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A Novel GelMA-based Bioadhesive for Repair of Corneal Stromal Defects

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Abstract

Purpose : Unlike epithelial defects, corneal stromal defects heal very slowly and can cause permanent vision loss due to fibrosis and scarring. Currently, there is no treatment to replenish the corneal stroma. Gelatin methacryloyl (GelMA) hydrogels, which resemble the extracellular matrix, are biocompatible and widely used in tissue engineering. Here, we engineered a transparent and visible light-crosslinkable GelMA-based bioadhesive and evaluated its physical properties, biocompatibility, as well as retention on the cornea.

Methods : We engineered visible light-crosslinkable GelMA-based bioadhesive, in which the concentrations of GelMA and degree of methacryloyl functionalization are tunable. Physical and adhesive properties of the bioadhesive were characterized *in vitro*. Cell viability and metabolic activity of human keratocytes encapsulated in GelMA were also determined using Live/Dead and PrestoBlue assays, respectively. Defects with 50% depth were created in the central cornea of isolated New Zealand rabbit eyes, and GelMA adhesive was used to fill and seal the defects. Retention of the bioadhesive was then evaluated using Anterior Segment Optical Coherence Tomography over a 4-week period.

Results : Compared to commercially available adhesives Evicel® and CoSEAL®, GelMA-based adhesive had higher adhesion strength (3.5-fold and 4.6-fold, $p<0.001$ and $p<0.01$, respectively), higher shear strength (1.7-fold and 5.1-fold, $p<0.01$ and $p<0.0001$, respectively), and higher burst pressure resistance (41.0-fold and 37.7-fold, $p<0.0001$ and $p<0.0001$, respectively). We observed more than 90% keratocyte viability and a 10-fold

increase in cell metabolic activity after 7 days of cell culture. Our *ex vivo* data showed that the GelMA-based bioadhesive remained intact and stayed completely attached to the cornea over the 4-week follow up.

Conclusions : This GelMA-based bioadhesive is tunable for optimal physical and adhesive properties. It is nontoxic to keratocytes, has high retention on the cornea, and offers a novel alternative for treatment of stromal defects.

This is an abstract that was submitted for the 2018 ARVO Annual Meeting, held in Honolulu, Hawaii, April 29 - May 3, 2018.