

Abstract: Novel Microfluidic Device for the Modeling of Controlled and Sustained Release of Therapeutics to Treat Posterior Capsule Opacification

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Posterior capsule opacification (PCO) is a vision impairing disorder that arises in approximately 20% of adults and nearly all within the first three years following cataract surgery. Currently, Nd:YAG laser therapy is utilized to treat PCO; however, such therapy is not available worldwide and complications may arise in response to treatment, including retinal detachment, damage to the intraocular lens, and glaucoma. Prevention of PCO remains an unmet need in ophthalmology. Therefore, there is a considerable unmet need for more efficacious and cost effective treatments for PCO. Our work focuses on the design of a novel microfluidic device to study the release kinetics of ocular therapeutics from self-assembled nanocarriers under proper anatomical and physiological flow rate conditions of the lens capsule for treatment of PCO.

The microfluidic devices are designed using SolidWorks Software and are 3D printed. The devices are fabricated from biologically inert biomaterials, including polydimethylsiloxane (PDMS), that support lens epithelial cell attachment and viability in vitro. Physically crosslinked nanocarriers consisting of, Poly(lactic-co-glycolic acid)-b-Poly(ethylene glycol) (PLGA-PEG-PLGA), are used to deliver anionic drug conjugates. These nanocarriers self-assemble in aqueous environments via reverse thermal gelation. The polymer has a lactic acid (LA) to glycolic acid (GA) ratio of 15, polymer concentration of 14% (w/v%), and poly-L-lysine (PLL) to control the release rate of both hyaluronic acid and 3DNA multivalent nano-carriers under physiological conditions.

Our unique microfluidic technology offers a more effective and efficient method to analyze the release kinetics of ocular therapeutics, for in this case, diseases affecting the lens capsule. Moreover changes in the physical and morphological states of the nanocarriers are rapid and controllable, making them attractive for drug delivery.