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Review

Clinical and forensic signs related to chemical burns: A mechanistic approach

Ricardo Jorge Dinis-Oliveira [a,b,c,d,e,*], Félix Carvalho [c], Roxana Moreira [b,e], Jorge Brandão Proença [b], Agostinho Santos [a,d,f], José Alberto Duarte [g], Maria de Lourdes Bastos [c], Teresa Magalhães [a,d,f]

[a] Department of Legal Medicine and Forensic Sciences, Faculty of Medicine, University of Porto, Porto, Portugal
[b] IINFACTS – Institute of Research and Advanced Training in Health Sciences and Technologies, Department of Sciences, Advanced Institute of Health Sciences – North (ISCS-N), CESPU, CRL, Gandra, Portugal
[c] REQUIMTE, Laboratory of Toxicology, Department of Biological Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal
[d] Center of Forensic Sciences (CENCIFOR), Portugal
[e] CBMA – Centre of Molecular and Environmental Biology, Department of Biology, University of Minho, Braga, Portugal
[f] National Institute of Legal Medicine and Forensic Sciences, North Branch, I.P., Portugal
[g] CIAFEL, Faculty of Sport, University of Porto, Porto, Portugal

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ABSTRACT

This manuscript highlights and critically analyses clinical and forensic signs related to chemical burns. Signs that may lead to suspicion of a particular chemical are thoroughly discussed regarding its underlying mechanisms. Burns due to sulfuric, hydrofluoric, nitric, hydrochloric (muriatic) and acetic (including derivatives) acids, hydrogen sulphide, sodium (caustic soda) and calcium (cement) hydroxides, paraquat, burns after inflation and rupture of airbags, povidone–iodine, chlorhexidine/alcohol (in preterm infants), laxatives, and vesicants (warfare agents), will be reviewed since these are the most common agents found in daily practice, for which relevant and timed information may be helpful in formulating an emergency treatment protocols and toxicological analysis.

* *Corresponding author at*: Department of Legal Medicine and Forensic Sciences, Faculty of Medicine, University of Porto, Jardim Carrilho Videira, 4050-167 Porto, Portugal. Tel.: +351 222073850.
E-mail address: ricardinis@sapo.pt (R.J. Dinis-Oliveira).
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1. Introduction

Physical, biological, or chemical agents can cause burns, leading to a local or generalized reaction, whose severity is related to its length and depth. Physical agents include thermal (heated object, flame, boiling liquid, vapor, *etc.*), electricity (electrocution/fulguration), hypothermia and hyperthermia, and radiation. Biological agents comprise substances produced by insects, jellyfish, fish, frogs and some plants. Concerning chemical agents, the focus of the present review, a large number of compounds (estimated at around 25,000) are capable of causing cutaneous, mucosa's and ocular chemical burns (producing more or less depth disorganization, including its complete destruction) as consequence of their caustic or irritant effects. Additionally, after absorption, several systemic manifestations in different organs and systems can be observed [1,2].

Potentially dangerous chemical products are ubiquitous in daily life particularly in industry, scientific laboratories, at home (*e.g.* cleaning products) and in agriculture settings [3–5]. In spite of this widespread use, chemical burns are uncommonly observed in daily practice in comparison to thermal/electric burns [6]. The extension of the burn lesion depends on several factors [7–10], which are highlighted in Table 1. Accordingly previous studies [10–22] chemical burns exhibit some general characterizes, which were resumed in Table 2.

The present review appears as a natural sequence of previous reports, in which signs and symptoms related to xenobiotic exposure have been highlighted [23–30]. Indeed, in forensic toxicological analysis, the suspicion based on signs and symptoms is an extremely important pre-analytical step since it allows the clinician to rapidly implement an appropriate therapy until toxicological results become available to corroborate (or not) the initial suspicion. In addition, for the toxicologist, the suspicion also acquires importance for the correct selection of biological matrices to be analyzed since when erroneously done it can introduce bias to the obtained analytical result [24,25,27]. In this manuscript, we highlight and discuss suggestive clinical and forensic images related to chemical burns that can further orientate toxicological analysis. Burns due to sulfuric, hydrofluoric, nitric, hydrochloric (muriatic) and acetic (including derivatives) acids, hydrogen sulfide, sodium (caustic soda) and calcium (cement) hydroxides, paraquat, inflation and rupture of airbags,

Table 1 – Factors that influence the extension of the burn lesion.

-Physical state (*i.e.* liquid, solid, gas)
-Mechanism of action of the chemical (*e.g.* acids, bases and other chemicals)
-Concentration of chemical in contact/ingested
-Amount of chemical in contact/ingested
-Intent
-Strength (*e.g.* extreme pH solutions with pH < 2 or pH > 12 have more serious corrosive effects)
-Duration of exposure (most relevant)
-Regional skin properties (*e.g.* pre-existing conditions such as dermatitis; plantar epidermis is less permeable due to thick *stratum corneum*)
-Skin differences between ages and races