Detection of intraocular pressure changes during acute chemical injury in the EVEIT system

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Severe eye burns damage the cornea very obviously by causing immediate clouding. Secondary damage by acutely increased intraocular pressure is mostly not detected, but can result in a damaged optic nerve head which then causes visual impairment after optical rehabilitation of the initially damaged cornea. Intraocular pressure spikes have been detected in living animals during acute corneal corrosive injury [1]. Creating a reproducible live-animal-free model poses a first major step in studying and ultimately countering pressure build-up in the intraocular space. For this we employed the Ex Vivo Eye Irritation Test (EVEIT) organ culture model as a platform [2].

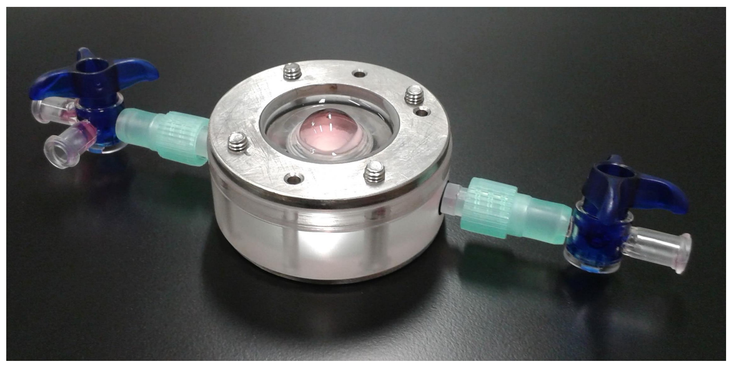

Figure 1: EVEIT chamber: The ex vivo cornea (middle, transparent, slightly pink) is installed into the chamber. The cornea is supplied with nutrients via source and drain openings (sides, blue valves) which have access to the endothelial side.

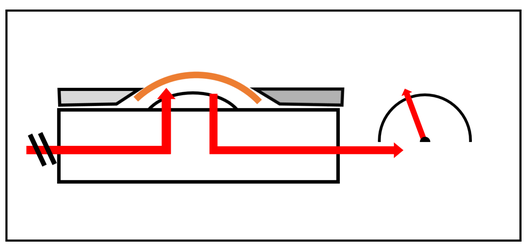

Figure 4: Function schematic: the artificial anterior chamber below the cornea (orange) is connected to a electronic manometer instrument (right).

The EVEIT ocular pressure model

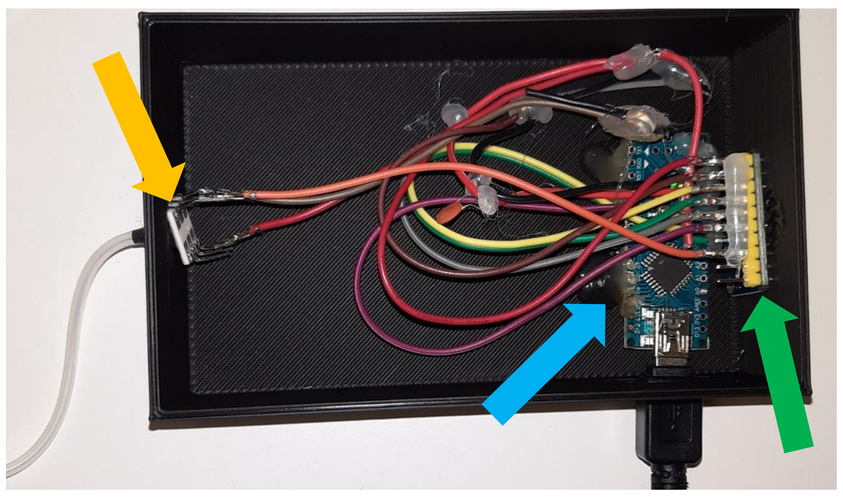

Figure 2: Pressure-Measurement setup: A microcontroller (blue arrow) receives the live-pressure data from a piezo resistive pressure sensor (yellow arrow) via a specialized module (green arrow). The data is then transmitted to a computer where the pressure trace of the experiment is recorded for statistical evaluation.

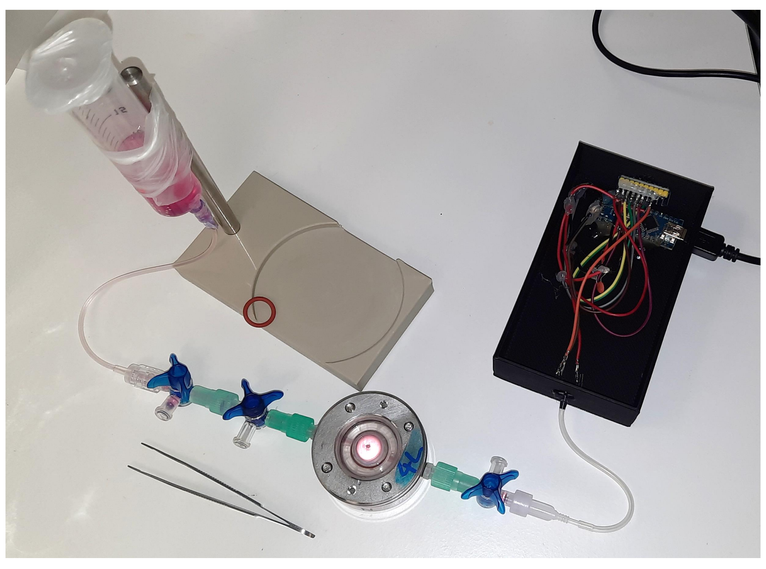

Figure 3: Measurement setup: The EVEIT chamber is connected to a medium reservoir, which exerts pressure in the artificial anterior chamber of the cultures cornea via hydrostatic pressure. During the measurement just the valve toward the measurement device (right) is opened.

Measurement of intracameral anterior pressure during NaOH exposure

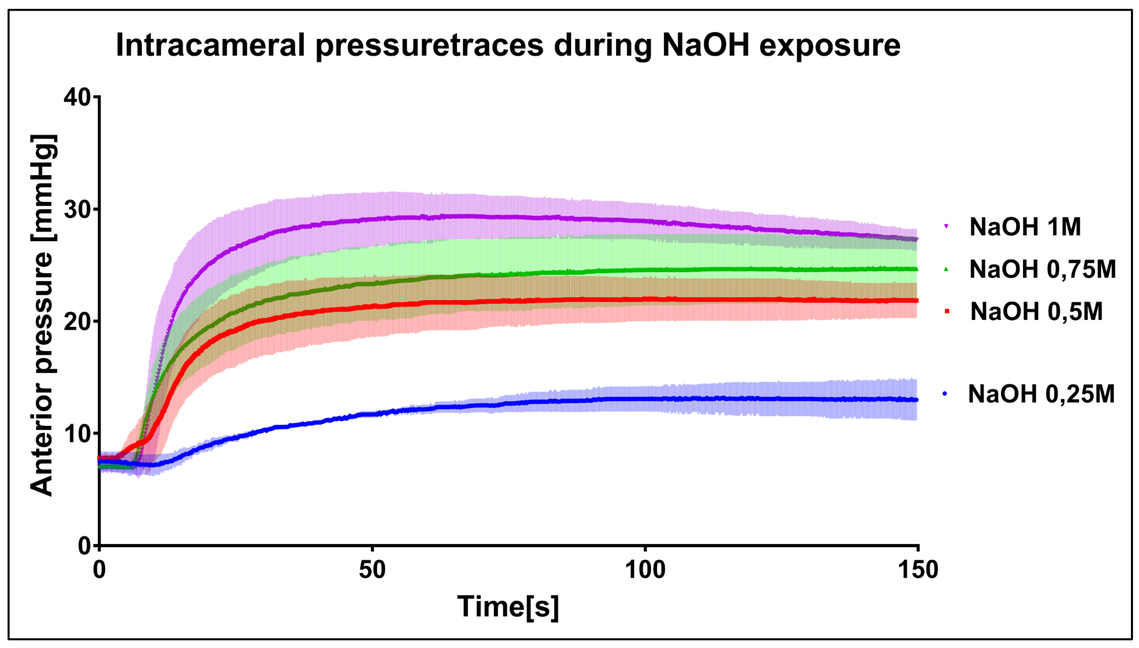

Figure 5: Means of pressure traces of corneas which were apically exposed to rising concentrations of NaOH (0,25 M; 0,5 M; 0,75 M; 1 M) respectively; n=3; approx. 1000 data points per graph were measured in each experiment.; the error bars (standard deviation) are depicted as transparent fields on both sides of the respective graph.

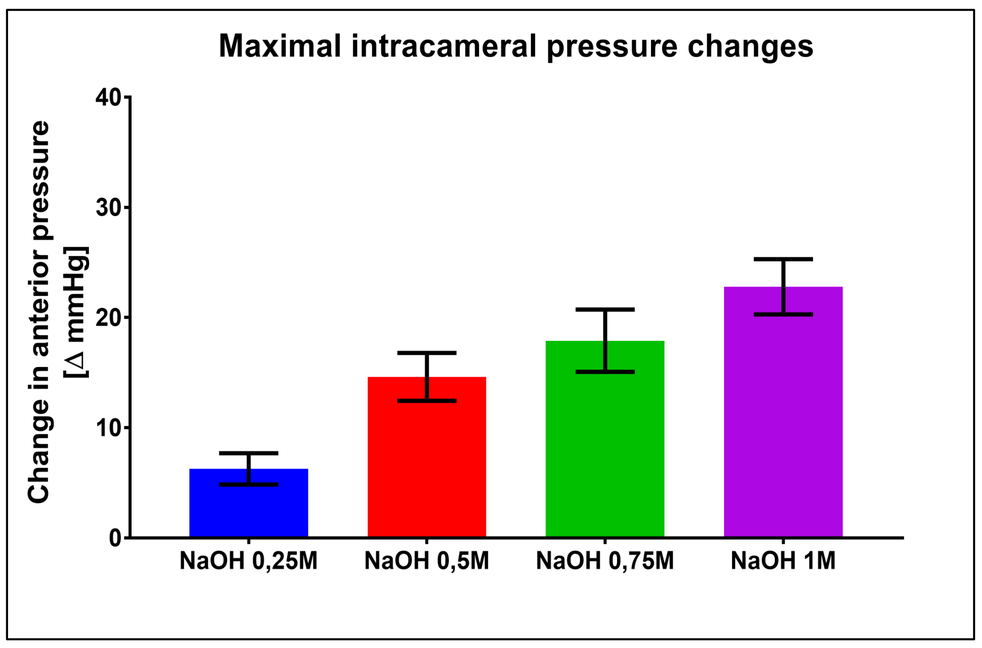

Figure 6: Means of intra-cameral pressure spike values of the respective NaOH exposures; n=3, error bars are standard deviation.

Notably different pressure traces were recorded during the exposure with rising concentrations of NaOH. All pressure traces progressed in a similar manner: After a short initial stagnant phase, the pressure increased steeply in the first 30 seconds to their respective maxima and then plateaued or decreased slightly over time (Figure 5). Exposure with higher concentrated NaOH yielded higher pressure spikes (Figure 6).

With this model, we are now able to precisely observe anterior intracameral pressure conditions in a highly resolved manner. Acute pressure changes during chemical corrosive injury can now be quantified in a standardized way and possible interventive measures explored. The EVEIT ocular pressure model – as a live animal free model – will also contribute to the ever expanding field of the 3R method principle.

Disclosure:

ACTO e. V. has no financial interests

References:

[1] Green K, Paterson CA, Siddiqui A. Ocular blood flow after experimental alkali burns and prostaglandin administration. Arch Ophthalmol. 1985 Apr;103(4):569-71. doi: 10.1001/archopht.1985.01050040111032. PMID: 3985842.

[2] Spöler, F., O. Kray, S. Kray, C. Panfil, and N. F. Schrage. 2015. 'The Ex Vivo Eye Irritation Test as an alternative test method for serious eye damage/eye irritation', Altern Lab Anim, 43: 163-79.