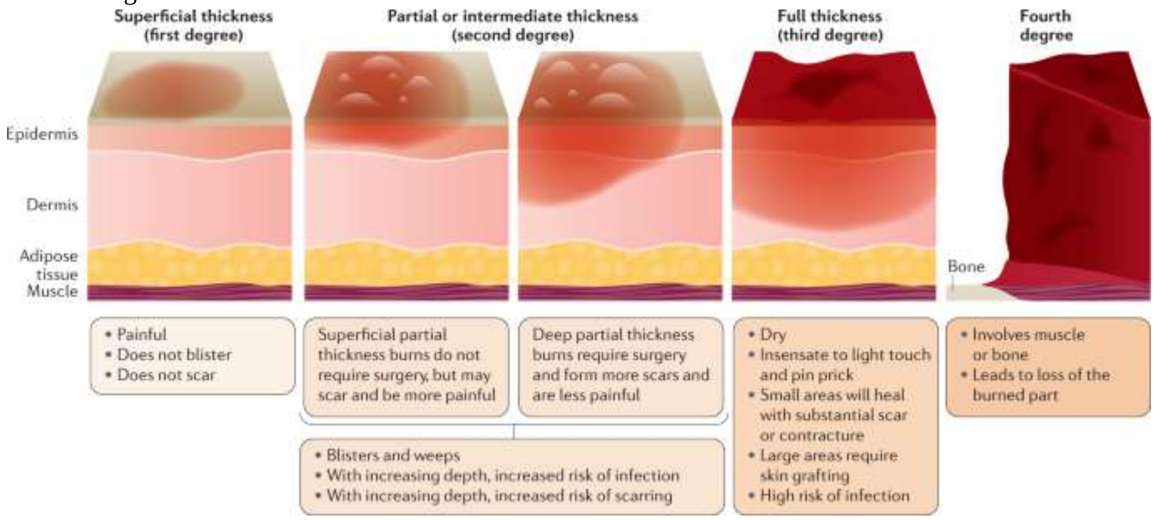

Fig 9. Burn depth is an important factor in assessing patient care. Burns extending into the underlying skin layer (dermis) are classed as partial thickness or second-degree; these burns frequently painful.

We discussed a case of a young adult who had burn injury on both of his feet after using a self-purchased wart removal solution, and one day before admission, his bare feet also accidentally in contact with paint mixture solution. Among many over-the-counter wart removal solutions, most of them contain salicylic acid and acetic acid derivatives.

Salicylic acid is a type of beta-hydroxy acid that helps dissolve the protein keratin (keratolysis).[9,10] Various concentrations of its derivatives have been used for different applications ranging from the treatment of acne to chemical peels. As far as we observed, there were not many reports in the literature with titles of skin burn due to salicylic acid. Keratolytic effect of salicylic acid appears to be concentration dependent, a 5% or higher concentration exerts an increasingly potent and rapid deep keratolytic effect on the stratum corneum and ultimately exerts an exfoliative action. A higher concentration of 40- 50% has been used for wart removal, with its mechanism of action is by reducing the intercellular cohesiveness of the keratinized cells by dissolving the intercellular cement material and reduces the pH of the stratum corneum that consequently increases hydration, induces softening and desquamation of corneocytes. Due to its exfoliative effect, most manufacturers warn against its application on moles, birthmarks, warts with hair, genital warts, or warts on the face or mucous membranes.[9-11]Acetic acid has been used for centuries for medical purposes to cure tinea pedis, remove nevus or warts, as well as to reduce infections and to support other means of treatment. Glacial acetic acid is an acetic acid form that contains a very low amount of water (less than 1%, anhydrous). It is a strong acid and the purest form of acetic acid commercially available. Glacial acetic acid is usually used as a reagent for the production of chemical compounds or as a solvent, and it can cause severe inflammation and chemical burns if it directly contacts mucosa or skin. When in direct contact with skin, glacial acetic acid denatures proteins and causes coagulation necrosis and slough formation, which prevents the acid from penetrating the skin. It also causes severe hyperpigmentation and/or scar contracture, and may eventually lead to intoxication via skin absorption, which causes haemolysis, hepatic insufficiency, hypotension, renal failure and metabolic acidosis.

Trichloroacetic acid (TCA) is a caustic substance derived from acetic acid by substituting the three hydrogen atoms of the methyl group with chlorine atoms, and widely used in cosmetic products as chemical peels and as chemoablation substance for warts –including genital warts. It is a corrosive substance and contact can severely irritate and burn the skin and mucosa.[12,13]

Utilization of such substance without health expert monitoring very much risks the coagulative necrosis of the skin and soft tissue in contact with it. Coagulative necrosis occurs when acid substance denatures tissue proteins to form cid proteinates, which later resulting in damage to both structural and enzymatic proteins. Protein denaturation damages cell structures including ones in the local microvascular network, causing the surrounding cells suffer from lacking of blood supply and subsequently die due to hypoxia. As a result of lysosomal enzyme denaturation, the structure of 'coagulated' dead tissue are preserved for at least a few days, leaving a clinical appearance of a (blackish) area of necrotic tissue in the centrum of a wound that is surrounded by a pale segment of tissue contrasting against the outer well-vascularized skin and soft tissue .[14] Furthermore, the patient had accidentaly stepped both of his bare feet on mix paint the day before presented to the hospital. It was very possible that the paint contamination worsened the wound condition, considering the fact that the paint solution involved much chemical substance.[12-13]

As the patient did not clearly aware of the paint he stepped on, we had to anticipate many possibilities about what kind of paint in contact with our patient. There are several type types of paints utilized in construction. Wall paints contain titanium dioxide to provide opacity and durability, calcium carbonate to provide bulkiness and smoothness, acrylic polymers to bind the paint substance together, ethylene glycol to facilitate flow and quick drying, propylene glycol to improve paint resistance to temperature, and biocides to prevent growth of mold. Titanium dioxide may be a mild skin irritant in certain people, although on contrary its nanoparticles may somehow improve burn wound healing.[15] Calcium carbonate is potentially harmful and causes tissue irritation only in concentrated solid form or in very concentrated solutions. In fact studies proved calcium carbonate had positive effects in acid burn wound healing.[16]

Other substances had been studied to have no to low potential to skin irritation. Wood paints contain alkyd resins to provide adhesion and durability, linseed oil to provide moisture resistance and enhanced the woody texture, urethane resins to provide protection against abrasion, mineral turpentine to facilitate flow and quick drying, certain pigment for paint colour, and biocides to prevent growth of mold. Among those substances, most substances had been studied to have no to low potential to skin irritation, in fact studies proved alkyd linseed oil had positive effects in wound healing.[17] Overexposure of mineral turpentine indeed has potential to cause skin irritation in certain people, but no skin problems ever reported from short contact occasions. However, it has defatting effect on deeper wounds.[18]

Reviewing chemical burn wound pathophysiology, we acknowledge six mechanisms of action for chemical agents in relation with human tissue: oxidation, reduction, corrosion, protoplasmic poison, vesicants, desiccants.[13] Classification of chemical agents is based on the chemical reactions that they initiates, mainly we divided them into four classes: acids, bases, organic and inorganic solutions.

1. Acid substances are proton donors. They release hydrogen ions and lower the pH value from 7 down to values as low as 0. Acid substances with a pH less than 2 can produce **coagulation necrosis** on contact with the skin. A better predictor than pH alone is the amount of alkali needed to neutralize and raise the pH of an acid. This may reflect the strength of the acid involved.
2. Base substances are proton acceptors. They will strip hydrogen ions from protonated amine groups and carboxylic groups. Alkalis with a pH greater than 11.5 produce severe tissue injury through **liquefaction necrosis**. Liquefaction process loosens tissue planes and allows deeper penetration of the agent and more damage consequently. For this reason, alkali burns tend to show deeper and more severe tissue defect than acid burns.
3. Organic solutions act by solving the lipid membrane of cells and disrupting the cellular protein structure.
4. Inorganic solutions can directly damage the skin by direct binding and salt formation.

It should be noted that all those reaction are also depended to amount and duration of contact.[1,2,5,12,14]

Lacking clear information about the chemical solution in contact with the burn wound, the surgeon author could only rely on patient's physical examination and could never determined the severity of burn wound clinical appearance was primarily due to wart removal solution or by the following paint solution. We learned that direct skin contact with paint solution in short duration should do no or minimal harm to human skin. However, as the wound tissue also in contact to paint solution, we anticipated a more difficult scenario and a more extensive necrotomy and cleansing during the wound debridement procedure to remove dead tissue completely, as we acknowledged how dead tissue blocking the proper wound healing by occupying the wound space, consequently preventing neovascularization, deposition of wound matrix, and (later) epithelialization from growing. Dead tissue also provides nourishment to microorganisms and makes a wound vulnerable to infection.

Wound healing is a complex process, it includes growth factors and many biochemical substances, cellular responses to them, and a good clinical care to facilitate it.[19] The fundamentals of proper burn wound care are frequent debridement, moist wound care, and management of infection. By the standard, our surgeon author performed surgical debridement, reinforced with enhanced topical antibiotics preparation of 1% silver-sulfadiazine and 0.2% hyaluronic acid as a moisture regulator (Burnazin® Plus). Silver sulfadiazine has been accepted as the topical antibiotics of choice for burn wound since the late 1960s and early 1970s due to its effectiveness against Pseudomonas infection of burn wound[20,21] and its combination with hyaluronic acid suggested a potential In result improvement for partial thickness burn wound.[22] We added non-antibiotic tulle sheets simply to facilitate non-adherent dressing changes. We selected Ceftaroline fosamil (Zinforo® in Asia and Europe) as our intravenous antibiotics due to its effectiveness for acute bacterial skin infections and its excellent activity against methicillin-resistant Staphylococcus aureus (MRSA) and other Gram-positive bacteria.[24] What is more, it also demonstrated superb activity against most of the aerobes found in moderate to severe foot infections.[24,25.]

CONCLUSION

Chemical burns are an uncommon form of burn injury. Knowing exactly what type of chemical substance in contact with the skin and tissues that caused the chemical burn injury is as equally important as the comprehensive management itself. In the immediate phase of management, the removal of substance and neutralisation with water is the most important step in the treatment. For acidic burn injuries, a proper and sometimes extensive necrotomy procedure is mandatory to provide a good tissue regeneration.

CONFLICT OF INTEREST

The authors had no financial and personal relationships with other people or any associations related to the medical products we utilized during our case management that could inappropriately influence our work

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