

Treating frostbite

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Frostbite is a cold-induced injury of tissue characterized by freezing and ischemic necrosis. It is most commonly observed in the extremities and is usually seen in those between the ages of 30 and 49 years. Risk factors for frostbite include prolonged exposure to below-freezing temperatures, particularly in conjunction with high humidity, low wind chill factors, and wet and constricting clothing.¹ Knowledge of its treatment is crucial for family physicians who work in areas where cold weather can occur. In this report, we will present our treatment of 7 frostbite cases.

Case description

Seven frostbite patients were hospitalized between September 2002 and January 2003. All patients were male soldiers with a mean age of 21.1 years (range 20 to 22 years). They were admitted to hospital with complaints of pain, tingling, burning, and numbness in their involved feet; they were otherwise healthy. The period of time from injury to treatment ranged from 6 hours to 24 hours. Their mean hospitalization period was 11.6 days (range 8 to 15 days).

The cases were classified in accordance with the Britt et al classification system.² Five patients had second-degree lesions on their feet, with erythema, edema, and black scar tissue (**Figure 1**). Two patients had third-degree lesions, with skin necrosis, blue-gray discoloration, and the presence of blood-filled blisters. Doppler ultrasonography was performed to evaluate the peripheral blood flow.

Rewarming of the affected extremities began immediately upon admission to the hospital by immersion in water with 10% povidone-iodine at 40°C for about 20 minutes, keeping the extremity elevated immediately afterward. This procedure was performed twice daily. Further medical treatment included a single injection of tetanus toxoid; 12 mg/kg of ibuprofen by mouth daily; 100 mg of acetylsalicylic acid by mouth daily; and 500 mg of pentoxifylline and 100 mg of bencyclane-hydrogen-fumarate in a 500 mL low-molecular-weight dextran solution (ie, dextran 40) by intravenous infusion every 24 hours for 5 to 7 days.

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Prophylactic antibiotics were not used other than in the 3 patients with infections in the affected extremities. Those patients were treated successfully with 1 g of cefazolin intravenously 3 times a day. No debridement or any other surgical procedures were performed. All patients were instructed to avoid alcohol and tobacco, and a high-protein, high-calorie diet was prescribed. All patients recovered fully (**Figure 2**).

Figure 1. Characteristic presentation of frostbite: Cyanosis, black scar tissue, and dry eschar.



Figure 2. View of foot after medical treatment



Discussion

A MEDLINE search was performed using the key words *frostbite* and *treatment*. Articles on frostbite and its clinical features, diagnosis, and management were reviewed in detail.

Exposure to low temperatures leads to ice-crystal formation, which results in damage to capillaries leading to progressive ischemia and infarction.^{1,3} Generation of oxygen free radicals, production of prostaglandins and thromboxane A₂, release of proteolytic enzymes, and generalized inflammation are the underlying mechanical effects of these injuries.^{1,4}

The treatment of frostbite is directed toward reversing the pathologic effects of ice-crystal formation, vasoconstriction, and the release of inflammatory mediators; therefore, rapid rewarming and anti-inflammatory agents are still the main components of treatment protocols.^{4,5} As rewarming followed by refreezing can be more harmful to the extremity than a delay in rewarming, protecting the involved extremity and avoiding rewarming until correct procedures can be performed is recommended.⁶ That being said, after the required conditions are achieved, rewarming should begin without delay.

This is the most accepted method to manage all degrees of frostbite cases.⁴⁻⁶ Nonsteroidal anti-inflammatory drugs, such as ibuprofen, act as a necessary adjuvant to rewarming, as they inhibit inflammatory reactions and pain by decreasing prostaglandin synthesis.^{1,7}

Prophylactic antibiotic use is controversial and usually not recommended unless signs of infection develop.^{1,7} The roles of hemodilution, vasodilators, and sympathetic blockades have been discussed as other possible methods of treatment.^{1,4,5} Low-molecular-weight dextran can prevent erythrocyte clumping in cold-injured blood vessels; also, low-dose infusions of heparin can prevent microthrombosis. These therapies have not been definitively validated and dosages have not yet been standardized.^{1,3,4}

Our literature search revealed several case reports with various treatments. None of these exactly matched our treatment protocol. In our protocol, in addition to the standard rapid rewarming and anti-inflammatory therapy, we administered low-molecular-weight dextran and pentoxifylline to prevent erythrocyte clumping and improve microcirculation. We also administered acetylsalicylic acid to prevent microthrombosis and bencyclane-hydrogen-fumarate to stimulate vasodilatation.

Frostbite is an important clinical condition, as it risks tissue or extremity loss. Although we have not performed a case-control study, we believe that our protocol can be successfully applied to most frostbite patients. Controlled clinical trials should be performed to show its effectiveness.

Our patients were otherwise healthy and we have not observed any complications or adverse effects with our treatment protocol. This protocol, however, might not be as applicable in other populations, such as among older persons, without some degree of ongoing vascular compromise.

As stated, we used Doppler ultrasonography to check the microvascular status of the affected feet and to define the extent of ultimate tissue loss. Although normal triphasic flow disappeared and blood flow decreased in patients with second- and third-degree lesions, we preferred to follow up as opposed to performing debridement, amputation, or any other surgical treatment to any patient, even those with severe injury. Affected areas generally heal or mummify without surgery; therefore, early surgery is rarely needed and is usually avoided for several weeks or even months.^{1,7-9}

Conclusion

In light of our results, we believe that rapid rewarming and prompt, proper medical treatment lead to dramatic improvement in the prognosis and outcome of frostbite-related injuries. ❁

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Competing interests

None declared

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