

Portable Hyperbaric Chamber and Management of Hypothermia and Frostbite: An Evident Utilization

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A HYPERBARIC CHAMBER IS AVAILABLE in most trekking and high altitude expeditions primarily to treat but also to prevent altitude illness. Physiologically, the device reproduces a low altitude evacuation when descent is not possible (Bartsch et al., 1993). Atmospheric pressure is increased inside the chamber using a mechanical pump. This induces an increase in arterial oxygen pressure, and improves symptoms.

However, frostbite and hypothermia also represent two severe diseases that frequently occur at high altitude. A human being is homeothermic and must maintain core temperature at about 37°C. Any external aggression, inadequate equipment, or insufficient endogenous heat production may prevent temperature conservation. The pathophysiology of frostbite involves arteriovenous anastomoses. In a cold environment, changes in blood flow rates within these junctions can severely reduce blood flow in the extremities. Precapillary sphincter may also close off to blood flow, while venous–arterial shunts open. These mechanisms may rapidly lead to frostbite. The body actually sacrifices peripheral blood flow to maintain central temperature. Cold-induced peripheral vasoconstriction has been shown to significantly increase at high altitude and may increase ischemia. Thus, as a treatment, increasing oxygen pressure in tissue could inhibit ischemia, remove arterial spasm, and help endogenous heat production (Dana et al., 1969; Mathew et al., 1977; Daanen and van Ruiten, 2000). Therefore, a quick descent to low altitude or an increase in barometric pressure as in a hyperbaric chamber could be a major help in treatment for frostbite. It is noted that descent alone is not an effective treatment but might enhance the effectiveness of rewarming. Thus, during the last 20 years, we have observed that the time before warming begins (<24 h) is a key factor in conditioning secondary progressive ischemia and therefore bone reperfusion after frostbite in the tissue (Cauchy et al., 2011). Consequently, a hyperbaric chamber could be used to reduce the warming time and treat frostbite in trekking and high altitude expeditions.

Hypothermia is characterized by a decrease in central temperature below 35°C. This pathology arises when endogenous heat production capacity cannot compensate for energy loss through conduction, convection, and radiation transfer mechanisms. When temperature keeps going down, hypothermia becomes severe, then profound, and may finally lead to a cardiopulmonary arrest (Avellanas et al., 2012). As in frostbite

cases, increasing arterial and oxygen pressure in tissue could improve thermogenesis and combat hypothermia (Frappell et al. 1998; Mortola, 2004; Madden and Morrison, 2005).

Hence, we suggest an extension of the therapeutic indication of a hyperbaric chamber for frostbite and hypothermia care. When severe frostbite cases occur during an expedition, we recommend supplementing the usual fast warming protocol (frostbites in water at 37°C to 39°C during 1 h and 250 mg Aspirin® dose) with regular compression chamber sessions as long as the patient is at high altitude (above 3500 m) (Cauchy et al., 2011). Hot beverage such as tea should be taken in order to rehydrate the patient and increase core temperature. This would help reopening of precapillary sphincters. The compression chamber sessions should last 1 h and proceed until digital reperfusion is observed. Criteria for reperfusion are recovering sensitivity of digits, natural skin color, and tip temperature.

In expeditions, hypothermia could also be treated with a hyperbaric chamber that will protect subjects from the wind factor and enhance thermogenesis through the increase in tissue oxygen pressure. If the patient is conscious and has frostbite, he should be rehydrated and kept warm with a hot beverage in and out of the hyperbaric chamber. In case of profound hypothermia where the patient is unconscious, adding hot water bottles on his body can enhance peripheral rewarming. In case of life-threatening injuries or severe trauma, specific care should be taken before using hyperbaric chamber.

Author Disclosure Statement

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