CLINICAL VIGNETTE

Chemical Burn to the Face

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A 71-year-old male presented to the ED after sustaining a burn to the right side of his face 6 days prior. He was charging a boat battery which overcharged and exploded with facial exposure to hydrochloric acid. Initially, blisters formed 2-3 days later he noted redness and swelling to his right forehead and upper face. For the past 2 days the redness has increased, and he has noticed warmth to the area. He denies fever, chills, shortness of breath, throat tightness, eye pain, change in vision.

His vital signs were unremarkable. Multiple healing crusting circular abrasions were noted on his right forehead and right parietal scalp with estimated 1.5% of Body Surface Area affected. There was surrounding redness over right side of his head up to mid right cheek and periorbital area. This area was swollen, tender, and warm. There was no fluctuance or discharge. His right eye had mild conjunctival injection with right upper eyelid swelling. Left eye and eyelid unremarkable.

Plastic surgery service was consulted and recommended transfer to a Burn Center. Additionally, due to concern for cellulitis, he received IV antibiotics.

Background

Chemical burns are caused by over 25,000 agents commonly found both in the workplace and at home.[1,2] Substances, like cement, tar, hydrochloric and hydrosulfuric acids, hydrofluoric acid, phosphoric acid, and alkali, are common causes of chemical burns.[1,2] Chemical burn agents can be categorized as acids, bases, organic solutions, and inorganic solutions.[1-3] Most chemical burns will require medical or surgical treatment.[1] Management of chemical burns is complicated, not only by the plethora of agents that can lead to them, but also by the difficulty in assessing burn depth and deciding whether to excise the injury.[1] Additionally, chemical burns tend to heal more slowly than thermal burns.[4]

Though chemical burns comprise only 3% of all burns, they can contribute to significant morbidity and loss of working time.[1,5] Surgical treatment is necessary for almost 55% of chemical burns.[1,5] In developed countries, up to 4% of admissions to burn units are due to chemical burns while in underdeveloped countries, this number is higher at 14%.[4] Thirty percent of deaths due to burns have been attributed to chemical agents in some studies.[1,2]

Pathophysiology

Chemical burns, like thermal, electrical, and radiation burns, lead to protein denaturation.[1,2] Unlike thermal burns, which are the product of a usually short exposure, a chemical could continue to damage the patient's skin for a longer period of time before the burn is recognized and can continue even after removal from the site.[1,2] Additionally, chemicals have continued disruption of proteins through hydrolysis as compared to thermal burns.[1,2] Chemical burn severity is based on concentration, quantity of agent, duration of skin contact, penetration and mechanism of action.[1] If the chemical agent enters the bloodstream, it can also lead to severe systemic effects, another important concern in chemical burns.[1,2]

Hydrochloric acid, the offending chemical for our patient, causes burns via reduction of proteins by binding to free electrons in the tissue.[1] This reduces the pH of the skin significantly.[1,6] Heat may also be a byproduct of this reaction and contribute to the burn.[1,2] Hydrochloric acid will lead to proteins denaturing and transforming into chloride salts.[1] Other mechanisms of action for chemical burns include: oxidation, corrosion, protoplasmic poisons, vesicants, and desiccants.[1-3]

Management

A complete history and rapid treatment to reduce tissue damage is essential in the management of chemical burns.[1,2] Injury severity worsens with longer duration of exposure, therefore prompt removal is important.[1,2,7] It is necessary to limit exposure by removing any contaminated clothing or jewelry and performing irrigation with water.[1,2,8,9] Irrigation is done with low pressure to avoid splashing and driving the chemical deeper into tissue.[10] It is important for the water runoff to avoid spreading the chemical to other areas of the patient's body, [1,2,8,10] which is why submerging in water is not advised.[1,8] Irrigation should be continued for at least 20-30 minutes.[1,2,8] Early and thorough irrigation has shown to improve patient outcomes in repeated experiments.[2,10,11] It is difficult to specify the duration of lavage, however testing the pH of the runoff water can serve as an indication of the effectiveness of hydrotherapy and irrigation should be continued until the pH normalizes.[1,9] It is preferable that the temperature of the lavage water is close to 37 degrees Celsius and that the patient's room is maintained between 28-31 degrees Celsius to avoid the complication of hypothermia.[1] Healthcare providers should take special care to wear protective clothing during lavage to

avoid exposure to the inciting chemical.[2,8] Hydrotherapy is the main treatment modality used for hydrochloric acid burns.[6] Some chemical burns that should not be irrigated with water including dry lime, phenols and elemental metals.[1]

Hydrotherapy also should not be used with chemicals that generate heat when combined with water or are insoluble in water, such as phenol, sulfuric and muratic acids, and chlorox.[1,12] These agents, should use a solubilizing agent or neutralizing substance, like soap, prior to hydrotherapy.[1,12] Use of neutralizing agents prior to hydrotherapy, remain controversial as it is difficult to control the amount of neutralizing agent.[1,3] Obtaining the appropriate neutralizing substance could also delay irrigation.[1] On the other hand, some neutralizing agents, like Diphoterine, a polyvalent, chelating neutralizer, has been shown to reduce morbidity and pain following a chemical burn.[1,12] Diphoterine is used in Europe currently, for acidic and alkaline burns.[1,12]

After irrigation, it is important to monitor systemic pH and check blood gas values in addition to electrolyte panels until the patient metabolically stabilizes.[1] Removal of destroyed and non-viable tissue should be done as soon as possible.[1,4]

In the Emergency Department, patients present with several different types of burns. However, specific measures need to be addressed when faced with a chemical burn. The extent of the injury may be underestimated with more severe injury to deeper tissue. Additional consultation with plastic surgery and/or a Burn Center should guide intervention.

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