404f Ophthalmic Drug Delivery of Timolol by Soaked Contact Lenses

Chi-Chung Li and Anuj Chauhan

Approximately 90% of all ophthalmic drug formulations are now applied as eye-drops. While eye-drops are convenient and well accepted by patients, about 95% of the drug contained in the drops is lost due to absorption through the conjunctiva or through the tear drainage. Ophthalmic drugs can be delivered more efficiently by placing on eye a contact lens that was soaked in the drug solution. Ophthalmic drug delivery via contact lenses is more effective because it increases the residence time of the drug in the eye and thus leads to a larger fractional intake of drug by the cornea.

In this talk we model the drug delivery of timolol, a common drug for treatment of glaucoma, by a contact lens that is soaked in the drug solution. This talk includes experimental studies and modeling of the transport of timolol in pHEMA gels, which are a common contact lens material and also a model for release of the timolol from contact lenses in the eye.

The transport behavior of timolol in pHEMA gels was studied by synthesizing gels by thermal polymerization, and then soaking the gels in aqueous solutions of timolol of various concentrations. The dynamic concentration of timolol in the fluid was monitored by UV Vis spectroscopy. The results show that the drug timolol interacts with the gel matrix and adsorbs on the polymer, and the equilibrium adsorption behavior can be described by the Langmuir isotherm. The adsorption of the drug is then incorporated into a mass balance for the transport of the drug in the gel to obtain a modified diffusion equation that includes adsorption-desorption of the drug in the gel matrix. The parameters for the model include the diffusivity, maximum surface coverage and the ratio of adsorption to the desorption constants. These parameters are determined by fitting the experimental data for drug loading in the HEMA gel to the modified diffusion equation.

The adsorption model described above is utilized in the model for release of timolol from a soaked contact lens into the eyes. The drug diffuses out from the contact lens into the pre and the post lens tear films, which are the thin tear films between air and the lens and the lens and the cornea, respectively. A part of the drug that diffuses into the post lens tear film enters the cornea and a fraction is lost from the sides to the tear lake.

Results show that drug delivery from a contact lens is more effective than drug delivery by drops and that delivery of timolol is about 40 times more efficient than topical delivery by drops. However soaked contact lenses can only deliver drugs for a few hours and thus cannot be used for extended ophthalmic drug delivery.