

Dynamic Analysis of Hydrofluoric Acid penetration and decontamination on The Eye using high resolution Optical Coherence Tomography

S. Rihawi ¹, M. Frenzt ^{2,3}, F. Spöler ⁴, M. Först ⁴, H. Kurz ⁴, N. F. Schrage ^{1,3}

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¹ Dept. of Ophthalmology, Cologne Merheim ² Aachen Center of Technology Transfer in Ophthalmology, ³ Dept. of Ophthalmology, RWTH University; ⁴ Institute of Semiconductor Electronics, RWTH Aachen University, Germany.

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Purpose

For chemical burns a considerable lack of methods exists for defining penetration kinetics and effects of decontamination within biological structures. We demonstrate that high-resolution optical coherence tomography (HR-OCT) can close this gap. This medical imaging technique was employed to evaluate the penetration dynamics and decontamination of hydrofluoric acid (HF) within the *ex vivo* eye irritation test (EVEIT).

Methods

Rabbit corneas *ex vivo* were exposed to 25µl of 2.5% HF solution for 20 sec. Post-burn the corneas were rinsed in triplicate with each 15 minutes of water, Hexafluorine® and 1% calcium gluconate solution, 3 were left untreated. The changes of the microstructure induced by the corrosive resulting in corneal opacity and the propagation within the corneal layers during and after decontamination by rinsing were monitored by OCT imaging.

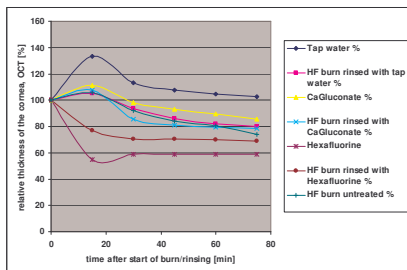


Fig. 1 Corneal thickness after different treatments with rinsing solutions without corneal burn and with rinsing solutions after HF burn. Each rinsing was performed for 15 minutes; HF burn was done with 2.5% HF with 25 µl in Machery-Nagel filter paper of 10 mm diameter.

Results

Application and penetration of HF resulted in a shrinking of the corneal thickness to be interpreted as result of osmolaric changes and of loss of water binding capacity. A substantial increase in OCT signal amplitudes was observed, showing full penetration in the untreated corneas within 240 seconds.

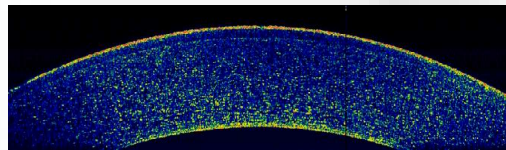


Fig. 2 Untreated rabbit cornea *ex vivo*

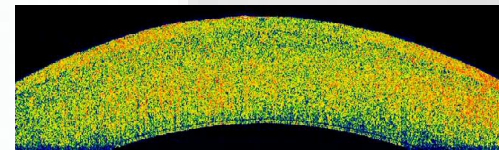


Fig. 3 Rabbit cornea 15 min after burn with 2.5% HF. No change in appearance of the untreated burned eye until the end of the experiment (75 min after application).

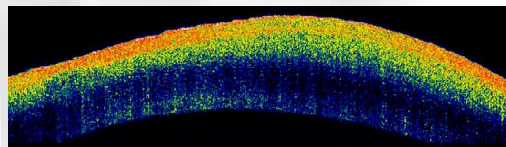


Fig. 4 Rabbit cornea 15 min after burn with 2.5% HF rinsed with tap water

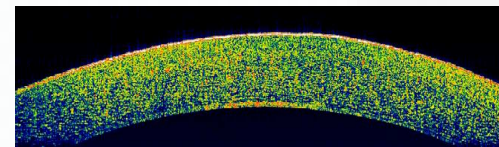


Fig. 5 Rabbit cornea 75 min after burn with 2.5% HF rinsed with tap water

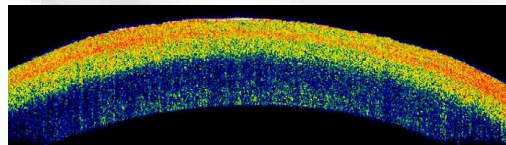


Fig. 6 Rabbit cornea 15 min after burn with 2.5% HF rinsed with calcium gluconate 1%

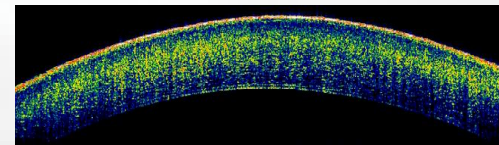


Fig. 7 Rabbit cornea 75 min after burn with 2.5% HF rinsed with calcium gluconate 1%

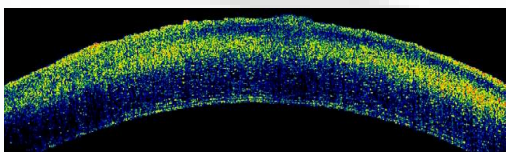


Fig. 8 Rabbit cornea 15 min after burn with 2.5% HF rinsed with Hexafluorine

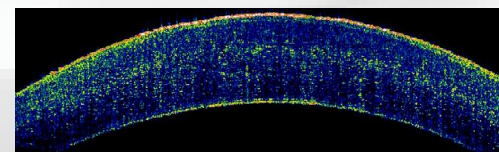


Fig. 9 Rabbit cornea 75 min after burn with 2.5% HF rinsed with Hexafluorine

Rinsing the burned cornea with tap water and calcium gluconate (1%), the deep corneal stroma was found to remain clear until the end of the rinsing period but became opaque later. When using Hexafluorine® the cornea still remained clear for 60 min after rinsing was stopped.

Conclusions

The use of OCT as an additional diagnostic tool within the EVEIT system is capable to essentially enhance the information available by this test method. The direct access to the diffusion process of HF into the cornea provided new and valuable informations on its penetration kinetic. It allows the quantification of the efficiency of new emergency substances like Hexafluorine® in comparison to established rinsing solutions like calcium gluconate and water with a reduced number of tests.

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Publications:
 Schrage N.F., Kompa S., Ballmann B., Reim M., Langefeld S. Relationship of eye burns with calcifications of the cornea Graefes Arch Clin Exp Ophthalmol. 2005 Mar 9
 Schrage N., Wuestemeyer H., Langefeld S. Do different osmolar solutions change the epithelial surface of the healthy rabbit cornea? Graefes Arch Clin Exp Ophthalmol. 2004 Aug;242(8):668-73.
 Schrage N.F., Rihawi R., Frenzt M., Reim M., Akuththerapie von Augenverätzungen. Klin Monatsbl Augenheilkd. 2004 Apr;221(4):253-61. Review.
 Langefeld S., Press UP, Frenzt M., Kompa S., Schrage N. Use of lavage fluid containing diphoterine for irrigation of eyes in first aid emergency treatment, Ophthalmologie. 2003 Sep;100(9):727-31.



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