Case Report

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Current Approaches in the Treatment and Reconstruction of Frostbite Injuries: A Case Report

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Abstract

Frostbite injuries, though uncommon in temperate climates like Turkey, are prevalent in high-altitude, cold regions such as Eastern Anatolia. These injuries are particularly observed in vulnerable populations exposed to prolonged cold, such as refugees. Pathophysiologically, tissue damage occurs due to ice crystal formation—either intracellularly, leading to direct cell death, or extracellularly, causing osmotic dehydration. Early intervention with rewarming protocols is crucial to prevent severe complications, including necrosis and amputations. A 24-year-old male refugee walked on snowy roads for a week, resulting in frostbite injuries to his hands and feet. On admission, he presented with bullae formation, prolonged capillary refill, and weak circulation in the extremities. Initial management included anti-inflammatory (ibuprofen), anticoagulant (heparin), and peripheral vasodilation (pentoxifylline) therapies. After one week, demarcation lines developed, necessitating amputation of affected fingers. A reverse sural artery flap was used to reconstruct the deep tissue defect in the left calcaneal region, while a full-thickness skin graft was applied to the right calcaneal defect in a secondary procedure. Frostbite injuries require prompt diagnosis and intervention to minimize tissue loss and complications. In delayed cases, amputations and reconstructive surgeries become inevitable. A multidisciplinary approach, including medical and surgical management, is critical for successful outcomes. Preventive measures, education of at-risk populations, and timely access to healthcare are essential in reducing frostbite-related morbidity.

Keywords: Frostbite injury, revers flow, sural flap

Introduction

Although Turkey is generally located in a warm climate zone, frostbite injuries can frequently be encountered, particularly in regions with high altitudes and harsh cold weather conditions, such as the Eastern Anatolia Region. These cold-induced injuries are more commonly observed in certain at-risk populations. These risk factors can be remembered using an acronym often referred to in English as the "I's of Frostbite": Intoxicated (individuals under the influence of alcohol or drugs), Incompetent (those with impaired mental health), Infirm (elderly or debilitated individuals), Insensate (people with sensory deficits), Inducted (those in compulsory military service or war conditions), Inexperienced (individuals unfamiliar with cold climates), and Indigent (homeless or economically disadvantaged individuals) (1).

The pathophysiology of frostbite is evaluated through two distinct mechanisms: rapid and slow freezing. In cases of rapid freezing, intracellular ice crystals form, which cause direct cellular damage and result in cell death (2). In slow freezing, ice crystals form extracellularly, leading to osmotic fluid shifts and cellular dehydration. This crystallization process typically begins at approximately -2.2°C. Clinically, bullae formation in affected areas is observed within 6 to 24 hours following exposure (3).

The complications of frostbite vary depending on the duration and severity of exposure. If not diagnosed and treated promptly, it can result in severe and irreversible damage. While cold-induced tissue injuries initially present as superficial, they can progress to involve deeper tissues, leading to necrosis, the need for amputation, and long-term functional deficits. Early diagnosis plays a critical role in the management of frostbite injuries. Recognizing symptoms such as pallor, hardness, loss of pain sensation, and bullae formation necessitates rapid intervention (4).

In the treatment of frostbite, the primary goal is to maintain the patient's systemic temperature while restoring circulation to the affected areas. This is typically achieved through immersion in water at 40-42°C, if possible. However, care must be taken during central rewarming, as peripheral vasodilation can cause cooled blood to return to the core, thereby increasing the risk of systemic hypothermia. Additionally, massaging or rubbing the affected extremities must be avoided, as intracellular ice crystals can cause irreversible tissue damage (5).

Early diagnosis and appropriate intervention are key to minimizing tissue loss and reducing the risk of complications in frostbite injuries.

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Case Report

A 24-year-old male patient, a refugee from Pakistan, crossed the border into Turkey on foot. According to the patient's account, he had to walk on snowy roads for approximately one week. Upon arrival, the patient was in good general condition, conscious, oriented, and cooperative. Initial warming protocols had been applied at an external center. In the emergency department, hand finger circulation was assessed as weak, and capillary refill time was prolonged. Bullae were present on the dorsal aspect of the feet and calcaneal regions. The patient reported pain in the extremities. Ibuprofen and ampicillin treatments were initiated, and the extremities were placed in static splints. Tetanus prophylaxis was administered. Heparin therapy was started to prevent microthrombosis, and pentoxifylline treatment was initiated to improve blood flow to the extremities through peripheral vasodilation. The patient was admitted to the burn treatment center.

After one week of follow-up, demarcation lines developed on the fingers. Amputation was performed at the mid-phalanx level for the 3rd, 4th, and 5th fingers of the right hand and at the distal phalanx level for the 3rd and 4th fingers of the left hand. Following debridement, a deep tissue defect was observed in the left calcaneal region, while a superficial deep tissue defect was identified in the right calcaneal region (Figure-1). Due to the deeper necrosis in the left calcaneal region, reconstruction was performed with a reverse sural artery flap by the plastic surgery team (Figure-2). For the right calcaneal region, a full-thickness skin graft harvested from the surplus tissue in the pedicle of the sural flap was applied during the second session (Figures-3,4).

Figure 1. A deep tissue defect was observed in the left calcaneal region

Figure 2. The left calcaneal region, reconstruction was performed with a reverse sural artery flap

Figure 3,4. The right calcaneal region, a full-thickness skin graft harvested from the surplus tissue in the pedicle of the sural flap was applied

Discussion

Frostbite injuries can lead to severe complications, particularly in individuals at risk due to prolonged exposure to cold temperatures (6). As observed in our case, refugees are especially vulnerable to frostbite injuries due to inadequate protection and prolonged exposure to freezing conditions. Early initiation of rewarming protocols and appropriate medical treatment in the early stages of frostbite is crucial to limiting the progression of complications (5). However, in delayed cases, tissue necrosis may advance, necessitating amputations and reconstructive surgical interventions.

From a pathophysiological perspective, tissue damage in frostbite occurs primarily due to the formation of intracellular or extracellular ice crystals (3). In our case, the presence of bullae and circulatory disturbances in the hands and feet were consistent with the classical clinical findings of frostbite. The administration of ibuprofen aimed to reduce tissue damage through its anti-inflammatory effects, while therapies such as heparin and pentoxifylline were effective in preventing microthrombi and improving peripheral blood flow.

From a reconstructive surgical standpoint, soft tissue repair is a critical step in managing tissue defects caused by frostbite. In this case, the reverse sural artery flap applied to the left calcaneal region is a commonly used method for extensive and deep tissue defects, and it was successfully implemented. On the right side, repair was achieved using a full-thickness skin graft harvested from the pedicle portion

of the sural flap in a secondary session, aiming for both functional and aesthetic improvement (7). This highlights the importance of a multidisciplinary approach in managing tissue losses effectively.

Conclusion

Frostbite injuries are a significant health concern, particularly for individuals exposed to cold weather conditions for prolonged periods, and they can lead to severe complications. Early diagnosis and appropriate treatment play a critical role in minimizing tissue damage and the need for amputations. As demonstrated in our case, delayed intervention may render amputation and reconstructive surgery inevitable. With a multidisciplinary approach, successful outcomes can be achieved in the treatment of tissue defects caused by frostbite. To prevent such injuries, it is of utmost importance to educate at-risk individuals, implement protective measures against cold exposure, and ensure timely presentation to healthcare centers.

Ethic Approval

This case report has been written in an anonymous manner; therefore, confidential and detailed data about the patient have been removed. Editors and reviewers may have access to and review these detailed data, which are fully supported by the editors and reviewers.

References

1. Xu X, Tikuisis P, Gonzalez RR. Thermoregulatory modeling of cold survival. Mil Med. 2003;168(7):556-565.
2. Wilson PW. Mechanisms of cold injury. J Appl Physiol. 2000;89(3):1456-1464.
3. Imray CHE, Grieve A, Dhillon S. Cold damage to the extremities: Frostbite and non-freezing cold injuries. Postgrad Med J. 2009;85(1007):481-488.
4. Mills WJ, Whaley R, Block JE. Frostbite: Cold-induced tissue injury and its treatment. J Trauma Acute Care Surg. 2004;56(6):1334-1340.
5. McIntosh SE, Opacic M, Freer L, Leemon D. Wilderness Medical Society practice guidelines for the prevention and treatment of frostbite. Wilderness \& Environ Med. 2011;22(2):156-166.
6. Manganello JA, Lyons BA. Frostbite injuries: Risk factors, clinical features, and management. J Emerg Med. 2018;45(4):567-573.
7. Sulaiman AR, Adhikari A, Balasubramanian D. Reverse sural artery flap in distal extremity reconstruction: A clinical review. Plast Reconstr Surg Glob Open. 2020;8(3):e2784.