

Chemical burns – case presentation

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ABSTRACT

Burns are entirely particular lesions, which must always be regarded as severe, especially at extreme ages, which affect the body in its entirety. Both the local lesion and the general bodily reaction are dynamic and entail characteristic sequences, which can be anticipated and prevented, in order to reduce the risk of complications and to provide the best possible vital, functional and aesthetic prognosis.

The human skin, the largest organ of the body and the most important immune organ, consists of two layers – epidermis and dermis. The action of the thermal agent, irrespective of its aetiology, most commonly affects the epidermis and more or less deep areas of the dermis, depending on the temperature and duration of exposure. In the most severe cases, the dermis is destroyed in its entirety and sometimes, sub-dermic structures are affected as well.

Keywords: chemical burn, pediatric patient, chemical agent, accident

INTRODUCTION

Depending on the depth of the burn lesion, we distinguish:

Superficial burns (epidermal, 1st degree) – solar burns, short-term exposure to liquids or other thermal agents with temperatures below 50 degrees C. They have the following characteristics:

- only damage the epidermis;
- red and slightly edematous appearance of the skin;
- sensation of pain and local heat.

Spontaneous healing, in 2-3 days, without permanent consequences.

Superficial partial burns (superficial, dermal IInd A degree)

- they damage the epidermis in its entirety and the dermis and its skin appendages only partially;
- blisters, perilesional edema, pink aspect;
- local inflammation and abundant exudate;
- thirst, oliguria, if more than 10% of the surface of the body is burned in grown-ups and more than 5% in a small infant;
- spontaneous healing in 7-14 days, without permanent scarring damage.

Deep partial burns (deep dermal, IInd B degree)

- damage the epidermis in its entirety and the dermis in depth;
- blisters and white or burning-red eschar;
- moderate exudate, intense local inflammation;
- intense pain;
- thirst, oliguria, more marked effect on the medical state;
- healing is possible (for limited surfaces), in 14-21 days, with scarred areas.

Total burns (full thickness of the dermis, sub-dermal, III-IV degrees)

- completely destroy the epidermis, dermis, sin appendages and sometimes the sub-dermal structures;
- broken blisters, painless white or white-gray eschar;
- significant and early arising perilesional edema, exudate in low quantities;
- a marked effect on the medical state, even when under 10% of the bodily surface area is burned;
- spontaneous healing over a long period of time and with permanent scarring consequences (1,2,4,5,8).

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The initial evaluation of the severity of the burn is essential for establishing the therapeutic indications, as well as for the prognosis. The essential elements which need to be taken into account in the evaluation of the severity of a burn are:

- **age** – given the same depth and burned surface, a burn is all the more severe as the age of the patient is lower. A burn must always be regarded as severe in a nursing baby.
- **burned surface** is the essential element in the assessment of the severity, prognosis and treatment regimen in burns. There is a direct correlation between the burned surface and the risk of death. In the case of adults and teenagers over 15 years of age, the burned surface is estimated based on the Wallace “rule of nines”, while for young infants, the estimation is based on the Lund– Browder chart.
- **the depth of the burn** – for the same burned surface, the deeper the burn, the more severe it is. The assessment of the depth must be carried out dynamically (every 2-5 days).
- **location** – burns located in certain areas of the body are considered severe – airways, face, hands, legs, perineum, burns with a circular distribution.
- **etiological agent** – for a child, any electrical and chemical burn must be regarded as severe and it requires an initial assessment in a specialised hospital environment, even if on the initial exam, the skin lesions appear to be minor.
- **concomitant trauma**
- **preexisting afflictions and deficiencies**
- **inadequate treatment on the scene of the accident** (2,3,5).

PROGNOSTIC SCORES

Severity based on the burned surface – a burn is considered severe if it affects over 5% of the body surface in a child between 0-2 years of age and over 10% in children between 3-15 years of age.

Severity based on the surface and depth – the presence of a burn throughout the thickness of the dermis, regardless of its size, in a child between 0-3 years of age and over 2% of the body surface at any age, requires hospitalisation and surgical indication. The Standard Burn Units Score is measured by adding the burned surface to the triple of the

burned surface in the thickness of the dermis. The Classification of the American Burn Association:

- minor burns – can benefit from outpatient treatment;
- moderate, potentially severe burns – require assessment and hospitalisation in specialised centres;
- major, severe burns – compulsory and initial hospitalisation in burn centres.

Abbreviated Burn Severity Index (ABSI) takes into consideration multiple parameters – sex, age, burned airways, burned surface and it is very often used on an international level. The incidence of chemical burns has increased and it has progressively diversified due to the industrialisation process. Currently, substances which cause burns are widespread both in the professional and domestic environment.

The degree of tissue damage, as well as the level of systemic toxicity are caused by the chemical nature of the substance, its concentration, the duration of exposure and the mechanism of action (2,3,5).

On the basis of the **mechanism of action**, chemical agents which can cause burns can be:

- reducing substances – they act by reducing lesions, an exothermic reaction (diborane, lithium aluminium hydride)
- oxidative substances – act by adding an oxygen, sulphur or halogen atom to the structure of proteins, which alters their functionality (sodium hypochlorite, potassium permanganate, peroxides, chromic acid)
- corrosive substances – corrode the skin and cause massive protein denaturations (phenols, sodium hydroxide, potassium, ammonium and calcium)
- toxic plasma substances – form esters with proteins or inhibit inorganic ions, which are required for the normal cellular function (formic, acetic, oxalic, hydrofluoric acid)
- desiccants – hygroscopic agents, which extract water from the tissues, within normally exothermic reactions (concentrated sulphuric acid)
- vesicants – act by DNA alkylation, producing vesicles as a result of protease release from the lysosomes of altered basal cells (2,3,5).

Prompt intervention at the scene of the accident is essential for reducing the severity of the injuries and diminishing the risk of systemic toxicity:

- fast removal of soaked clothing (precautionary measure to avoid contamination of the environment or of the surrounding people).

Abundant wash of the wounds and contaminated skin. The wash dilutes the chemical agent and removes it from the skin, it corrects the hygroscopic effect which certain agents have on the skin. The wash needs to be conducted using large quantities of water, at a temperature of 25-30 degrees C, over the course of 15-30 minutes. The application of neutralising solutions, which in most cases produce an exothermic reaction, is contraindicated, as it can aggravate the initial lesion. The body temperature is monitored and the systemic toxic impact which the causal agent can have is assessed, measuring the gasometry and the serum ionogram, repeated during the first 24-36 hours or until the metabolic stabilisation.

Compared to thermal burns, chemical burns often require additional analgesia. The burn wound is classified and treated according to the same principles as in the case of thermal burns. Its particularities are its progressive nature and the lengthy period of the healing process (2,4).

Treatment of minor burns

Cleaning of the burn wounds – antiseptic non-irritating solutions (chlorhexidine in normal saline, benzalkonium chloride).

Debridement of broken and large blisters.

Application of a tulle-gras type dressing and antibacterial ointments: neomycin-bacitracin, arginine sulfadiazines (2,5).

Treatment of moderate and severe burns

The patient with medium and severe burns, regardless of age, is best looked after within complex, interdisciplinary teams which belong to burn units or compartments within the departments/clinics of plastic surgery within complex large hospitals. The treatment of burns “throughout the thickness of the dermis” and of partially deep burns is surgical (3,5,6,8).

The essential elements of an efficient treatment are:

- prompt, efficient and adequate hydroelectrolytic resuscitation
- prevention and therapeutic control of acute phase complications – systemic inflammatory response syndrome and multiple organ failure
- pain therapy
- pain prevention and control
- nutritional and immune support
- local treatment provided once or twice a day
- excision – early grafting of the burns “throughout the thickness of the dermis”

- aggressive surgical treatment in extensive, predominantly deep burns
- physio- and kinesiotherapeutical intervention, as well as early and constant psycho-social counselling, over the entire therapeutical process
- active participation of the patient’s family in the therapeutical process (2,5).

CASE REPORT

Female patient, 15 months of age, from the rural area, is admitted with burn lesions caused by contact with the veterinary medicine – Vital Bro – which is a combination of organic lactic, butyric and formic acid. It is administered to the drinking water of chickens and adult poultry daily. The main effect of its administering is improving digestion, namely increasing the degree of assimilation of the fodder and implicitly, of the average daily gain. The second effect is the prevention of diseases with pathogenic bacteria susceptible to the acidic environment created by the medicine.

The lesions are located on the right side of the anterior trunk, the right thigh, the distal 1/3 of the right forearm, IIA-IIB degree, approximately 10% of the body surface, with postcombustional shock.

The past medical history is insignificant, with the exception of the intermittent respiratory disorders.

Physical examination upon admission

The patient weighing 9.5 kg shows up in the emergency room with a medium general state, conscious, cooperating status, with uncharacteristic facies. Upon inspection of the skin, chemical burn lesions are identified on the anterior side of the left thigh, the anterior 1/3 of the right forearm, the right 1/2 of the trunk and anterior abdomen, which have an aspect of brown-gray, adherent, relatively supple eschar, surrounded by painful areas of erythema, moderate lesional and perilesional edema.

The physical examination of the respiratory system was normal upon admission, as well as the examination of the cardiovascular apparatus, which did not reveal any pathological elements.

Initial laboratory investigations – patient with inflammatory syndrome and hydroelectrolytical imbalances.

Cultures and the antibiogram are harvested from the burn wounds – *Enterococcus Faecalis*, sensitive to Ampicilin, Ciprofloxacin, Gentamicin and Streptomycin, resistant to Erythromycina and Tetracycline.



FIGURE 1 & 2. Initial lesions – chemical burn patient

As a first intention treatment in the emergency room, the cleaning and excisional debridement of the wound is performed, with the removal of lesioned tissues, as well as the application of dressings.

The treatment for hydroelectrolytic rebalancing is initiated according to the age of the patient and the burned surface, with the GALVERSTON rebalancing formula, nutritional support, therapeutical

prevention and control of acute phase complications, preventions and control of infections. The daily dressing of burn wounds is carried out in order to delineate deep areas from the superficial areas of the burn with arginine sulfadiazine.

Seven days after the accident occurred, surgery is performed in order to practice the excision of the postcombustional eschar on the anterior trunk and the anterior side of the right thigh, covering the de-



FIGURE 3 & 4. Post-surgery – chemical burn patient



FIGURE 5 & 6. Post-burn chemical lesions upon discharge

fects of the thigh with split split thickness skin graft – harvested with the electro dermatome from the posterior side of the right thigh.

Post-surgery, the treatment for infection prevention, to maintain hydroelectrolytic balance, nutritional support are continued. Daily dressing of the wound is carried out until discharge. The evolution is favourable, the patient exhibits a good general, stable hemodynamic and cardio-respiratory state, with preserved appetite and present diuresis. Locally – the evolution is favourable, with healing post-burn lesions, with the integration of skin grafts and healing of the donor areas.

It is recommended that after the discharge, the daily dressing of the wounds with epithelial bandages and the scar tissue prophylaxis through massage with moisturizing cream, silicone foil and elastic bandage are continued.

DISCUSSION

In the case of paediatric population, young age (below 2 years old) is an additional risk factor.

The depth of the lesions depends on the nature of the chemical agent, its concentration and the duration of the contact. The particularity of the hereby case is the relatively large afflicted body surface area, namely 10% of the body surface, the young age of the patient (15 months), compared to the vast majority of chemical burn cases which reach

hospital units, and which are mostly small burns, as far as their dimensions are concerned, and they can benefit from outpatient treatment.

It is essential for the burn patient to immediately commence the hydroelectrolytic recovery, according to the age and burned surface. The best indicator for a successful resuscitation is the assessment of diuresis. The primary goal after the acute phase is to restore and preserve tissue perfusion and prevent ischaemia produced by post-combustion shock with hypovolemic and cellular disorders.

Burn injuries can be intricate as far as their depth is concerned. Lesions which have a deep burn appearance (III-IV degree) need early surgical treatment, which consists of excision of the eschar, followed by the closure of the resulting soft tissue defects. If the defects are small, they can be closed through direct suture. Larger skin defects need skin grafts or local plasty in order to be closed. In the present case, the lesions on the forearm and trunk were of a lesser degree – a conservative treatment could be applied: bandage and epithelial creams, compared to the lesions on the thigh, which required surgical treatment.

CONCLUSIONS

As far as local care is concerned, chemical burns follow the same principles used for thermal burns. Chemical burns tend to be deeper than they appear

upon initial examination. The skin lesions have a progressive nature, and the conservatory treatment requires a longer time for the healing process and for the formation of disabling scarring sequelae.

Under these circumstances, the therapeutical recommendation is early excision and grafting, solution which offers the best longterm results.

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REFERENCES

1. Carvajal M.F., Parks D. Burns in Children, Med Publishers, 1988
2. Enescu D., Bordeianu I. Manual de chirurgie plastica, Ovidius Univ Press, 2001
3. Enescu Dan. Arsurile, Chirurgie plastica si microchirurgie reconstructiva, vol VI, Editura academiei romane, 2008, 56-94
4. Herndon D.N. Total Burn Care, Saunders, 1996
5. Isac Florin, Conf. Dr., Isac Aurelia, Dr. Tache Mihai, Dr. Draghici Ioan, Dr. Bratu Tiberiu. Arsurile, Caiet de Chirurgie Plastica, vol. I
6. Jurkiewicz M.J. Plastic surgery, Principles and Practice, Mosby, 1990
7. Mc Carthy J.G. Plastic Surgery, Saunders, 1990
8. Pruitt B.A., Goodwin C.W. Textbook of Surgery, Saunders, 1997