ONLINE EXCLUSIVE

Acute bilateral hand edema and vesiculation

Environmental history exposed the diagnosis.

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A 27-YEAR-OLD MAN presented to the urgent care clinic with acute bilateral hand swelling, blisters, numbness, and pain. History taking revealed that these symptoms developed after he was locked outside of his apartment for 45 minutes in –22°C (–8°F) weather following a night of heavy drinking.

On physical examination, the patient had a temperature of 36.2°C (97.2°F) and a heart rate of 116 beats/min. He had edema, tenderness, decreased sensation, and distal cyanosis involving all of his fingers (FIGURE 1). He also had large, tense, clear bullae over the dorsal aspect of his fingers (FIGURE 2).

- WHAT IS YOUR DIAGNOSIS?
- HOW WOULD YOU TREAT THIS PATIENT?

FIGURE 1
Palmar erythema with acrocyanosis

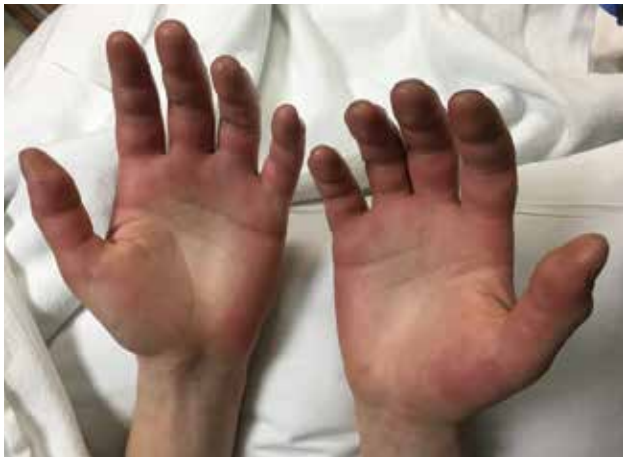

FIGURE 2
Bilateral large, tense, and clear bullae

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Angiography should be performed on patients with third- or fourth-degree frostbite. In cases of vascular occlusion, tPA and heparin can be started to reduce the risk for amputation.

Diagnosis: Second-degree frostbite

Frostbite is the result of tissue freezing, which generally occurs after prolonged exposure to freezing temperatures (typically –4°C or below).[1,2] The majority (~90%) of frostbite injuries occur in the hands and feet; however, frostbite has also been observed in the face, perineum, buttocks, and male genitalia.[3]

Frostbite is a clinical diagnosis based on a history of sustained exposure to freezing temperatures, paresthesia of affected areas, and typical skin changes. Evidence is lacking regarding the epidemiology of frostbite within the general population.[2]

Pathophysiology. Intra- and extracellular ice crystal formation causes fluid and electrolyte disturbances, cell dehydration, lipid denaturation, and subsequent cell death.[1] After thawing, progressive tissue ischemia can occur as a result of endothelial damage and dysfunction, intravascular sludging, increased inflammatory markers, an influx of free radicals, and microvascular thrombosis.[1]

Classification. Traditionally, frostbite has been classified according to a 4-tiered system based on tissue appearance after rewarming.[2] First-degree frostbite is characterized by white plaques with surrounding erythema; second degree by edema and clear or cloudy vesicles; third degree by hemorrhagic bullae; and fourth degree by cold and hard tissue that eventually progresses to gangrene.[2]

A simpler scheme designates frostbite as either superficial (corresponding to first- or second-degree frostbite) or deep (corresponding to third- or fourth-degree frostbite) with presumed muscle and bone involvement.[2]

Risk factors. Frostbite is often associated with risk factors such as alcohol or drug intoxication, vehicular failure or trauma, immobilizing trauma, psychiatric illness, homelessness, Raynaud phenomenon, peripheral vascular disease, diabetes, inadequate clothing, previous cold-weather injury, outdoor winter recreation, and the use of certain medications (eg, beta-blockers).[1-3] Apart from environmental exposure, frostbite can also occur by direct contact with freezing materials, such as ice packs or industrial refrigerants.[3]

Differential includes nonfreezing injuries

Frostnip, pernio, and trench foot are other cold-weather injuries distinguished by the absence of tissue freezing.[4] Raynaud phenomenon is a condition that is triggered by either cold temperatures or emotional stress.[5]

Frostnip is characterized by pallor and paresthesia of exposed areas. It may precede frostbite, but it quickly resolves after rewarming.[2]

Pernio occurs when skin is exposed to damp, cold, nonfreezing environments.[6] It results in edematous and inflammatory skin lesions that may be painful, pruritic, violaceous, or erythematous.[6] These lesions are typically found over the fingers, toes, nose, ears, buttocks, or thighs.[4,6] Pernio may be classified as either primary or secondary disease.[5] Primary pernio is considered idiopathic.[6] Secondary pernio is thought to be either drug induced or due to underlying autoimmune diseases, such as hepatitis or cryopathy.[6]

Trench foot develops under similar conditions to pernio but requires exposure to a wet environment for at least 10 to 14 hours.[7] It is characterized by foot pain, paresthesia, pruritus, edema, erythema, cyanosis, blisters, and even gangrene if left untreated.[7]

Raynaud phenomenon results from transient, acral vasocontraction and manifests as well-demarcated pallor, cyanosis, and then erythema as the affected body part reperfuses.[5] Similar to pernio, it can be categorized as either primary or secondary.[5] Primary phenomenon is idiopathic. Secondary phenomenon is thought to be a result of autoimmune disease, use of certain medications, occupational vibratory exposure, obstructive vascular disease, or infection.[5]

In the absence of a history of exposure to subfreezing temperatures, frostbite can be excluded from the differential diagnosis.

Treatment entails rewarming

The aim of frostbite treatment is to save injured cells and minimize tissue loss.[1] This is accomplished through rapid rewarming and—in severe cases—reperfusion techniques.

Tissue should be rewarmed in a 37°C to 39°C water bath with povidone iodine or chlorhexidine added for antiseptic effect.[1] All

efforts should be made to avoid refreezing or trauma, as this could worsen the initial injury.[2] Oral or intravenous hydration may be offered to optimize fluid status.[1] Supplemental oxygen may be administered to maintain saturations above 90%.[1] Nonsteroidal anti-inflammatory drugs are helpful for analgesia and anti-inflammatory effect, and opioids can be used for breakthrough pain.[1] It is recommended that blisters be drained in a sterile fashion and that all affected tissue be covered with topical aloe vera and a loose dressing.[1,2,4]

Treatment of severe frostbite. Angiography should be performed on all patients with third- or fourth-degree frostbite.[3] If imaging shows evidence of vascular occlusion, tissue plasminogen activator (tPA) and heparin can be initiated within 24 hours to reduce the risk for amputation.[8-10]

Iloprost is another proposed treatment for severe frostbite. It is a prostacyclin analog that may lower the amputation rate in patients with at least third-degree frostbite.[11] Unlike tPA, iloprost may be given to trauma patients, and it can be used more than 24 hours after injury.[2]

In cases of fourth-degree frostbite that is not successfully reperfused, amputation is delayed until dry gangrene develops. This often takes weeks to months.[12]

Our patient underwent rewarming and was orally rehydrated. He was discharged home with ibuprofen, oxycodone-acetaminophen, topical aloe vera, and loose dressings. His bullae enlarged the next day (**FIGURE 3**). One week later, his blisters were debrided and dressed with silver sulfadiazine at his plastic surgery follow-up. He experienced sensory deficits for a few months, but eventually made a full recovery after 6 months with no remaining sequelae. **JFP**

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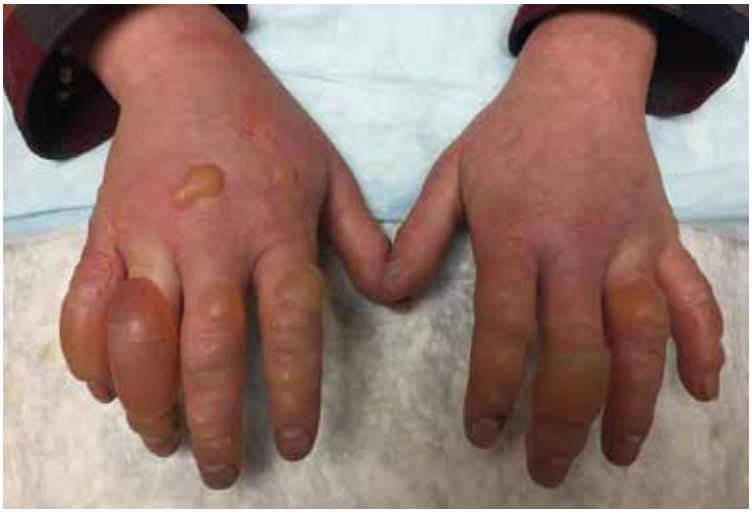
FIGURE 3
Worsening of the bilateral dorsal hand bullae on the day after discharge



REFERENCES

1. Handford C, Thomas O, Imray CHE. Frostbite. *Emerg Med Clin North Am.* 2017;35:281-299.
2. Heil K, Thomas R, Robertson G, et al. Freezing and non-freezing cold weather injuries: a systematic review. *Br Med Bull.* 2016;117:79-93.
3. Millet JD, Brown RK, Levi B, et al. Frostbite: spectrum of imaging findings and guidelines for management. *Radiographics.* 2016;36:2154-2169.
4. Long WB 3rd, Edlich RF, Winters KL, et al. Cold injuries. *J Long Term Eff Med Implants.* 2005;15:67-78.
5. Baker JS, Miranpuri S. Perniosis: a case report with literature review. *J Am Podiatr Med Assoc.* 2016;106:138-140.
6. Bush JS, Watson S. Trench foot. Updated February 3, 2020. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2020. www.ncbi.nlm.nih.gov/books/NBK482364/. Accessed April 22, 2020.
7. Musa R, Qurie A. Raynaud disease (Raynaud phenomenon, Raynaud syndrome). Updated February 14, 2019. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2020. www.ncbi.nlm.nih.gov/books/NBK499833/. Accessed April 22, 2020.
8. Bruen KJ, Ballard JR, Morris SE, et al. Reduction of the incidence of amputation in frostbite injury with thrombolytic therapy. *Arch Surg.* 2007;142:546-551; discussion 551-553.
9. Gonzaga T, Jenabzadeh K, Anderson CP, et al. Use of intra-arterial thrombolytic therapy for acute treatment of frostbite in 62 patients with review of thrombolytic therapy in frostbite. *J Burn Care Res.* 2016;37:e323-e334.
10. Twomey JA, Peltier GL, Zera RT. An open-label study to evaluate the safety and efficacy of tissue plasminogen activator in treatment of severe frostbite. *J Trauma.* 2005;59:1350-1354; discussion 1354-1355.
11. Cauchy E, Cheguillaume B, Chetaille E. A controlled trial of a prostacyclin and rt-PA in the treatment of severe frostbite. *N Engl J Med.* 2011;364:189-190.
12. McIntosh SE, Opacic M, Freer L, et al; Wilderness Medical Society. Wilderness Medical Society practice guidelines for the prevention and treatment of frostbite: 2014 update. *Wilderness Environ Med.* 2014;25(4 suppl):S43-S54.