"My fingers just started hurting!"

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A healthy 52-year-old firefighter was clearing a table at the firestation when he noticed a sudden, intense pain on the tips of his left index and middle fingers after picking up a rag. The rag had been used earlier that day to polish the chrome on the fire engine's wheels. Although he flushed the fingers copiously with tap water, the pain continued to escalate.

He presents in severe distress. His fingers are red and swollen just proximal to the nail, although clinical findings are less than would be expected with the degree of pain (Figures 1 and 2).

Figure 1. Redness and swelling of left index and middle fingers.

Figure 2. A closer look at affected digits.

Questions:

1. *What is the likely offending agent?*
2. *What are typical clinical signs of exposure?*
3. *How does the offending agent cause these symptoms?*
4. *How can we manage this?*

Answers:

1. What is the likely offending agent?

The substance is most likely hydrofluoric acid (HF), one of the strongest inorganic acids. Although a gas at room temperature, HF is commercially available in aqueous forms (Table 1).

HF burns should be suspected in patients with possible symptoms who work with HF-containing products.

2. What are typical clinical signs of exposure?

The hallmark symptom is increasingly intense pain in exposed areas. If untreated, initial redness can progress to induration with vesicles and, finally, to a black necrotic appearance. Full thickness burns and loss of digits can occur.

Surface involvement in weaker solutions may be minimal and hide significant deep involvement.

Ingestion and eye exposure can also cause severe toxicity. Solutions of 20% or more will usually produce symptoms in 30 to 60 minutes or less; at lower concentrations, symptoms may be delayed up to 24 hours. Inhalation of HF can cause severe pulmonary edema.

Table 1

Products in which hydrofluoric acid is commonly found

- Rust removal solutions
- Aluminum cleaners
- Glass-cleaning solutions
- Ceramics and ceramic tiles
- Commercial and home laundry products
- Dental labs

Hydrofluoric acid is also used for petroleum exploration and electronics manufacturing.

3. *How does the offending agent cause these symptoms?*

Although solutions > 40% can cause immediate burns due to acidity (H^+ ions), the usual mechanisms of damage are via the fluoride ions (F^-), which are sufficiently small to diffuse readily through tissues. The F^- ions attack many cellular constituents, binding irreversibly to magnesium and calcium ions and precipitating. Acidosis, hypocalcemia, and hypomagnesemia can result.

If HF exposure is left untreated, initial redness can progress to induration with vesicles; full thickness burns and loss of digits can occur.

Prolongation of QT interval can be seen on electrocardiogram (ECG), with resulting dysrhythmias.

Hypocalcemia is more likely with inhalation of > 60% solutions or with burns from HF of any concentration that affect > 5% body surface area.

4. *How can we manage this?*

Most minor exposures will respond favourably to irrigation with copious amounts of water for at least 30 to 60 minutes. All blisters should be removed, as they may harbour F^- ions. If subungual tissue is involved, the nailbed should also be exposed for the same reason.

To neutralize the F^- ions, an insoluble calcium salt can be made. This can be applied in one of three ways:

1. through topical treatment,
2. through local infiltrative treatment, or
3. through intra-arterial or intravenous treatment with calcium.

For mild, superficial burns, calcium gluconate, 2.5% gel is the preferred topical agent. It should be applied generously and covered by an occlusive dressing.

Novel topical iodine preparations have shown some early promise in animal models, and magnesium hydroxide-containing antacid preparations may be used if calcium gluconate is unavailable. The skin, however, is impermeable to calcium, so for deep and painful burns, 5% or 10% calcium gluconate should be injected with a 30-gauge needle into the affected area. Although it is often recommended to titrate the dose infiltrated to symptomatic improvement, the infiltration itself usually causes pain, so local anesthesia is usually necessary (which hides the effect of the treatment).

Unbound calcium can be toxic to tissues; caution should be exercised to avoid exceeding the maximum dose of 5% calcium gluconate.

Extensive exposure, or severe symptoms should prompt consideration of intra-arterial therapy or, ischemic arm, intravenous therapy. These

procedures require admission to hospital and monitoring of ECG and serum ions.

Inhalational exposures can be managed with nebulized 2.5% calcium gluconate and supportive treatment. Dx

This department covers selected points to avoid pitfalls and improve patient care by family physicians in the ED. Submissions and feedback can be sent to diagnosis@sta.ca.

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Back to our patient....

The fingers were initially soaked in a glove containing calcium gluconate gel. When this failed to relieve the symptoms in the index finger, the nail was removed under a digital block and intralesional calcium gluconate was injected.

After several hours of observation, he remained pain-free, with no electrocardiogram or electrolyte changes. He was discharged soon after.