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Ocular chemical burns: experimental proof of the influence of key parameters one both diffusion and decontamination

Purpose

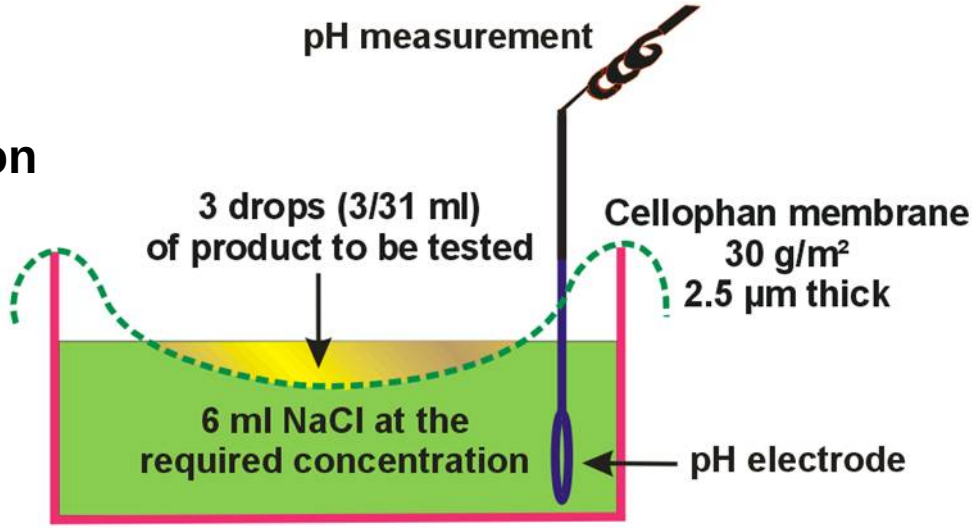
Ocular chemical burns result from the destruction of biochemical components of living tissue at the time of contact with irritating or corrosive chemicals. A new *in vitro* method is presented here in order to study ocular chemical burns using key parameters.
An active solution, Diphoterine®, with amphoteric, hypertonic and chelating properties, used as a washing solution, is compared to water washing of chemical splashes.

Method

1- In vitro simulation of the diffusion of NaOH through a membrane, depending on the concentration of NaOH

1.1 – Experimental device

The compartment simulating the anterior chamber of the eye contains sodium chloride (6 ml, 420 mosmoles/kg).



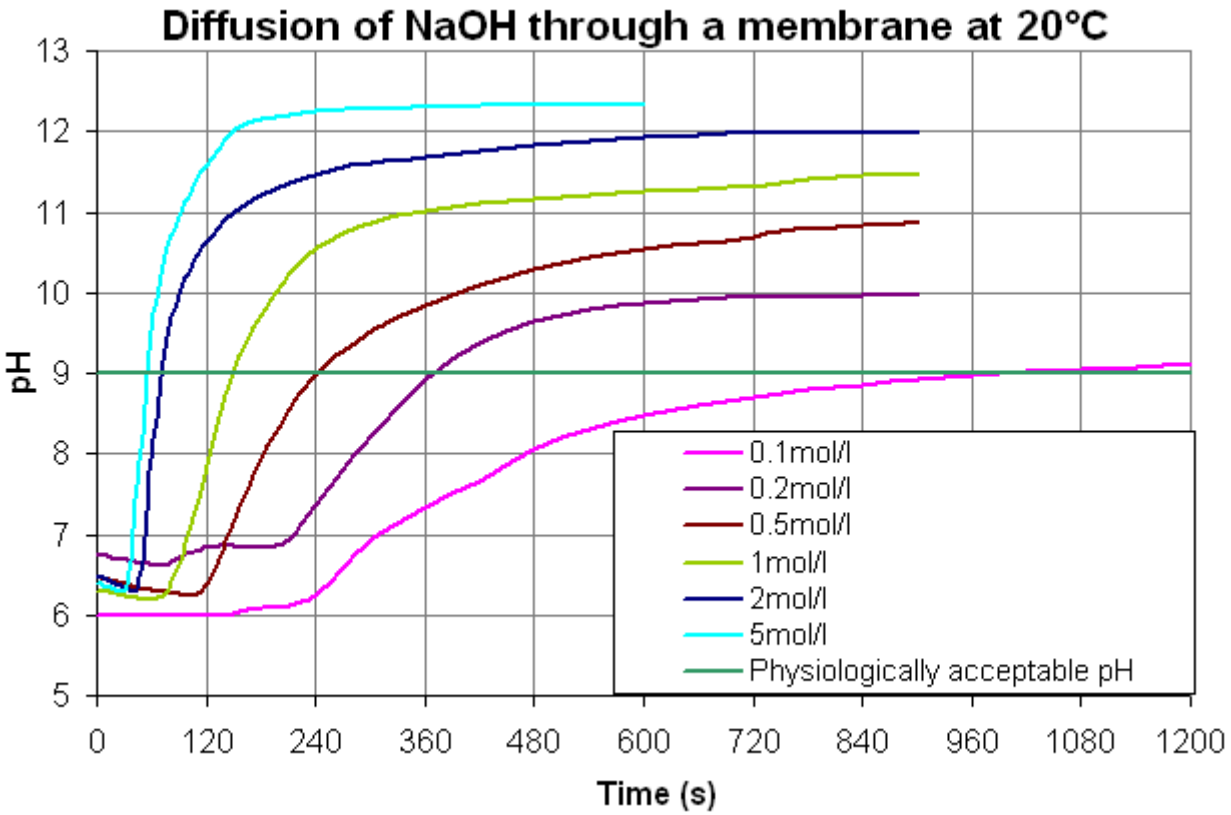
(1) Prevor, Valmondois, France – (2) IHT, Aachen University, Germany – (3) ACTO, Aachen, Germany – (4) Cayenne Hospital, France – (5) Fort de France Hospital, France

1.2- Results

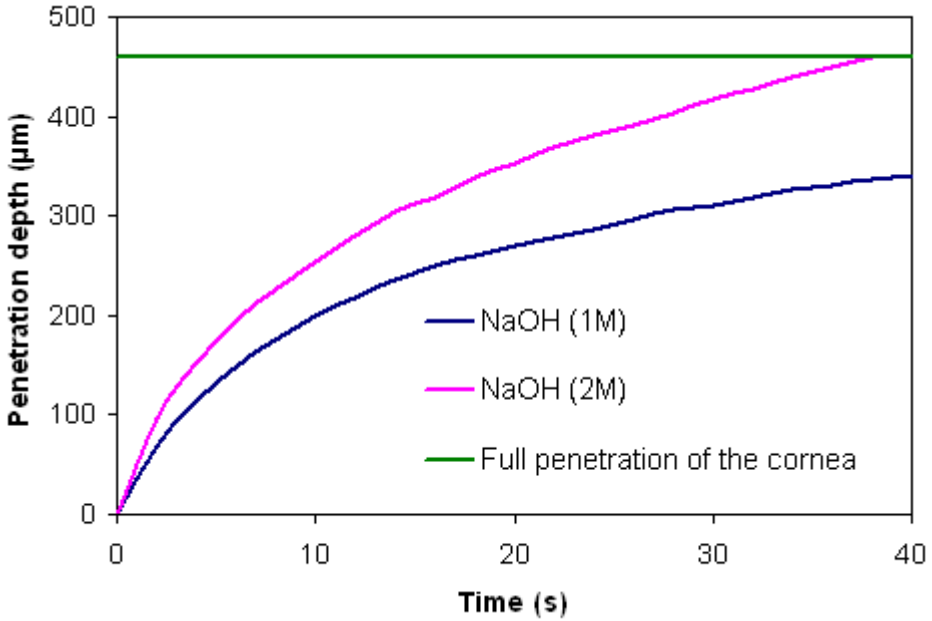
Final pH in the anterior chamber after 10 minutes of contact.

NaOH Concentration (mol/L)	0.1	0.2	1	2	5
pH (anterior chamber)	8.61	9.91	11.25	11.95	12.34

The concentration influences the speed of NaOH penetration. The larger the concentration, the faster its diffusion.
The penetration is very weak when lower than 0,2M,.
A similar experiment a 55°C shows the role of the temperature which also accelerates the penetration.



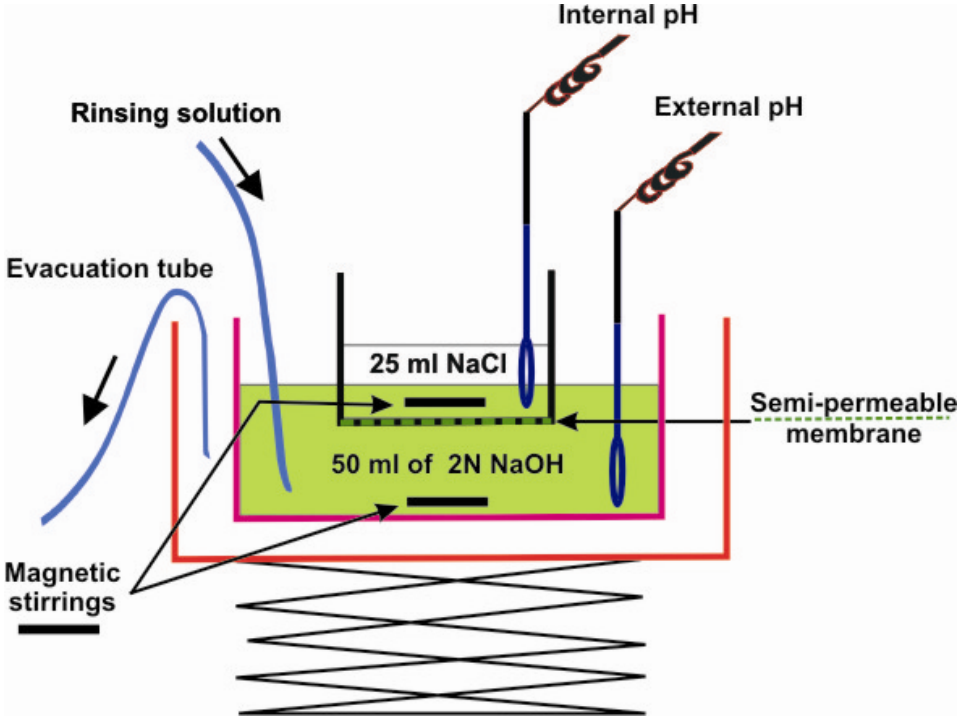
1.3 - Confirmation of the experimental model by an *ex-vivo* [1]



- Complete penetration of the cornea in 38s for NaOH 2M and in 120s for a 1M solution.
- As previously noted, for a less concentrated solution (0.5M) the penetration remains incomplete.

2. - In vitro simulation of a complete rinsing of exposure to NaOH 2N depending on the time exposure[2]

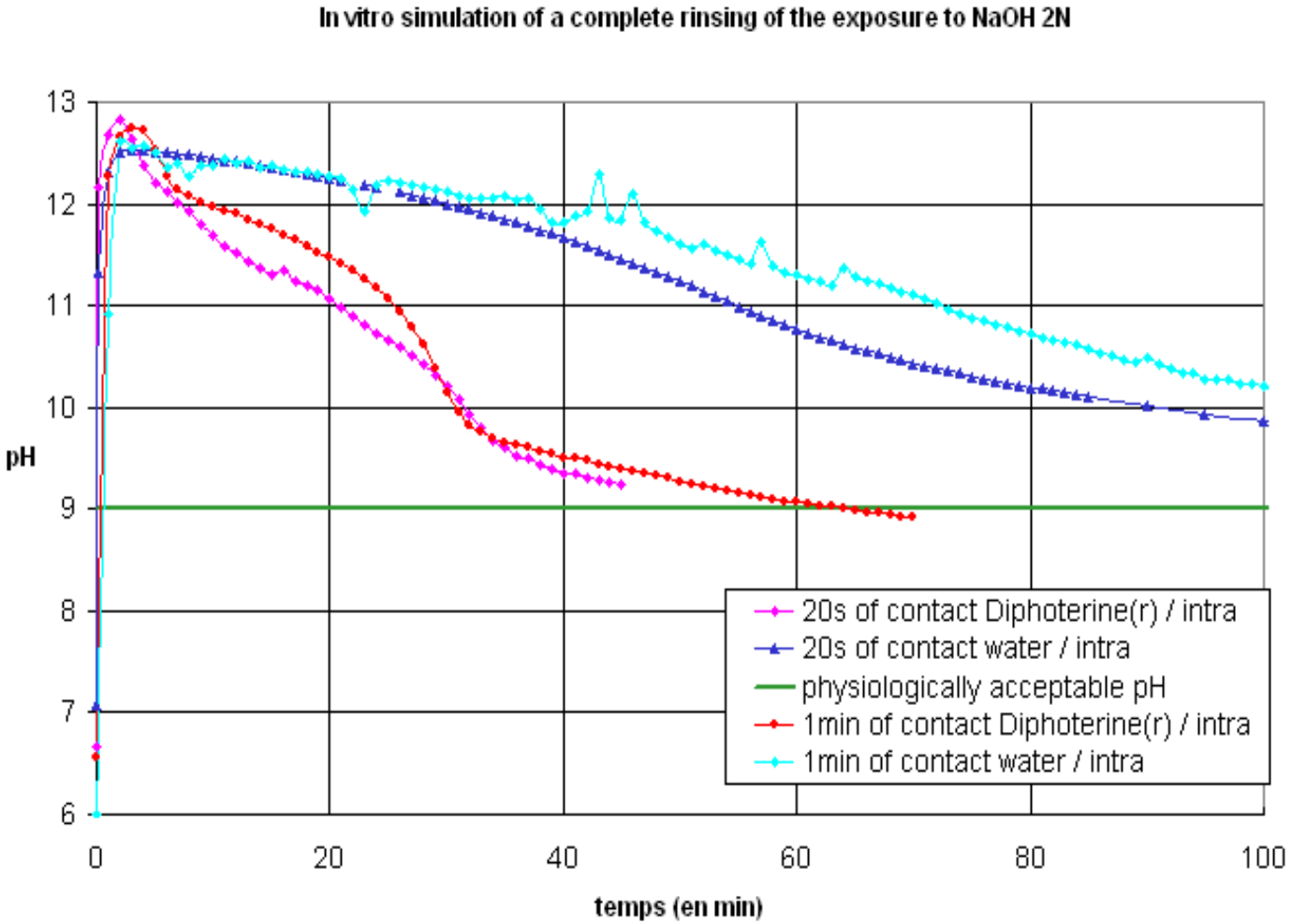
2.1 – Experimental device



- The semipermeable membrane model is also used to simulate a complete rinsing of the exposure to NaOH 2N after 20 seconds or 1 minute of exposure. The “anterior chamber” (25 ml of sodium chloride 420 mosmoles/kg) is then exposed, via the membrane, to 50 ml of sodium hydroxide 2M.

2.2 - Evolution of internal pH NaOH 2M

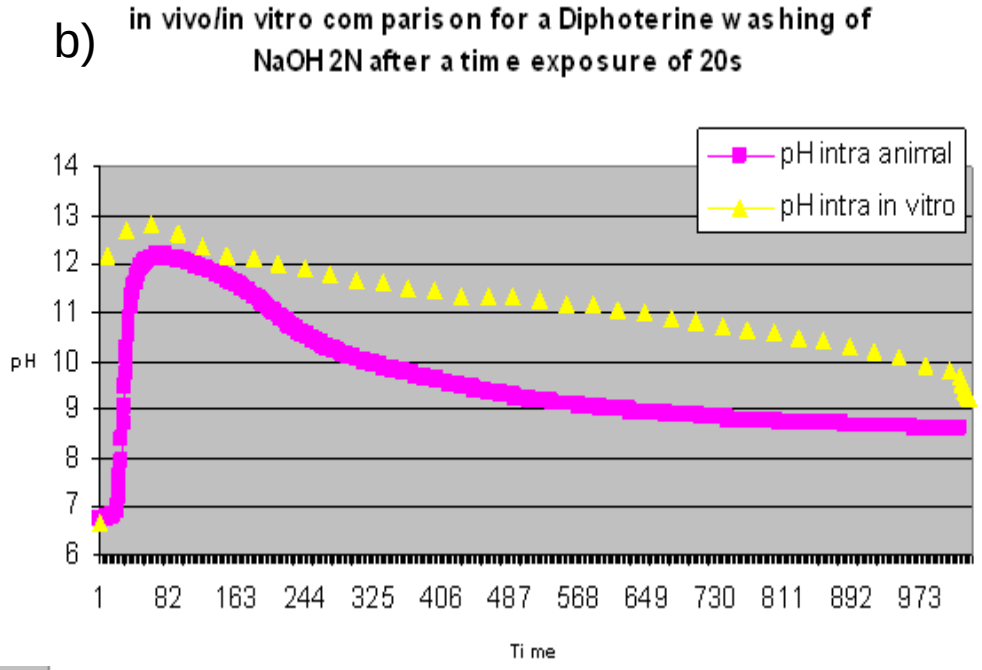
- For 20 S of contact and after 3 minutes of washing, the external pH is equal to 9.12 for Diphotérine® and 12.8 for water.
- After 45 minutes, the internal pH is equal to 9.25 with the amphoteric solution and 11.5 with water rinsing.
- For one minute of contact, the pH curves are similar with a decrease of the pH. The internal pH is equal to 9.4 with the amphoteric solution and 11.85 with water.



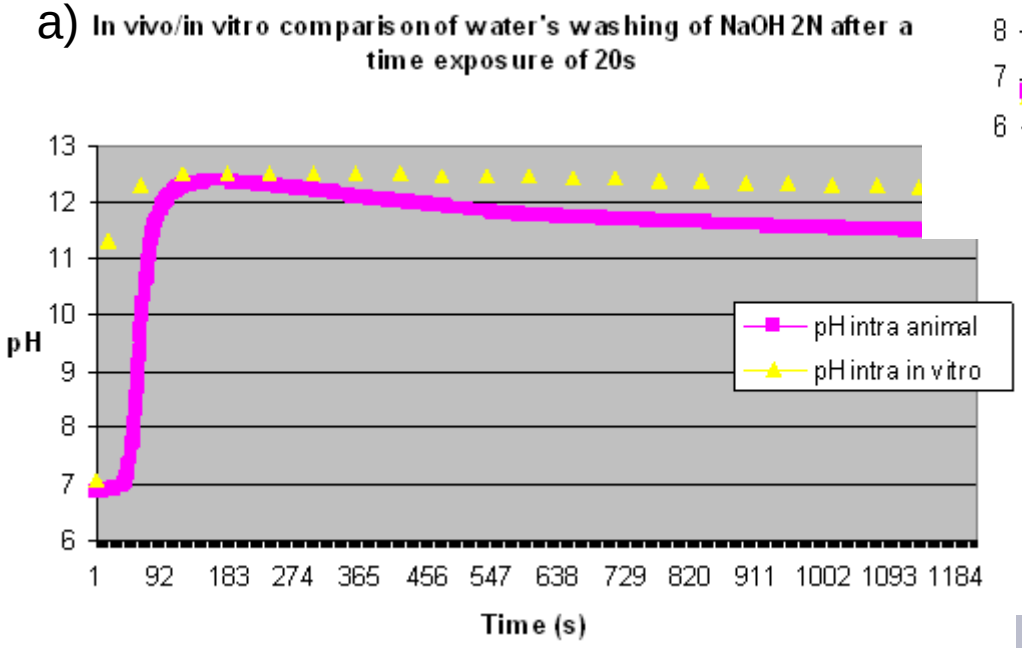
2.3 - Validation of *in vitro* model in comparison with an animal model

- Comparison of the model *in vitro* of the semipermeable membrane of the NaOH 2M washing after a contact time of 20s - a) washing with water - b) washing with Diphotérine®

b)



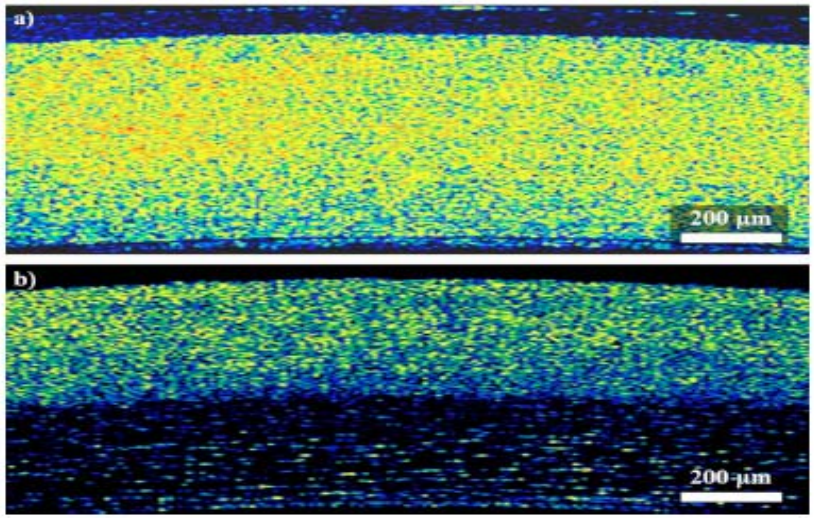
a)



OCT – HR image 16 minutes after washing.
EVEIT model (rabbit cornea)[1]

a) no washing

b) after washing with 1000ml of Previn ® (Diphoterine®) – (15 minutes of washing)



The penetration of the corrosive chemical is stopped. The structural modifications of the stroma are negligible. The endothelium is completely preserved.

- The amphoteric and hypertonic traits of Previn® (Diphoterine®) make it possible to act on the chemical attacker at the same time on the surface as well as on the corrosive chemical which has already penetrated.

On the contrary, passive washing with water, which only acts by dilution, does not prevent the deep alteration of ocular tissue. Moreover, if washing with water makes it possible to remove 80 to 90% of the product on the tissue surface, it was shown [3] that by its hypotonic nature, water creates a flow towards the interior, facilitating the partial diffusion of the corrosive chemical towards the anterior chamber.

Conclusion

- These results are in accord with the clinical observations as well as with the results of validated *ex vivo* models.
- *These* in vivo *results are completely in agreement with those of the* in vitro *experimentation.* The experimental model with the semipermeable, reproducible, similar to the results of the *ex-vivo* model and simple in its implementation, has the advantage of making it possible to evaluate the corrosivity of chemicals and to highlight the effects of an effective decontamination. These phenomena can be tracked and assessed with precision using the experimental model of explanted corneas coupled with OCT and secondly allow the burn to be qualified and quantified with a histological analysis.

[1] : Spöler & al., Dynamic analysis of chemical eye burns using OCT-HR, JBO 2007, 12(4), 041203 – [2]: Mathieu L & al., Comparative evaluation of the active eye and skin chemical splash decontamination solutions diphoterine® and Hexafluorine® with water and other rinsing solution: effects on burn severity and healing, JCHAS 2007, 14(4), 32-39 – [3] : N.F.Schrage, Akuttherapie von Augenverätzungen, KMA 2004 ; 221 : 253-261