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Burns: Definition, Classification, Pathophysiology and Initial Approach

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Abstract

Burns are the most devastating form of trauma that has afflicted mankind since ancient times, its short- and long-term consequences leave severe squeal in the patients affected by them, the costs they generate to health systems are very high and it is counted At present with few hospital centers specialized in the treatment of these affections. The initial approach of the burned patient is fundamental in the survival of the patients, but also in the morbidity that they cause so it is essential to have a multidisciplinary team for its proper management. The main pillars in the treatment of burns are adequate water therapy, airway management and comprehensive surgical treatment of the patient as a final resolution, the following pages addresses the definition and general epidemiology of burns, pathophysiology and the initial approach.

Keywords: Burns; Diagnosis; Treatment; Airway burn

Background

A burn is a thermal injury caused by biological, chemical, electrical and physical agents with local and systemic repercussions, these are the most severe form of trauma that has afflicted humanity since time immemorial and that over the years and the scientific revolution has improved the results in its treatment [1]. These types of injuries are relatively frequent and have a greater incidence in economically and culturally marginalized countries. Every year, emergency services in the United States treat 500,000 patients with burns. Of these, 46% are caused by flame and cause about 3,500 deaths/year [2]. In 2011, in Mexico, there were 17 new cases of disease, affecting 129,779 patients, the gender most affected being male, and the age group is 24-40 years old, with an alarming incidence in low social classes. The impact of burn injuries is based on the complex response that triggers and the cost generated by their care because they require multidisciplinary management, in our country it is estimated that moderate burns generate an average cost between 30,000 and 500,000 pesos; On the other hand, serious burns can reach costs of up to 40 million pesos [3]. Therefore, the approach to this type of affection is fundamental not only to promote its prevention in society but to provide the best care with the objective of improving survival and morbidity outcomes.

Classification

Because of its etiology, burns are classified as burns by flame, chemical (caused by acids or alkalis), electric high voltage (>1000 mV) and low voltage (<200 mV), by scalding and by contact; In the world scald burns represent the most frequent group (Table 1).

Due to their depth they are divided in first degree that affect only epidermis (sunburn), second superficial degree that affect epidermis and papillary dermis, second deep degree that affect epidermis and reticular dermis and third degree or total thickness that affect the three layers of the skin and muscles [4].

Etiology Description	Etiology Description
Flame	Flame injury due to overheated rusty air
Scalding	Scalding injury due to contact with hot liquids
Contact	Contact injury due to contact with hot or cold solids
Chemistry	Chemistry contact with harmful chemicals
Electricity	Electricity transmission of electrical current through the fabrics

Table 1: Classification by etiology of burns.

Approach to Burns

In order to offer a suitable treatment, the approach of the patient must be multidisciplinary, however in the first instance the entire body surface must be quantified and not only the percentage but also the depth. Once the classification of the burns by their depth is understood, clinically these are manifested with characteristic lesions that help us to recognize them in a practical way (Table 2). Currently there are several methods of which the rule of nine is the most used and useful tool to evaluate burns, this and all existing scales include in the quantification of the percentage to those who are second grade on and useful in those burns Which are delimited to a zone, however is not so practical when burns affect various areas of the body surface, for this type of burn is useful hand technique, where the area of the patient's palm is considered 1% And is useful when burns are mixed. However, because of the difference in body proportions with respect to adults, the formula of Lund and Browder [5,6] which assigns different percentages to the various body regions according to the age of the patient, is used in children. According to this first approach there are a series of criteria that are used to define which patients are candidates for specialized centers in the treatment of burn patients; since it has been shown an increase in the survival of those patients who refer to these centers promptly (Table 3).

Type of burn	Clinical appearance
First grade	Painful
	Pores the pressure
	Does not leave scar
	Heal 3-6 days
Second grade superficial	Pain, erythema, Flictenas
	Pale to pressure
	Heal in 7-20 days
Deep second grade	Include the reticular dermis
	Whitish, mottled, not paling under pressure
	Heal 2 to 5 weeks with large scar
Third grade	Hard, painless scalps
	Always require grafts

Table 2: Clinical characteristics according to the degree of depth.

Burn of partial thickness greater than 10%
Burns that affect the face, neck, palms, plants, genitals or joints.
Third-degree burns at any age
Electrical or chemical burns
Injury of the airway
Burns in patients with debilitating diseases
Burns in patients with concomitant trauma.
Children and pregnant women with any percentage of body surface area burned.

Table 3: Criteria of reference to a center specialized in burns.

Pathophysiology

Burns is now considered one of the most devastating forms of trauma that afflict humans because they induce local and systemic damage that seriously alter homeostasis. The local pathophysiological changes were described by Jackson several years ago and consist in the formation of three zones, the first of which is the one of coagulation that is in intimate contact with the aggressor agent and where immediate necrosis of the tissue occurs with denaturation of proteins and Release of molecular patterns associated with damage, the area of stasis is peripheral to the one described above and this one retains its blood flow which according to water resuscitation has a 50% chance of surviving, finally the area of hyperemia is that which retains its Blood flow and in most cases survives the injury [7].

At the endothelial level there is a severe dysfunction of the cells with severe capillary leakage which accentuates the shock state. Also, by the activation of the immune response, there is an increase in the production of nitric oxide synthase, which increases the vasodilatation and Capillary leakage. Systemic changes depend on the affected body surface, generally occurring on burned body surfaces greater than 10%. They severely alter homeostasis and are triggered by the release of insulin-regulating hormones and proinflammatory cytokines (associated with the severity of the lesions) that favor hyperglycemia and hyperinsulinemia and induce hypercatabolic states, humoral and cellular immunodeficiency, water balance disorders, temperature, Hemodynamic and nutrient absorption [8].

These changes generate a general catabolic state that carries a greater risk of developing infections with fatal outcome, in several studies in the world it has been seen that sepsis is the leading cause of death among patients affected by burns and the bacteria most frequently encountered are Pseudomonas, acinetobacter and S. aureus. There is also release of molecular patterns associated with damage recognized by toll type receptors with systemic inflammatory response marked by activation of the Nfkβ receptors.

Initial Treatment

The care of the burned patient is divided in two stages, the primary care that is to protect the airway and to prevent or treat poisonings by carbon monoxide or cyanide and an adequate water reanimation [9,10]. On the other hand the secondary attention is directed to reassessment to determine if there was progression of the burns and to give the definitive treatment through the cutaneous graft [11].

The priority in the management of the burned patient is to ensure the airway and thereby allow an adequate process of oxygenation, the data that should alert about a burn of the airway are: facial or neck burns, burns of the vibrisas or eyebrows, Carbonate deposits and inflammatory changes in the oropharynx, hoarseness, burns in closed places, a history of mental confusion or being under the influence of drugs or alcohol, carboxyhemoglobin levels greater than 10% and burns by explosion; All these conditions raise the suspicion of airway burn and have an emergency intubation as the airway suffers a process of inflammation and edema of the airway mucosa with sphincter and obliteration of the same that makes possible the posterior intubation even In hospital units that have the necessary equipment. Once the airway has been secured, patients with airway burns should refer to a specialized unit and confirm such airway injury through bronchoscopy. Although several studies have attempted to improve airway burn injury through the administration of corticosteroids or nebulized adrenaline, none have demonstrated efficacy in improving survival, the only drug that has demonstrated efficacy only when bronchospasm is the administration of nebulized salbutamol.

Once the airway is secured, the second step is to remove all the patient's clothing to avoid the progression of the burns and expose the patient's entire body surface in order to evaluate the affected body surface and the depth of the burns. Of the body surface, depth and clinical characteristics of the patient will be decided whether or not candidate is to be sent to a specialized unit in care of the burned patient. Evaluated body surface and depth of the condition starts the second pillar of care of the burned patient: hydration. The resuscitation or fluid therapy of the burn is vital because if it is successful it will avoid the progression of the burns (it will avoid the death of the area of stasis described by Jackson), it will revert the shock state secondary to the trauma and improve the overall survival. At present there are many works that try to demonstrate the best way to administer intravenous fluids to the burned patient, however once in the care of the burn the less is the placement of two short and thick peripheral catheters for the administration of the fluid therapy. Many formulas designed according to burned body proportion have been created but none have shown

superiority over others, the simplest of all is the one created by Parklan which consists of giving 3 to 4 ml of crystalloid solutions (Hartman solution or Lactated Ringer) Per kilogram of weight per percentage of burned body surface, half of the total of this calculation must be spent within the first eight hours after the burn and the other half must be administered within the sixteen hours after the burn. The goal in water resuscitation is to reach urine volumes greater than 0.5 ml per kilogram per hour, as well as to maintain mean arterial tensions greater than 65 mmhg and to avoid with this the presence of organic faults, at least in the first 24 hours should be avoided The use of colloids because there is a capillary failure that allows the escape of all kinds of molecules and solutions that could accentuate the state of shock and even render it irreversible.

However, in the next 24 hours, the use of albumin as a colloidal solution could be justified to avoid the water overload that leads to leakage to the third space, manifested as acute pulmonary edema, edema of intestinal loops with increased pressure Abdominal and compartment syndrome; this condition is more likely in patients with comorbidities that weaken the cardiac reserve. There are other formulas for the administration of colloidal solutions (Table 4); however, the best marker indicating successful resuscitation is adequate urine volume.

In the initial treatment of the burn, prophylactic antibiotics should not be used in any way, nor should they undergo surgical treatment before securing the airway or treating intoxications and performing adequate fluid resuscitation, transfusions should also be reserved for patients who later Water reanimation are found with hemoglobin levels below 7 mg/dl, offering if necessary blood products at the rate of 1 globular package: 1 fresh frozen plasma: 1 platelet concentrate to avoid coagulopathy.

In the follow-up or secondary treatment of the burned patient, it is essential, after adequate fluid reanimation, to evaluate the progression of burns 48 hours after the beginning of the medical treatment and on this basis to restart the treatment, reiterating that the surgical treatment must be offered once hemodynamic stability has been achieved and after adequate fluid resuscitation.

Formulas	Description	Colloidal solution
Parkland	Riger lactate 4 ml/kg /% SCT (1/2 in the first 8 hrs and the second half in the following 16 hrs)	-
Modified Brooke	Lactated Ringer's Solution, 2.0 ml /kg /% TBSA Burned	-
Haifa Formula	Lactated Ringer's Solution, 1 ml /kg /day /% TBSA burned ½ volume in the first 8 h after injury; Remaining half in the following 16 h after injury	Fresh frozen plasma, 1.5 ml/kg /% TBSA burned, ½ volume within 8 h after the injury; The remaining half for the next 16 h after injury
Monafo Formula	25 meq/L NaCl; The volume is adjusted until uresis of 30 ml/h	-
Warden's formula	Lactated Ringer's solution plus 50 meq $NaHCO_3$ (180 meq Na/L) adjusted to achieve uresis of 30 to 50 ml/h for 8 h after injury	-
Evans formula	0.9% saline, 1 ml/kg /% TBSA burned. Glucose solution at 0.9% 2000 ml	Fresh frozen plasma, 1 ml /kg/% TBSA burned
Brooke's Formula	Lactated Ringer's Solution, 1.5 ml/kg /% TBSA Burned 0.9% Glucose Solution 2,000 ml	Fresh Frozen Plasma, 0.5 ml/kg/% TBSA Burned
Slater's formula	Lactated Ringer's Solution, 2000 ml/24 h	Fresh frozen plasma, 75 ml/kg/24 h
Demling formula	Dextran 40 in 0.9% NaCl solution, 2 ml/kg /h for 8 h after injury; The Ringer solution with Lactate is adjusted to obtain uresis> 30 ml/h for the following 18 h after burn Fresh frozen plasma, 0.5 ml/kg/h Starting 8 h after the Burn and continued for 18 h	-

Table 4: Formulas for water resuscitation.

Predictors of Severity

For many years we have tried to find scales or prognostic markers that allow us to know the chances of success or survival in various clinical conditions and burns are no exception. Historically, the Baux index was used, which results from multiplying the percentage of body surface area burned by the age of the patient. However, this index fell into disuse because it overestimates the mortality rate of the patients. Time was developed the Garces index that takes into account all the degrees of affection added and the age of the patient. However, as the former underestimate other conditions that also influence the survival of the burned patient. At present, studies have been developed that found three conditions that are directly associated with the prognosis of the burn and are: age over 60 years, airway injury, concomitant trauma (Figure 1) and a burn rate greater than 40%, each of them is associated with worse outcomes, the more likely they have a worse prognosis.

Surgical Treatment

Cutaneous grafts are fragments of skin extracted from a donor surface without own vascularization that are placed on a receiving surface and undergo an integration process [12]. Its beginnings go back to the 19th century where Ollier extracted the first dermoepidermal graft, later in 1929 Brown and Barret published the first article on cutaneous grafts [13]. There are several classifications of grafts, by their origin they are classified in autografts (of the own patient), allografts (another individual of the same species) and

xenografts (other species); By their thickness they are classified in partial thickness and total thickness (includes the three skin layers) [14,15]. Treatment with cutaneous grafts focuses on avoiding the granulation phase where there is contraction of the wound, especially in aesthetically and functionally privileged places.

Figure 1: Traumatic amputation of the lower extremity

Graft integration occurs in three phases: the plasma imbibition phase lasts the first three days, in which graft survival occurs thanks to capillary uptake of protein-rich exudates from the recipient site; The vascularization phase is carried out from the fourth to the eighth day after the graft is placed, it occurs if an adequate immobilization of the graft is maintained and there is an elevated secretion of endothelial growth factor inducing the formation of blood vessels.

Finally, the maturation phase is reached on average after 21 days of grafting, at this stage the graft is fully integrated [16]. Survival of the graft is ensured only if it has been placed in an area with adequate vascularization, free from infection, adequate fixation and hemostasis.

Early tangential excision with graft application and grafting has been shown to reduce the percentage of infection, the days of hospital stay and produce better aesthetic and functional results [17]. It is recommended to perform it in the first 7 to 14 days with the hemodynamically stable patient, and proper debridation must be performed with the aim of removing the devitalized tissue and avoiding the loss of the graft 18. Partial thickness grafts (0.20 to 0.55 mm) taken with a suitable dermatome are preferred [18].

There are priority sites for grafting, these are the aesthetically privileged or functional areas described above, graft extraction sites are preferred near the recipient site since the skin tone, thickness and functional characteristics of the skin are similar [19].

Once placed, they should be adequately fixed by sutures and compressive dressings to reduce the interface between the recipient graft site [20], and the exudation of the receptor site should be avoided by placing fatty dressings or negative pressure systems (such as VAC) [21] that allow the interface between the Graft-site receptor and almost perfect integration as it eliminates infectious agents, suppresses exudation, fixes the graft and allows an adequate vascularization phase [22].

Nutritional status is a factor whose importance has been demonstrated in different studies [23], historically its evaluation has been made by the concentration of serum albumin, however it has been shown that it does not predict the evolution of the grafts [24]; A study was published in 2010 that evaluated the relationship between prealbumin concentration and the percentage of cutaneous graft integration, in which it was concluded that a higher level of prealbumin predicts a higher percentage of cutaneous integration [25].

However, prealbumin determination is not available in all hospital settings, limiting its clinical application. Ulibarri and colleagues developed a screening tool to evaluate the nutritional status of hospitalized patients through the routine examination analysis (CONUT) [26].

This tool uses two biochemical parameters and an immunological one: total cholesterol (evaluates the caloric aspect Level of albumin (indicator of protein reserves) and total lymphocytes (parameter related to protein depletion and expresses the loss of immune defenses as a result of malnutrition).

Each of these parameters provides a specific score and the result classifies patients in mild, moderate and severe malnutrition (Table 5). In recent years, this tool has been shown to maintain high sensitivity and specificity (82-92.3% and 85%, respectively) in evaluating the nutritional status of surgical patients with liver, heart and other diseases.

This tool is harmless, versatile and biochemical parameters can be measured in virtually any hospital, these advantages increased its use and although there is a history of its usefulness in surgical pathology, its usefulness has not been evaluated in burn patients who will be treated with placement of skin grafts [27].

Parameter	Normal	Mild malnutrition	Moderate malnutrition	Severe malnutrition
Serum albumin (mg/dl)	3.5-4.5	3-3.49	2.5-2.9	<2.5
Rating	0	2	4	6
Lymphocytes	>1600	1200-1599	800-1200	<800
Rating	0	1	2	3
Total cholesterol (mg/dl)	>180	140-180	100-139	<100
Rating	0	1	2	3
Rating	0 -1	2-4	5-8	>8

Table 5: CONUT index.

Conclusions

Burns are the most severe form of trauma that has afflicted humanity since time immemorial with fatal health consequences. Their understanding and initial approach are fundamental to increase the chances of long-term survival, in their approach requires the participation of a multidisciplinary team.

The definitive treatment of burns is tangential excision and early grafting, since they are the only measures that decrease the metabolic demand, infections, hospital stay and mortality.

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