
Phosphorus Burns: A Practical Approach to Local Treatment

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Most phosphorus burns are of limited extent. First aid consists of vigorous irrigation with water or saline followed by application of soaked dressings. At the Rambam Medical Center Burn Unit, washing of the wounds with 1% copper sulfate and 5% sodium bicarbonate solutions occurs before removal of phosphorus particles. In selected patients, prompt excision of the injured tissue and skin grafting are recommended. Fluid replacement and close monitoring of ECG, serum calcium, phosphorus, and electrolytes are recommended for all patients with such burns.

Phosphorus burns, which are relatively rare, are encountered mainly during military conflicts or terrorist attacks. During the past 18 years, more than 20 cases of limited phosphorus burns ($\leq 10\%$ total body surface area) were treated in our Burn Unit. This paper will briefly outline our approach to the local treatment of phosphorus burns.

Methods

Our phosphorus burn care treatment procedures follow.

1. Under general or regional anesthesia, thoroughly irrigate the burn area with large amounts of 0.9% NaCl solution. To facilitate mechanical elimination of phosphorus particles, we use a Waterpik.

2. Irrigate the chemical burns with 1% copper sulfate and 5% sodium bicarbonate solutions; after doing so, cleanse again with large amounts of saline.

3. Avoid using a brush to remove the phosphorus particles. In most instances, such attempts might result in further embedding of the phosphorus into the injured tissue.

4. Delicately remove the black particles by means of a metal forceps. Not infrequently these particles are located deep in the tissue; identification could be made easier by locating the origins of the slim smoking points. Larger and more superficial particles can be visualized by a fluorescent Wood's lamp.

5. If the injury is extensive and deep, consider the need for prompt excision to the fascia and skin grafting.

6. Dress the wound with dressings soaked with 5% mafenide solution or any other antimicrobial agent.

7. Inspect the wound at least twice per day. Should new particles or smoking areas be identified, surgical removal as previously described is mandatory.

8. After successfully eliminating the phosphorus particles, treat the burn wound conservatively or surgically, according to its estimated depth.

9. During the first 48 hours after the injury, be aware of serum electrolyte levels, with special attention to calcium and phosphorus levels. Replace intravenous fluids to all patients. In addition, ECG, hemodynamic, and cardiovascular state monitoring is recommended, especially in patients with extensive phosphorus burns.

Discussion

Phosphorus is characterized by continuous burning when it contacts ambient oxygen. Hence, phosphorus burns should initially be treated by irrigation with water or saline and then by soaked dressings. When patients are referred to the Burn Unit, more specific local treatment is indicated. Ben-Hur and colleagues¹⁻³ introduced a combination of 5% sodium bicarbonate with 1% hydroxyethyl cellulose and 3% copper sulfate solutions for the treatment of phosphorus burns. In contradistinction, Cason⁴ recommends the use of 1% sodium bicarbonate as well as other buffered solutions. He suggests using only 1% copper sulfate solution 24 hours following the injury. In the tradition of Curreri,⁵ it is our approach to use this antidote immediately after the patient's hospital admission. We treat these injuries with 1% of the agent followed by vigorous irrigation with saline because of severe complications expected in these patients; ie, massive hemolysis, hemoglobinemia, hematuria, hemoglobinuria, and oliguria.⁶ All patients, regardless of the extent of their limited burns, are intravenously resuscitated with crystalloids to eliminate any possible absorption of copper sulfate into the system.

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McCarter and Fecitt⁷ postulated that local tissue damage results from the production of P_2O_5 , which is a very potent hydroscopic agent. By interaction with water, it produces H_3PO_4 , which significantly digests the local tissue. Hence, early surgical removal of phosphorus particles in limited and superficial burns is mandatory to further decrease the potential tissue damage. In more extensive and selected burns (>10% TBSA), excision to the fascia should be considered with prompt skin grafting.

Not infrequently, phosphorus burns can be life threatening. Serum calcium levels might drop while phosphorus levels are elevated, leading to elongation of ST intervals, progressive bradycardia, elevation of QT segments and, finally, sudden death.⁸ A relatively small burn might mislead a clinician. Hence, close monitoring of serum calcium and phosphorus levels as well as ECG is crucial during the first 48 hours postinjury.

In conclusion, phosphorus burns are of limited extent in most instances. Vigorous local treatment with an antidote, followed by irrigation with saline and early removal of phosphorus particles, is mandatory. In selected patients, surgical excision of the damaged tissue should be carried out. Intravenous fluid replacement is essential even in limited burns in view of potential serum disturbances. Close ECG, serum calcium, and phosphorus mon-

itoring during the first 48 hours following the injury is recommended.

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