SODIUM HYDROXIDE

In vitro model of eye penetration and active decontamination of a corrosive

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Presented at SOT congress, New Orleans, Louisiana, USA, March 2005

Introduction

The aim of this study is to show by in vitro experiments the penetration of a corrosive such as sodium hydroxide (NaOH) and to evaluate the interest of a rinsing of chemical burns with an active solution such as Diphotérine® compared to water rinsing. Diphotérine® is an eye/skin decontamination solution for chemical splashes(1,2,3), produced by the PREVOR Laboratory, France.

Results

1. SIMULATION OF SODIUM HYDROXIDE OCULAR PENETRATION depending on its concentration

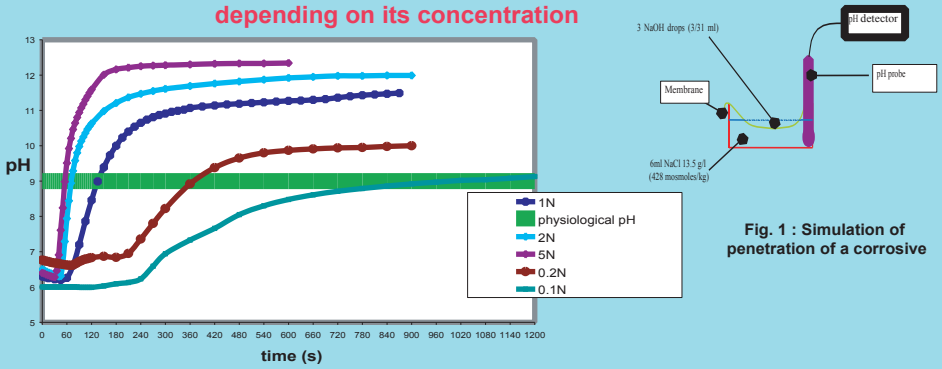

Fig. 1 : Simulation of penetration of a corrosive

Fig 3: Penetration of 2N sodium hydroxide through a plastic membrane as a function of time

2. COMPARAISON OF THE EFFICACY DIPHOTERINE® VERSUS WATER

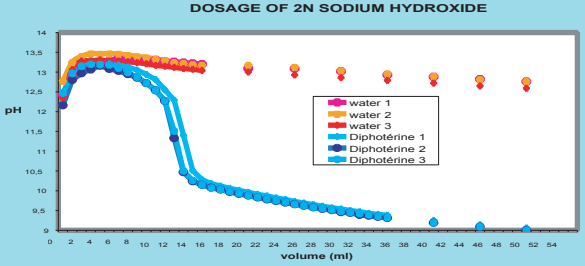

Fig. 4: Evolution of the pH of 1 ml of 2N NaOH with an increasing volume of water or Diphotérine®

References

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Materials and methods

In Vitro studies were performed at PREVOR Laboratory, Valmondois, France: 1) Ocular penetration of NaOH through the tissues was simulated through a semi-permeable membrane **(model in Fig. 1)** depending on the concentration. A volume of NaOH is put at the surface of the membrane and the evolution of the pH is measured in a compartment containing sodium chloride (420 mosmoles/Kg). 2) the efficacy of Diphotérine® versus water on 1 mL of 2N sodium hydroxide was evaluated by simple dosage. **3)** A model of semi-permeable membrane was used to simulate a complete rinsing of 2N NaOH exposure **(Model in Fig. 2)**. Comparison was made between a water rinsing and an active rinsing solution such as Diphoterine®. Two times of exposure were tested, 20 seconds and 1 minute. 1 ml of 2N sodium hydroxide represents about five times the volume of an ocular chemical splash. The saline solution represents an internal physiological compartment of the eye, the semi-permeable membrane (Hutchinson, cellophane paper, 30g/cm^2, 2,5 micrometer thickness) simulates the cornea.

3. SIMULATION OF A COMPLETE RINSING

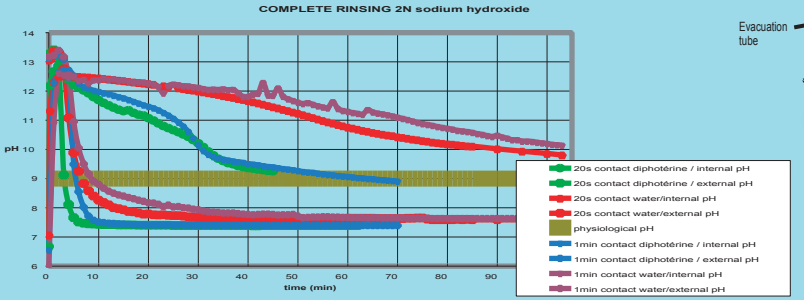

Fig. 5: Simulation of a complete rinsing of an ocular splash due to 2N NaOH

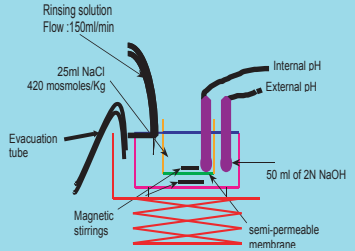

Fig. 2 : Simulation of a complete rinsing

Discussion

The penetration of sodium hydroxide depends on its osmotic pressure. For 0.1N and 0.2N NaOH concentrations (with osmotic pressure of 190 and 367 mosmoles/Kg), the penetration through the semi-permeable membrane was delayed and a final pH value after 900 seconds was respectively about 9 and 10, which means non aggressive. When the NaOH concentration is 1N , the penetration is faster due to a higher osmotic pressure (1741 momosmoles/Kg) than cornea (420 mosmoles/Kg); the final pH value after penetration is 11.5 at 900s. For 2N and 5N concentrations, the penetration is really higher than for 1N concentration and a final pH value is respectively 12 at 900s and 12.3 at about 600s. The effect of the correlation between the osmotic pressure and the concentration of sodium hydroxide has already been showed in an *in vivo* model by Reim(4) with no effect or no burn with a concentration less than 0.2N, what we observed again with our *in vitro* model. The dosage of 1 ml of 2N NaOH by Diphotérine® shows a quick decrease of the pH with a return to a physiological pH within 50 ml added when the pH with water rinsing was about 12.7 for the same added volume and about 900 ml of water were added to 1 ml of 2N NaOH to return to a physiological pH. The complete rinsing showed better efficacy with Diphotérine® rinsing versus water rinsing at all the times of exposure. For a 20 seconds time of contact and after 3 minutes of rinsing, the external pH value was respectively about 9 for Diphotérine® and about 12.8 for water . After 45 minutes, the internal pH value is about 9 with Diphotérine® rinsing and 11.5 with water rinsing. For one minute of contact, the curves are similar with a delayed decrease of pH. Schrage et al(5) have studied on an enucleated pig eye model the penetration and decontamination of 50 microliters of 2N NaOH soaked on a paper filter with a 20s contact. The anterior chamber pH was measuredand arises after a 110 seconds delay. Rinsing with Diphotérine® proved to be more efficient than water and other rinsing solutions in this pig eye model.

Conclusion

This in vitro model has shown and confirmed the effect of concentration and osmotic pressure of sodium hydroxide on the penetration through the eye. The *in vitro* experiments showed the importance of using an active rinsing solution such as Diphotérine® compared to water rinsing against ocular sodium hydroxide splashes. These results confirm the efficacy of Diphotérine® already shown by a first aid use in industries (4,5,6): it allowed a quick return to physiological pH , stopping the penetration of NaOH and neutralising the aggressiveness of corrosive H^+ ions. Further experiments will be done on simulation of rinsing and cell cultures with these *in vitro* models to bring new data on burning knowledge and efficacy of various decontaminations solutions.