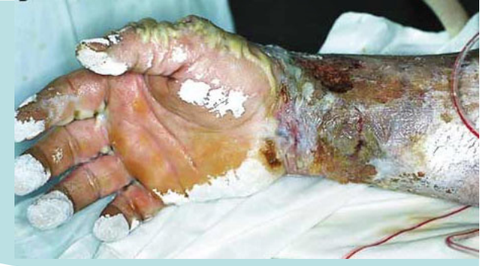
70 % Hydrofluoric Acid (HF) Cutaneous Decontamination?

Comparison of Different Washing Protocols with a New Type of *Ex Vivo* Data



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Objective

HF is a very hazardous acid used mainly in glass etching, surface treatment and electronics manufacturing. Its very hazardous properties are due to a double mechanism of action:

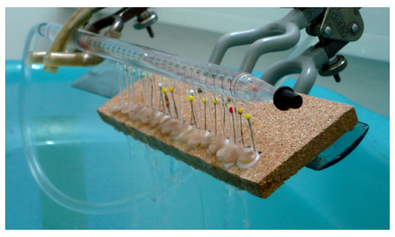
- corrosiveness, due to the presence of H^+,
- local and systemic toxicity, due to the presence of F^-.

The aim of this presentation is to determine the benefit of different rinsing protocol versus no decontamination on an innovative *ex vivo* model. (This new *ex vivo* model is presented in poster n°739).

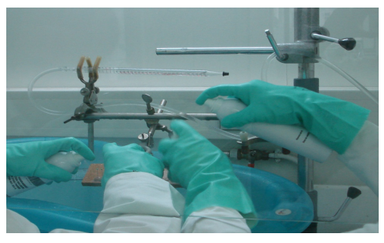
Methods

86 explants of human skin were divided into 4 groups:

- 1 control,
- 3 exposed to HF:
  - One group without decontamination;
  - One with 15 minutes of tap water flushing plus one topical application of calcium gluconate (CaGlu) 1g/cm²;
  - One washed with Hexafluorine® during 10 minutes.



Water flushing of the explants during 15 minutes, prior to GluCa application (1 g/cm²)



Hexafluorine® washing with sprays during 10 minutes

The exposition to HF was done during 20 seconds by topical route from filter paper disks, previously saturated with 30 µl 70% acidic solution.

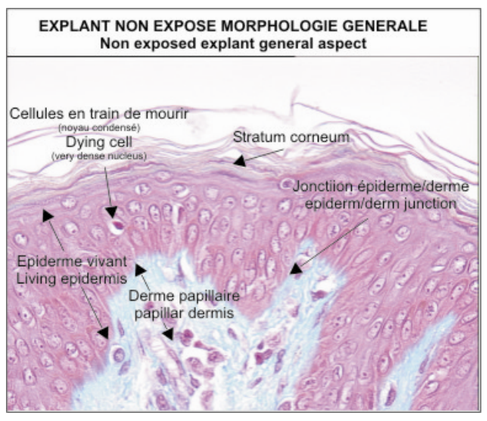
Histological samples were taken at the end of washing, then regularly up to 24 hours. The observations were performed by optical microscopy X40.

Results

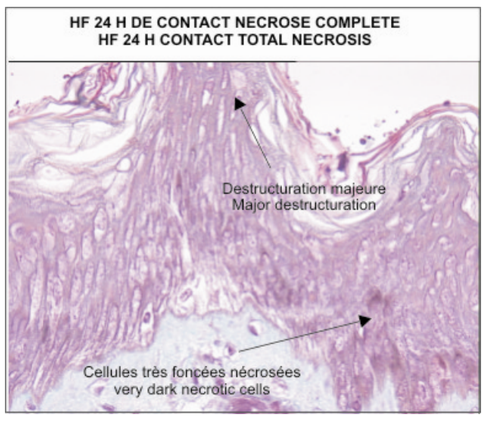
Results are presented in Table 1. Alterations were searched for in stratum corneum, basal epidermis, papillary and reticular dermis.

		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	GM	GM	GM
	Papillary dermis				
	Reticular dermis				
20 s	Epidermis				
	Papillary dermis				
	Reticular dermis				
5 min	Epidermis		PN = pyknotic nuclei + AC = Acidophilic cytoplasm	GM	
	Papillary dermis				
	Reticular dermis				
10 min	Epidermis				
	Papillary dermis				
	Reticular dermis				
15 min	Epidermis			NP + CA moderately	
	Papillary dermis			PN + AC	
	Reticular dermis			Some necrotic cells	
30 min	Epidermis			GM	
	Papillary dermis				
	Reticular dermis				
1 h	Epidermis				
	Papillary dermis				
	Reticular dermis				
2 h	Epidermis				
	Papillary dermis				
	Reticular dermis				
4 h	Epidermis			Slightly edematous cells with mild acantholysis	
	Papillary dermis			GM	
	Reticular dermis				
24 h	Epidermis		Totally necrotic	Very edematous cells with a very clear cytoplasm	
	Papillary dermis		PN + AC	PN + AC	
	Reticular dermis			Lesser deterioration	

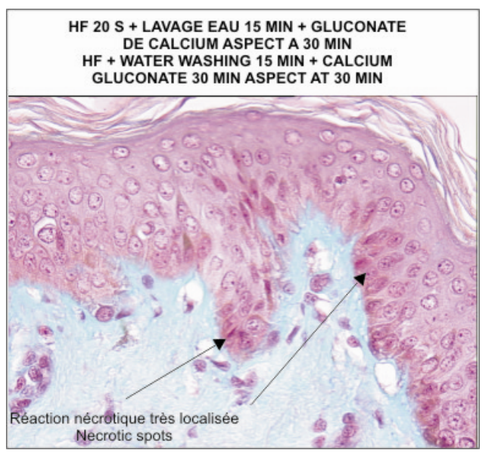
Table 1: Morphological evolution of the different groups of explants with time



Non exposed explant general aspect



HF 24H after contact (no decontamination)



HF+Water washing+CaGlu 30 minutes after contact

HF+Hexafluorine® washing 24 hours after contact

Results (continued)

Control group: no lesions in any layer at anytime.

HF-exposed explants without decontamination: severe burns in the 4 layers, from 10 minutes onwards.

With tap water plus CaGlu: alterations of the 4 layers after 15 minutes, decreasing after 30 minutes. Resumption of lesions in epidermal cells from the 4th hour onwards and in dermal cells at 24h.

With Hexafluorine® decontamination: no alteration of epidermal or dermal cells, even after 24h.

These results are in accordance with those obtained on an *ex vivo* model for the eye (1). The effectiveness of Hexafluorine® decontamination, in this study, can be linked with successful results (without secondary care or systemic effects) obtained on three 70% HF workplace splashes (2), (3).

4 case studies of emergency decontamination with Hexafluorine®

Number Of cases	Splashed by	Affected body surface	Type of washing	Consequences/Results
1	HF/HCl* Bath	Total immersion	*Hexafluorine® on the body, **Ocular washing with water	*Slight burns on the abdomen and the back **Serious burn on the left eye
1	70% HF vapour	Right cheek	Hexafluorine®	Slight painless erythema. Application the next day with calcium gluconate gel, no lost work time
2	5% HF	body	Hexafluorine®	No burns, no lost work time

Series of 10 cutaneous cases at the Mannesmann Plant (Remscheid, Germany)

Splash	*40% HF*	*6% HF / 15% HNO_3*
Number of cases	**5**	5
% Affected area	**0.2 – 1 – 4.5 – 4.5 – 16.5***	0.2 – 2.25 – 4 - 4.5 - 10.5
First washing (on the site of the accident)	**Hexafluorine®**	Hexafluorine®
Second washing (at the infirmary)	**Hexafluorine®**	Hexafluorine®

Series of 12 cutaneous cases at Outokumpu (AVESTA, various sites, Sweden) Decontamination with Hexafluorine®

Number of Cases	*Splashed with*	*Affected body surface*	*Duration of contact*	*Work loss*
2	70% HF	Left forearm– oral cavity	< 1 min	0 - 1
1	HF/HNO_3 pH=1	One thigh	< 1 min	0
2	HF/HNO_3 pH=1	Two thighs	1h - 1h30	2 - 2
1	HF/HNO_3 pH=1*	Face	3 - 5 min	3
2	HF/HNO_3 pH=1	Face + oral cavity – Forehead	< 1 min	1 - 1
3	HF/HNO_3 pH=1	Forearm-arm – arm + hand – Two elbows	< 1 min	0 – 0 - 1
1	HF/HNO_3 pH=1	Wrists	2 h	0

Conclusion

This new model allows a comparison of decontamination methods of cutaneous exposure to 70 % HF. These experimental results are in accordance with those showed in case reports. Decontamination with tap water followed by CaGlu requires several and deeply penetrating applications of CaGlu to minimize and delay lesions, whereas the best washing results were observed with Hexafluorine® spray where no lesions appeared at all.

With the human explant model, there is no more need of extrapolation from animal to human. Furthermore, this type of test is in agreement with the new European REACH regulation. This model will allow us to test other acids (such as sulphuric and nitric) and different bases (such as sodium hydroxide).

References

(1) Spöler F et al. Analysis of hydrofluoric acid penetration and decontamination of the eye by means of time resolved optical coherence tomography. Burns 2008; 34(4):549-55

(2) Soderberg K et al. An improved method for emergent decontamination of ocular and dermal HF splashes. Vet Hum Toxicol 2004; 46(4):216-218

(3)Mathieu L et al. Comparative evaluation of the active eye and skin chemical splash decontamination solutions Diphoterine and Hexafluorine with water and other rinsing solutions: Effects on burn severity and healing. JCHAS 114, July/August 2007, p32-39