Characterization of Corneal Healing Dynamics in a Rabbit Mechanical Epithelial Removal Model

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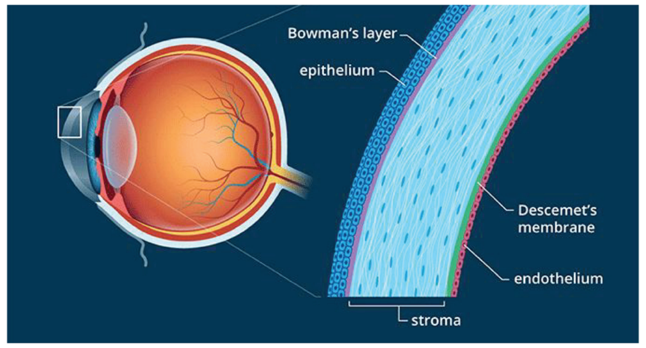
INTRODUCTION

The human cornea is the transparent, 5-layered structure in front of the eye that refracts light and helps to focus vision is highly innervated with thousands of nerve endings, and as the outermost protective barrier of our eye, can be prone to dryness, allergies, and injury. Disorders involving the corneal epithelium can cause persistent pain and discomfort, foreign body sensation, epiphora, and even lead to chronic disorders which if left untreated may require more invasive therapies. This model, by inducing a superficial mechanical wound to the epithelial (outermost layer) of the cornea, allows us to visualize and measure in real time, using fluorescein staining and imaging, the regeneration and healing of this very sensitive structure.

This poster describes the development of a rabbit corneal wound model and the longitudinal characterization of corneal wound healing dynamics following full-surface mechanical epithelial removal using multimodal assessments, including structural imaging, ocular surface staining and intraocular pressure (IOP) measurements.

Figure 1: Cross-section of the eye showing details of the cornea



METHODS

Using a “modified scalpel” (15 blade), unilateral mechanical epithelial removal was performed in female New Zealand White Rabbits (n = 4), aged 3-6 months, with the contralateral eye serving as an untreated control. Assessments were conducted at baseline (Day 0) and Days 1, 2, 5, and 7 post-injury. Corneal fluorescein staining was performed to evaluate epithelial defect area and healing progression. Images at each time point were obtained using a slit-lamp mounted iPhone. Intraocular pressure (IOP) was measured using rebound tonometry (i-Care TONOVET). Anterior segment optical coherence tomography (AS-OCT) was used to visualize central corneal thickness (CCT) and wound depth (Heidelberg Spectralis). Tear secretion using capillary action was measured at each timepoint for multiplex cytokine analysis. All animal procedures adhered to Institutional Animal Care and Use Committee (IACUC) guidelines and the Use of Animals in Ophthalmic and Visual Research standards.

RESULTS

Mechanical epithelial removal generated robust, reproducible epithelial wounds that underwent progressive re-epithelialization. Fluorescein staining revealed substantial healing by Day 4 and complete closure by approximately Day 7. Preliminary AS-OCT imaging analyses showed a transient reduction in CCT following injury, with a trend toward normalization by Day 7. The depth of the wound generated was consistent across multiple eyes. Following injury, animals received topical antibiotic ointment or drops at least 2-3 times per day through Day 4. Assessments were performed in tandem with corneal imaging on Day 0 (post injury), and on Days 1, 2, 5, and 7, with topical fluorescein staining (Figure 2), anterior chamber inflammation assessment, and intraocular pressure measurements using the iCare TONOVET on the Lapine setting.

While all animals exhibited moderate to heavy staining following debridement, only one animal (1103) showed any signs of anterior inflammation (cells). This animal, in addition to increased topical antibiotics, received Tropicamide 1% twice daily for four days to prevent development of synechiae, and Prednisolone 1% three times daily for four days. Treatments for all animals were discontinued on Day 4, and inflammation had resolved in animal no. 1103. The intraocular pressure did not show any reliable patterns which can be due to several factors including time of day, level of sedation, and level of stress (Figure 3). Additionally, tear collection was attempted for cytokine analysis. Collections were not reliable at each scheduled time point, and subsequent cytokine analysis did not yield any useful data.

Figure 2: Anterior Segment OCT imaging and fluorescein stain imaging of 4 experimental animals (#1101-1104) on day 2 and day 7 post injury

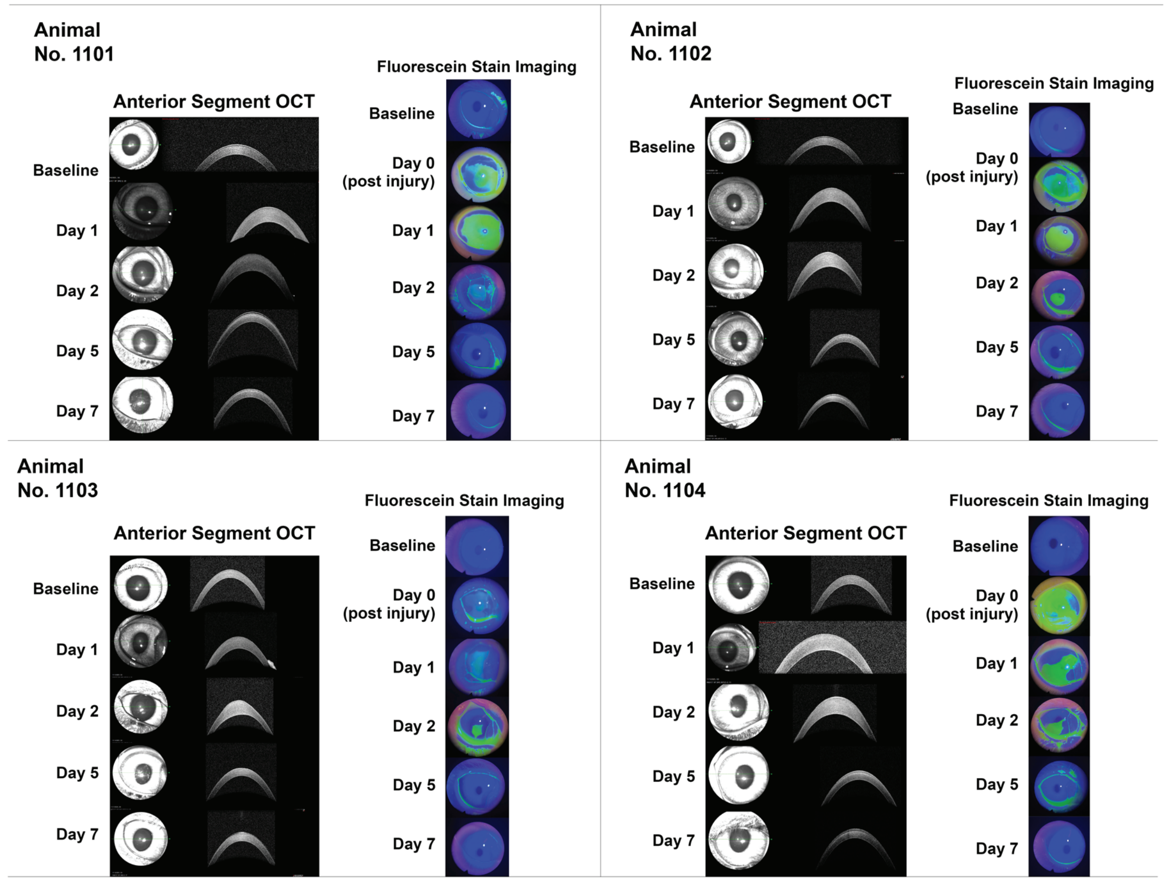


Figure 3: Intra-ocular Pressure (IOP) measurements of 4 experimental animals (#1101-1104)

IOP Values (mmHg)

Time Point (Day)	1101		1102		1103		1104	
	OD	OS	OD	OS	OD	OS	OD	OS
Pre	28	23	28	16	28	19	28	21
	27	24	19	15	20	19	22	22
	26	21	19	15	21	21	20	23
Mean	**27.00**	**22.67**	**18.67**	**15.33**	**20.33**	**19.67**	**21.67**	**22.00**
1	19	20	16	22	31	25	14	22
	19	20	17	22	33	23	15	21
	18	19	17	24	34	22	15	23
Mean	**18.67**	**19.67**	**16.67**	**22.67**	**32.67**	**23.33**	**14.67**	**22.00**
2	20	28	17	19	15	15	15	14
	19	26	17	19	16	14	15	16
	19	26	18	17	16	15	14	17
Mean	**19.33**	**26.67**	**17.33**	**18.33**	**15.67**	**14.67**	**14.67**	**15.67**
5	19	21	19	24	14	17	17	20
	17	19	17	26	14	17	18	19
	17	19	17	25	14	16	18	21
Mean	**17.67**	**19.67**	**17.67**	**25.00**	**14.00**	**16.67**	**17.67**	**20.00**
7	21	22	20	21	16	18	18	19
	20	20	21	22	15	17	17	18
	18	21	20	23	16	17	16	20
Mean	**19.67**	**21.00**	**20.33**	**22.00**	**15.67**	**17.33**	**17.00**	**19.00**

CONCLUSIONS

Full-surface mechanical epithelial removal in a rabbit model produced consistent and reproducible corneal wounds, enabling systematic longitudinal characterization of healing dynamics. Comprehensive assessments including structural imaging, and ocular surface staining, collectively demonstrated rapid re-epithelialization, transient corneal thickness changes, and restoration of surface integrity by 1 week post-injury. The model reliably captured uniform wound depth and progressive normalization of corneal architecture.

While the cornea heals relatively quickly, due to its very densely innervated nature, the time it takes to heal can be a painful process often requiring frequent lubrication, topical medications, and bandage contact lenses. Furthermore, chronic disorders such as Dry Eye Disease (DED) and Recurrent Corneal Erosion (RCE) often need continued therapies to keep the epithelial layer healthy. The success of this model provides an avenue to test the efficacy of novel therapies and devices that may aid in treatment and faster healing for chronic disorders such as DED and RCE, and acute injuries such as corneal abrasions and foreign bodies.

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