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Burn and Frostbite Injuries in Disaster and Earthquake Treatment

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Abstract

Burn injury can be defined as the tissue damage caused as a result of the effect of various factors. It is an important type of injury that should not be overlooked during earthquakes and other natural disasters. First aid and patient follow-up of burn cases are life changing. The first thing to do is to prevent furhter burning process by moving the patient away from the burning agent. The treatment and evaluation should be followed by airway, breathing, and circulation protocol before transfer to hospital. The extent, depth, and region of the burn affect the severity. The percentage of body area is calculated to determine the width. Early initiation of fluid resuscitation is very important. Burn dressings differ in varying degrees. Escharotomy, debridement, and wound care are used in surgical treatment.

Although the source of damage is not heat but cold, frostbites cause similar damage to the tissues. Gradual heating and gentle debridement of the affected areas should be the first treatment. Surgical treatment should be delayed until demarcation occurs.

Keywords: Burn, earthquake injuries, frost, frostbite

Introduction

Burn injury can be defined as tissue damage caused as a result of the effect of a caustic factor. There are many factors that cause burns. Examples include scalding burns, thermal burns, contact burns, electrical burns, chemical burns, friction burns, and radiation burns.[1]

Earthquakes and other natural disasters can cause buildings to collapse and fires to break out as a result of the destruction. At the same time, people may be close to hot liquids during an earthquake. Therefore, burn injuries are one of the most common types of injuries during and after earthquakes. In the literature, there are reports of burn cases developing after severe earthquakes. Approximately 10% of serious injuries after the earthquake in Haiti in 2010 were calculated as burn injuries.[2] In the 1994 San Francisco earthquake, this rate was found to be 7.3%.[3] A report on the Van earthquake in 2011 reported that flame burns were more common and had a higher mortality rate.[4] Among 40 scald cases recorded in the 1999 Düzce earthquake, the most common site of injury was found to be the lower extremities.[5]

First Aid

It should not be forgotten that in a burn case, the first thing to do for the burn is to end the burn by removing the patient from the burning agent. It is important to stop the burning process by irrigating the burning area with water for 15 minutes. Jewelry such as bracelets and rings, if present, should be removed from the extremities. It is appropriate to remove all wet clothing in the case of a scalding burn. In flame burns, the patient should be removed from the area, breathing 100% oxygen, and evaluated for the need for intubation. It is important to cut off the electrical current in electrical burns and to evaluate the patient in terms of cardiopulmonary resuscitation need. In chemical burns, it is important to remove the chemical substance from the contact surface by washing with water and not to use any neutralizing agent. After all these are done, a vascular access should be implemented in the patient under emergency conditions, and hydration should be started with lactated Ringer's as the most appropriate fluid.

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Evaluation of Burn Severity

It is important to determine the severity in burn evaluation. The extent, depth, and region of the burn affect the severity. First of all, the patient's clothes should be stripped completely, and the whole body should be evaluated. The clinical initial evaluation of the burn wound may not always be accurate, in order to make a definitive decision.

Basically, a 3-dimensional ischemic wound is formed after a burn injury. The necrosis (coagulation) zone is the area with the most tissue damage. In this area, irreversible tissue damage occurs after coagulation of structural proteins. The ischemic (stasis) zone is the area where tissue damage is caused by significant inflammation but where viable tissue is present. The main goal of systemic and local treatment is to increase the perfusion of this zone. In cases of inadequate perfusion, infection occurring in this area, or desiccation of this area due to inappropriate dressing, the zone of necrosis will expand, and the wound may progress both deeper and to the periphery. It is necessary to wait 24-48 hours for the progressive damage of ischemia zone to end, and consecutive examinations should be performed during and after this. The zone of inflammation is the most distal hyperemic area with increased perfusion. This zone shows absolute healing unless severe sepsis or prolonged global hypoperfusion occurs.

The percentage of body area is calculated to determine the width. For this, usually the rule of nines can be used in adults. According to this rule, the head is 9%, each upper extremity i 9%, the anterior trunk is 18%, the posterior trunk is 18%, each lower extremity is 18%, and the genital area is 1% of the total body area. Another practical calculation method is the one that assumes that the palm surface is equal to 1% of the body surface area. In addition, different scales such as Lund–Browder chart should be used in children because the head surface percentage is larger and the lower extremities cover less space. In these scales, the affected total body percentage can be calculated by using the age of the patient and the affected areas.

Evaluation of burn depth is divided into 4 degrees in total. In first-degree burns, just the epidermis is affected and there is erythema. In second-degree burns, the depth of the burn includes dermis and the development of bullae is observed. These burns are painful. Since all layers of the dermis are involved in third-degree burns, the skin is hard, flattened, pale, and painless. Thrombosed vessels may be seen. Classic burnt eschar appearance can be detected. In fourth -degree burns, all layers of the skin, subcutaneous fat, and deeper structures such as muscles and tendons will be involved, and it is possible to face a charred appearance.[1]

Evaluation of the location of the burn is also important in determining the severity of the burn. In case of burns involving the face, hands, feet, genital area, perineum, and large joints, referral to a burn center is indicated. This is because burns in these areas may require additional procedures in conjunction with basic treatment.

Burns Requiring Referral to the Burn Unit

The cases requiring transfer to the burn unit include the presence of second-degree burns over 20% in patients aged 10-50 years, the presence of second-degree burns over 10% in patients under 10 years of age or over 50 years of age, third-degree burns above 5% in patients of all ages, the patients requiring shock resuscitation, and cases involving special areas such as the face, ear, hand, foot, genitalia, perineum, and large joints. Other conditions include electrical burns, the presence of chemical burns, trauma associated with a suspected respiratory injury, or additional diseases that may affect the treatment. The list of indications for referral to a burn center is revealed at Table 1.

Treatment

Burned patients are real trauma patients. Initial assessment should be made according to advanced trauma life support protocols. The Airway, Breathing, Circulation, Disability, and Exposure protocol is the protocol that should be followed in the hospital after first aid. Intubation may be indicated in cases of hoarseness, stridor, extensive facial burns, burns inside the mouth, signs of airway obstruction, difficulty in swallowing, use of additional respiratory muscles, inadequate oxygenation, and ventilation.

Table 1. Indications for referral to a burn center

Split thickness burns over 20% (10-50 years)
Split thickness burns over 10% (<10 and > 50 years)
Full-thickness burns over 5%
Burns involving face, ear, hand, foot, genitalia, perineum, and large joints
Electrical and chemical burns
Suspicion of respiratory injury and inhalation burn
Additional trauma and diseases affecting the treatment

Early initiation of fluid resuscitation in burns is very important. The aim is not only to replace the loss from the burn surface but also to replace the fluid lost by systemic pooling. Burns below 20% can generally be tolerated with oral hydration. The most commonly used formula for resuscitation is the Parkland formula, and it is calculated with the formula (4 × percentage of burn area to total body area × weight). The amount, which we find as a result of this calculation, is the amount that the patient should receive within the first 24 hours. It is recommended to apply half of this amount in the first 8 hours and the remaining half in the next 16 hours.

In addition to fluid resuscitation, it may be necessary to provide pain control, to start prophylactic proton pump inhibitors to prevent curling ulcers, to apply anxiolytics, and to apply a nasogastric tube. In case of systemic shock or acute renal injury due to global hypoperfusion, patients should have a urinary catheter placed. Prophylactic antibiotherapy is not indicated for burns. However, if evidence of burn area, ventilation, or catheter-related infection is detected during the patient follow-up, antibiotherapy should be initiated in accordance with the culture results.

If the patient is to remain immobile, it should be kept in mind that prophylactic anticoagulant treatment should be applied in terms of deep vein thrombosis.[6]

In burn cases, the ebb phase occurs metabolically first, and the flow phase occurs after approximately day 5. The flow phase is characterized by hyperdynamic circulation and increased metabolic rate. In burns affecting 30% or more of the body surface area, epinephrine and norepinephrine increase 10-fold in a very short period of time. These catecholamines cause a hypermetabolic response in the burn traumatized patient. Some mathematical formulas have been developed to estimate the energy requirements of burn injured patients. Indirect calorimetry is superior to other methods in estimating energy requirements. Another commonly used formula is the Curreri formula, which is calculated as "25 × body weight + 40 × burn width." Carbohydrates are the main source of energy in the diet of patients with burns. Although there are reports indicating that their ratio in the diet should be between 60% and 65%, higher ratios are recommended. At the same time, a burned patient has an increased protein requirement due to increased protein losses from urine and wound, protein utilization in gluconeogenesis, and protein requirement during the wound healing process. Excess lipid intake in the diet during the burn healing period may delay the healing processes. Excess lipid levels may impair immunologic responses and increase the tendency to infections. Zinc and copper deficiencies are also seen in burn patients. These deficiencies are probably due to tissue destruction and increased urinary excretion. Antioxidant therapy with ascorbic acid, glutathione, carotenoids, and vitamins A and E reduces burn-related mortality, attenuates changes in cellular energetics, protects microvascular circulation, and reduces lipid peroxidation.[7]

Patients with burns should receive nutrition immediately after fluid resuscitation to avoid gastrointestinal dysfunction. Patients who cannot tolerate oral nutrition can be provided enteral nutrition by either nasogastric or nasojejunal tube. Patients who cannot tolerate enteral nutrition should be started on parenteral nutrition.

Urgent escharotomy may be necessary in surgical treatment of third-degree circular burns to prevent circulatory compromise. Immediate escharotomy should be performed on both lateral sides for the extremities and in a single quadrangle connecting the anterior axillary lines from the subcostal and infraclavicular areas

for the trunk to allow the lung to expand, especially to enable breathing.

Burn dressings differ in varying degrees. For second-degree burns, it would be appropriate to apply a Vaseline-impregnated gauze as the first layer and gauze soaked with saline as the second layer. A dry gauze or pad should be used to cover the dressing. In third-degree burns, it is best to first apply silver sulfadiazine cream liberally and then apply Vaseline-impregnated gauze and dry gauze pads on it. If escharotomy has been applied, the moist absorbent dressing should be the dressing of choice.

Advanced surgical treatment should be performed in burn centers by experienced surgeons. Early excision and grafting are preferred in full-thickness and deep partial burns. If the general condition of the patient allows, closure procedures can be started from the third day after the burn. In the tangential excision technique, Watson or Goulian blades are used. It carries the risk of serious blood loss. Evaluation of the viability of the wound bed is important in determining the margin of tangential excision. In fascial excision, dissection is provided up to the muscle fascia. Healthy subcutaneous tissue is also excised. Contour irregularities and cosmetic problems are common.[8]

Frostbite

Especially after earthquakes and natural disasters in winter, frostbite injuries can occur. The frostbite causes damage similar to a burn; but it is caused by the cold. Two mechanisms are mainly responsible for tissue damage in frostbite injuries. The first one is direct cell damage that develops during exposure to cold. The other is damage and necrosis due to progressive dermal ischemia. It can occur especially in the distal parts of the body such as fingertips, nose tip, and ear. Initially all cases of frostbite are similar. Therefore, classification is done after warming. Historically, frostbite is classified into 4 categories. First-degree frostbite shows a centrally located white plaque with loss of sensation and erythema around it. In the second-degree frostbite, bullae are seen in addition to erythema and edema. Hemorrhagic bullae are seen in the third-degree frostbite. After a period of about 2 weeks, it leads to the development of a stiff black eschar tissue. The fourth-degree frostbite is associated with total necrosis and tissue loss. Recently, many centers have implemented the Cauchy grading of frostbite, which relies on radioactive uptake on bone scans and the presence of skin lesions.[9,10]

Pernio is considered a mild form of cold injury and is differentiated from true frostbite. It is characterized by red, itchy, and often very painful lesions that develop after prolonged exposure to temperatures above freezing. This condition is self-limiting and treatment is conservative.

Frostbite cases should be transferred to hospital without unconscious heating. After arriving at the emergency service, heating should be applied in the treatment; however, the heating should be done gradually. For this, the patient should be warmed slowly by holding the damaged area in warm water for 15-30 minutes. Rapid warming can cause further damage because of secondary inflammation. However, after warming is provided, the patient will begin to feel pain. Therefore, pain control should be applied. It is correct to apply gentle cleaning and debridement. Local wound care should be provided to the affected areas.

Imaging in frostbite injuries is important in terms of both status determination of injury and prognosis of treatment. Plain radiography, Doppler ultrasound, bone scintigraphy, and single-photon emission computed tomography fused with conventional computed tomography (SPECT/CT) are among the methods used in imaging. If bone fracture due to additional trauma is suspected in cases of frostbite injury or in case of potential foreign body injury, plain radiography should be used. In patients with signs of vascular insufficiency, vascular status can be investigated by Doppler ultrasound or angiography. Single-photon emission computed tomography fused with conventional computed tomography or bone scintigraphy is used in cases where the depth of damage is not clearly understood. Single-photon emission computed tomography fused with conventional computed tomography is preferred for soft tissue perfusion, while bone scintigraphy is preferred for bone perfusion and viability.

Several studies have shown that thrombolytic therapy administered within 24-48 hours is effective in cases of frostbite with arterial insufficiency detected by angiographic imaging. In terms of response to treatment, angiography should be repeated every 12-24 hours in these patients. Bone scintigraphy examinations also provide important information regarding the time and level of amputation. IIn cases of grades 2-4 frostbite, bone scintigraphy is recommended by most protocols on days 2-4 and 7-8. If no progression is detected in this interval, amputation will likely occur.

Patients with grade 1 frostbite injury recover without the need of surgical treatment. In patients with grades 2-4, surgical intervention is necessary. The typical acute surgical treatment is fasciotomy. Urgent fasciotomy should be performed in patients with compartment syndrome. According to old protocols, frostbitten tissues were treated conservatively until auto amputated to ensure maximum tissue viability. This period ranged from 3 to 6 months. Nowadays, bone scintigraphy and SPECT/CT can measure the extent of damage within the first week of injury. Therefore, the current literature recommends delayed surgery (2-4 weeks after injury) with soft tissue debridement and bone scintigraphy-guided amputations. Skin grafts, local flaps, and free flaps can be used to restore previous form and function after delayed surgery.[11]

Conclusion

Both burn and frostbite injuries are vital. Applying an appropriate first aid will be lifesaving. Determining the severity of the injury, fluid resuscitation, pain control, and proper care of the burn wound form the basis of early interventions. Further treatment of severe burns should be undertaken by experienced surgeons in burn centers.

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