HYDROFLUORIC ACID (HF) BURN INJURIES DECONTAMINATION IN *EX VIVO* HUMAN EYE AND SKIN MODELS

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Introduction

Hydrofluoric acid (HF) is a partially dissociated acid but has serious dermal, local and systemic toxicity. HF is widely used in different industries but is a very hazardous chemical because of the acid corrosivity of its hydrogen ion (H^+) and the chelating properties against calcium and magnesium of its fluoride ion (F^-). HF induces both tissues necrosis and cardiac systemic toxicity (depending on its concentration and on the surface of contamination).

Objectives

The objectives were: firstly to present results on HF penetration in the cornea and through the skin with ex vivo models; secondly, to compare different washing decontamination products.

Methods

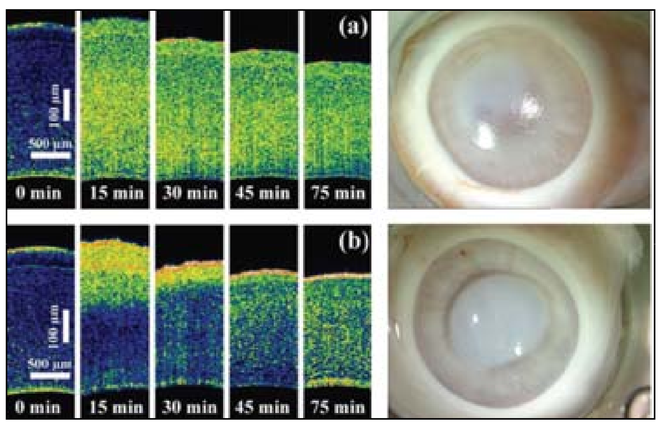
Method 1 - New *ex vivo* models for eye contamination:

Acute Ex Vivo Eye Irritation Test (aEVEIT) and Optical Coherence Tomography (OCT) technique for eye burn. EVEIT, associated with OCT high speed micrometer resolution, offers the possibility to qualify and quantify the penetration into the eye of 25 µL of 2.5 % HF on a filter paper in contact with enucleated rabbit eye. Decontamination occurs just after 20 s of contact. The comparison is done between 15 min of tap water rinsing, the use of 1 % CaG solution and Hexafluorine® washing during 3 minutes (166 mL/min).

Method 2.2 – New ex vivo model for skin HF contamination:

BIO-EC technique using human skin explants burnt by topic application of 30µL 70% HF on a filter paper for 20s. Histological samplings are made at 20s, 5, 10, 15, 30min, 1, 2, 4 and 24 hours. 40X optical microscopy shows 4 skin layers: stratum corneum, basal epidermis, papillary and reticular dermis. It precisely shows the progressive penetration and the extension of cellular lesions within tissue. Then this study compares the efficacy of water rinsing during 15 min followed by a Ca-G application versus washing with Hexafluorine®.

Results



Eye burnt with 2,5 % HF: OCT and morphological appearance

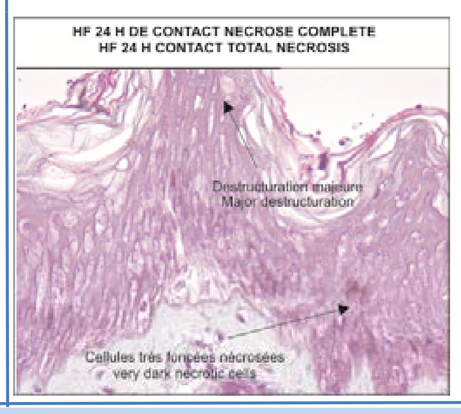
a) Without rinsing = burn

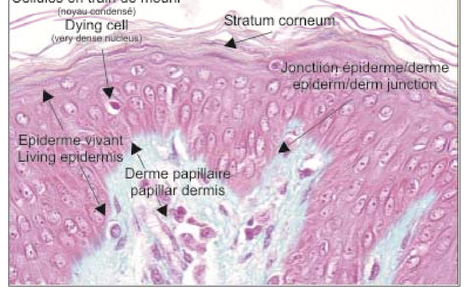
b) Water rinsing = burn

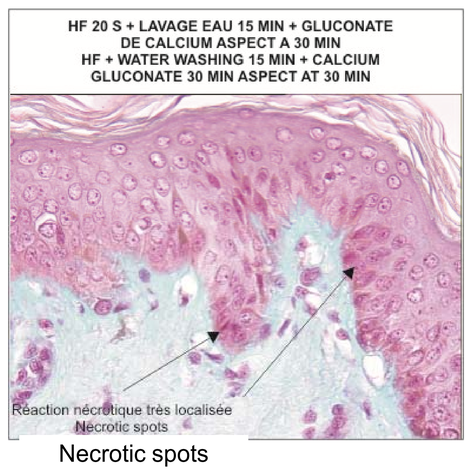
c) 1 % Calcium Gluconate rinsing = burn

d) Hexafluorine® rinsing = preserved cornea

		Control (untreated group) (20 explants)	HF without washing (18 explants)	HF + water washing + calcium gluconate (16 explants)	HF + Hexafluorine 400 ml (16 explants)
T0	Epidermis	GM = good morphology			
	Papillary dermis	GM			
	Reticular dermis	GM			
20 s	Epidermis	GM			
	Papillary dermis	GM			
	Reticular dermis	GM			
5 min	Epidermis	GM	PN + AC	GM	GM
	Papillary dermis	GM	PN + AC	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
10 min	Epidermis	GM	PN = pyknotic nuclei	GM	GM
	Papillary dermis	GM	AC = Acidophilic cytoplasm	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
15 min	Epidermis	GM	PN + AC	NP + CA moderately	GM
	Papillary dermis	GM	PN + AC	PN + AC	GM
	Reticular dermis	GM	PN + AC	PN + AC	GM
30 min	Epidermis	GM	PN + AC	Some necrotic cells	GM
	Papillary dermis	GM	PN + AC	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
1 h	Epidermis	GM	PN + AC	GM	GM
	Papillary dermis	GM	PN + AC	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
2 h	Epidermis	GM	PN + AC	GM	GM
	Papillary dermis	GM	PN + AC	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
4 h	Epidermis	GM	PN + AC	Slightly edematous cells with mild acantholysis	GM
	Papillary dermis	GM	PN + AC	GM	GM
	Reticular dermis	GM	PN + AC	GM	GM
24 h	Epidermis	GM	Totally necrotic	Very edematous cells with a very clear cytoplasm	GM
	Papillary dermis	GM	PN + AC	PN + AC	GM
	Reticular dermis	GM	PN + AC	Lesser alterations	GM







Necrotic spots

Results

For eye burns, 2.5 % HF needs only 240 s to achieve full corneal penetration. Decontamination with water and/or with calcium gluconate has resulted in deep stromal changes: loss of transparency with milky aspect, very characteristic of the burn by HF. Use of CaG initially stopped the burn but a later progression. Hexafluorine® anti-HF rinsing solution has proved to fully stop burns due to its specific properties. This is the only rinsing solution that keeps the cornea totally clear 75 min after burning.

For skin burns, 70 % HF on skin without rinsing induces the first cellular lesions after 1 minute of contact. HF reaches the deepest layer of dermis in less than 5 minutes. The BIO-EC technique is able to compare the evolution of a human skin spontaneously burnt with 70 % HF, after water rinsing and calcium gluconate application and after decontamination with a 2 x 200 mL Hexafluorine® spray. Rinsing 15 min with water followed by a unique Ca-G application only delays the initial corrosive effect but the process goes on after 4 h and up to 24 h. With Hexafluorine®, we observe a total absence of lesion in any layer and at any time: precociously or later up to 24 h.

Conclusion

The double hazardous mechanisms and the lethal risk of HF require highly efficient emergency care in case of contact. Based on the results obtained here, Hexafluorine®, as a specific rinsing solution, is fully effective on ocular as well as cutaneous HF splash decontamination. In the future, the use of these two new *ex vivo* models on eye and skin could help us to evaluate the chemical contamination due to various chemicals and the benefit of using improved decontamination agents.